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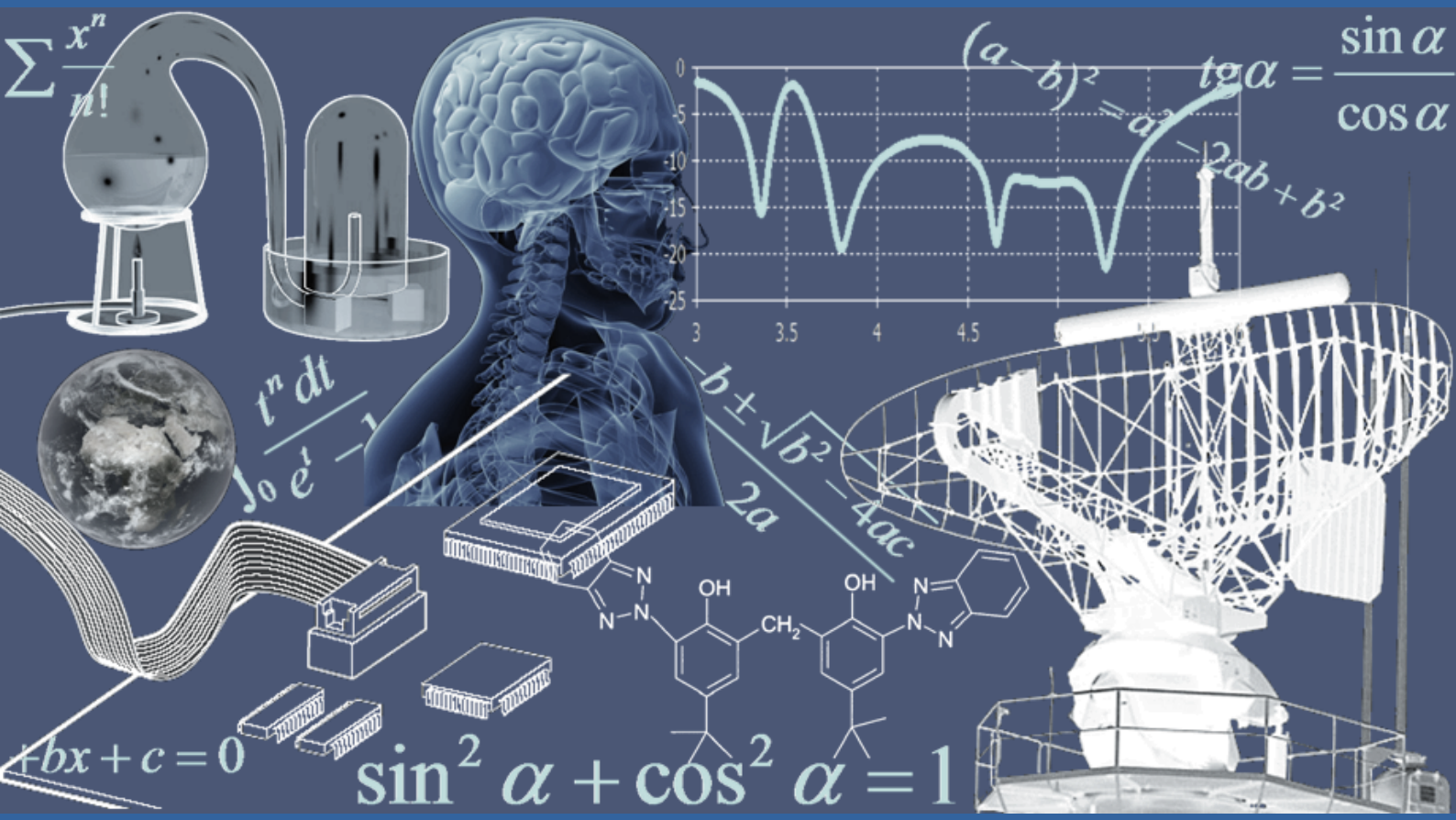

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Waterflooding identification of continental clastic reservoirs based on neural network

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ABSTRACT: This article describes an approach based on artificial neural network to identify waterflooded zone of continental clastic reservoirs. For the logging sequence of waterflooded zone matching the characteristics of the continental oilfield, the application of artificial neural network algorithm is able to distinguish water layers, oil reservoirs and dry layers among reservoirs of waterflooded zones. The output vectors of the network represent the fluid types. Thus, better results are supposed to be obtained than traditional methods in the crossplot plate after network training. Distribution becoming non-uniform and contact between grains being loose were found after microscopic observation in the waterflooded zones. It has revealed that the waterflooded characteristics are of great significance, and it has also proved the accuracy of identification from another perspective.

KEYWORDS: Waterflooding, continental reservoirs, neural network, identification, fluid.

1 INTRODUCTION

Most oilfields in China belong to continental deposition. Because of strong reservoir heterogeneity and lacking of natural energy, water injection exploitation has been widely used. China is also one of the countries with the highest proportion of waterflooding oilfields in the world [1]. High complexity of waterflooded reservoirs and uncertainty of remaining oil distribution have made oilfield development become more and more difficult. In the current situation, the understanding of waterflooded condition has become a very important and urgent issue in oilfield development. It also has a positive significance on tapping the potential synergies work at high water cut stage. However, traditional methods on waterflooding identification have limited applications due to the identification accuracy rate of less than 50 percent [2].

By considering the identification accuracy, neural network integrated multi-logging information was brought in to achieve better results in quantitative identification. In the past 20 years, neural network technology has been used in petroleum exploration and development, including reservoir rock properties [3], lithology [4,5], porosity and permeability [6,7,8], and flow units [9] estimation.

This article aims at describing waterflooding identification of continental clastic reservoirs in China based on the back-propagation neural network. As a new information processing technology, the neural network approach has a broad application prospect. Moreover, this method has several advantages over traditional methods in identification accuracy rate.

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2 METHODS

2.1 THE CHOICE OF INPUT AND OUTPUT VECTORS

Logging curves corresponding to the testing data that determine the oil and water layer is the input vector of the network training. Several well logs are selected from the existing well log data for the network input and these log curves basically reflect the lithological and electrical characteristics of the waterflooded reservoirs. Before neural network training, log curves must be normalized to make their values between 0 and 1.

Types of reservoir fluid are the neural network training target vectors. Digital processing is done on the target vectors corresponding to the types of fluid, in order to facilitate the project on the two-dimension corresponding system. The output code of oil reservoir is set as (0.25, 0.25), dry layer as (0.25, 0.75), waterflooded zone as (0.75, 0.25) and water layer as (0.75, 0.75).

2.2 THE CHOICE OF NETWORK STRUCTURE PARAMETERS

The back-propagation neural network is a network of multi-level structure with the input layer corresponding to the well logs and the output layer corresponding to the fluid type.

However, the middle layer has no uniform standard selection. When each node uses the S-shaped activation function, a middle layer can be achieved for the classification of any judgment.

2.3 NETWORK TRAINING

Using of BP neural network algorithm, appropriate weights and threshold values are selected to build the network model and used for model training and error testing.

The neural network training is carried out against the known input vectors and target vectors. The various parameters of the network are identified after the success of online learning.

Thus, a crossplot plate for identifying oil reservoir, dry layer, waterflooded zone and water layer is created.

The key to identify fluid type based on BP neural network algorithm is to choose high-quality well logs, oil test data and network structure parameters. Based on BP neural network, a simulation crossplot plate applying to continental clastic reservoir development is designed in this study that can be used to identify oil reservoirs, water layers, dry layers and waterflooded zones in continental oilfields (Fig.1).

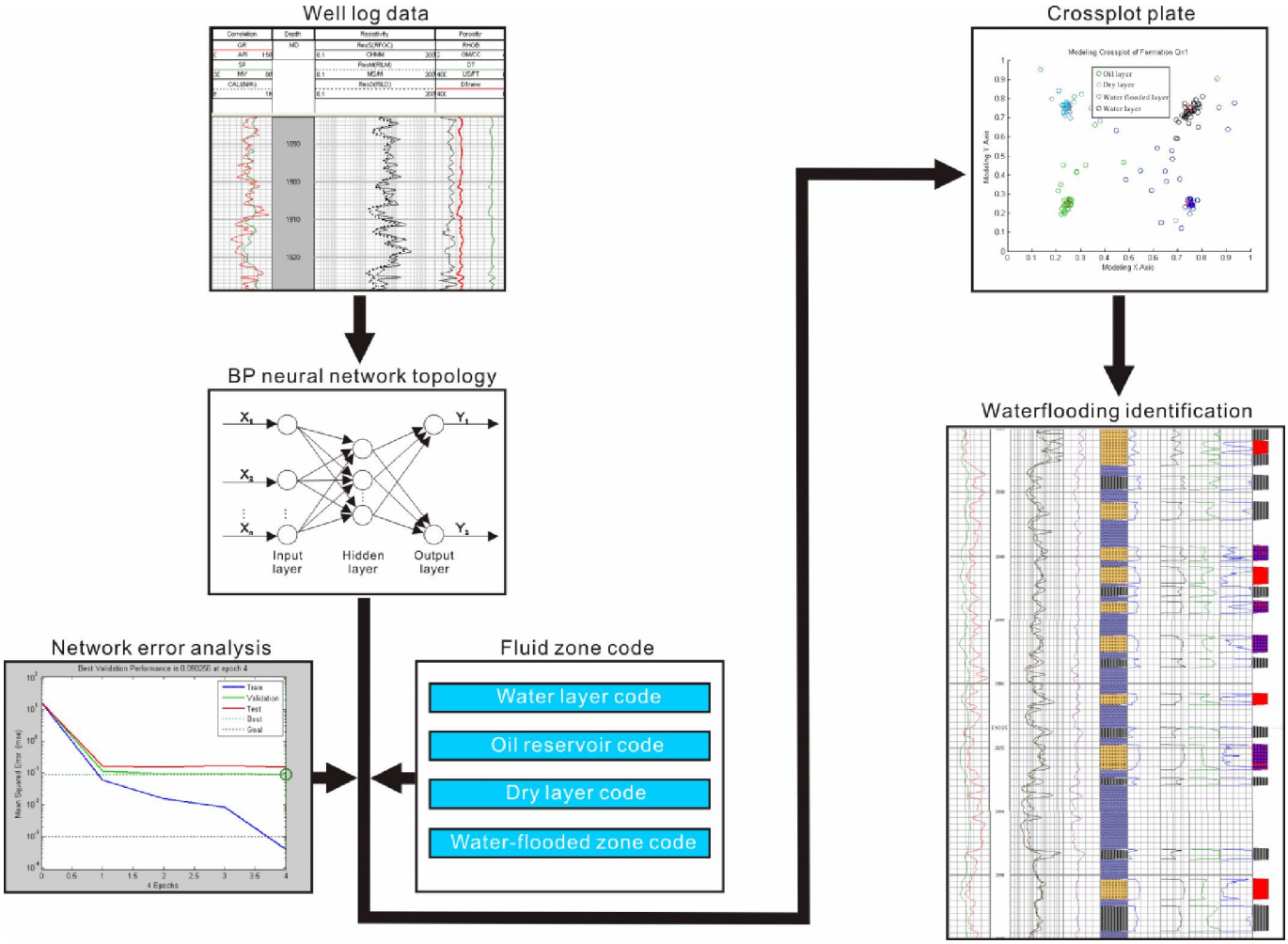

Fig. 1. Simplified workflow showing the key components of the approach of the waterflooding identification with an artificial intelligence tool (neural network)

3 RESULTS

Due to different sedimentary characteristics of each continental oilfield, there are various waterflooding characteristics. Gaoji Oilfield in Subei Basin of east China is taken as an example to describe this methodology.

Five well logs (GR, DT, RFOC, RILD, and RILM) are selected as the input to the network in the water flooding study of Gaoji Oilfield. The input and output vectors are initialized for 5-dimensional and two-dimensional respectively to build the BP neural network model, applying the unique non-linear mapping features of the neural network. After adding fluid zone code and doing network error analysis, the training is ended by superimposing the network output values and the oil production conclusions. Of course, the process of network error analysis should be continued until it meets the waterflooded identification accuracy.

Thus, a crossplot plate is acquired that can predict waterflooded reservoirs in the Funing Formation of Gaoji Oilfield. As a result, we obtain the distribution of the recognition results on the crossplot plate, achieving the entire prediction process.

Through the projection points of identification vectors on the network output, Euclidean distance is used to determine the distance between the centers of these distribution points with the fluid types. The shortest distance from the center of the depth of segment reservoir fluid type represents the fluid type. The log curve values of sandstone sections that can identify fluid type are input, and the waterflooded zones of each well are found.

Using the method discussed previously, 11% of the data is selected to enter into the crossplot plate which is trained by another 89% of the data. Prediction accuracy rate of the network is up to 85% by comparing the oil production test conclusions and neural network recognition results. It proves that neural network acts as a good and useful tool from well

logs to predict waterflooded reservoirs. It should be noted that we should avoid the proportion of samples of the same characteristics being too large, resulting in the so-called over-learning.

4 DISCUSSION

A neural network crossplot plate for waterflooded reservoirs identification is set up, and the identification accuracy rate is ideal [10]. The neural network demonstrates the superiority of its information processing and achieves automatic processing and interpretation of logging data. It has the guidance of the general method for the identification of a variety of fluid types. And it has been already widely used in multiple fault-blocks in Gaoji Oilfield, Pucheng Oilfield, Weicheng Oilfield, Wenmingzhai Oilfield et al.

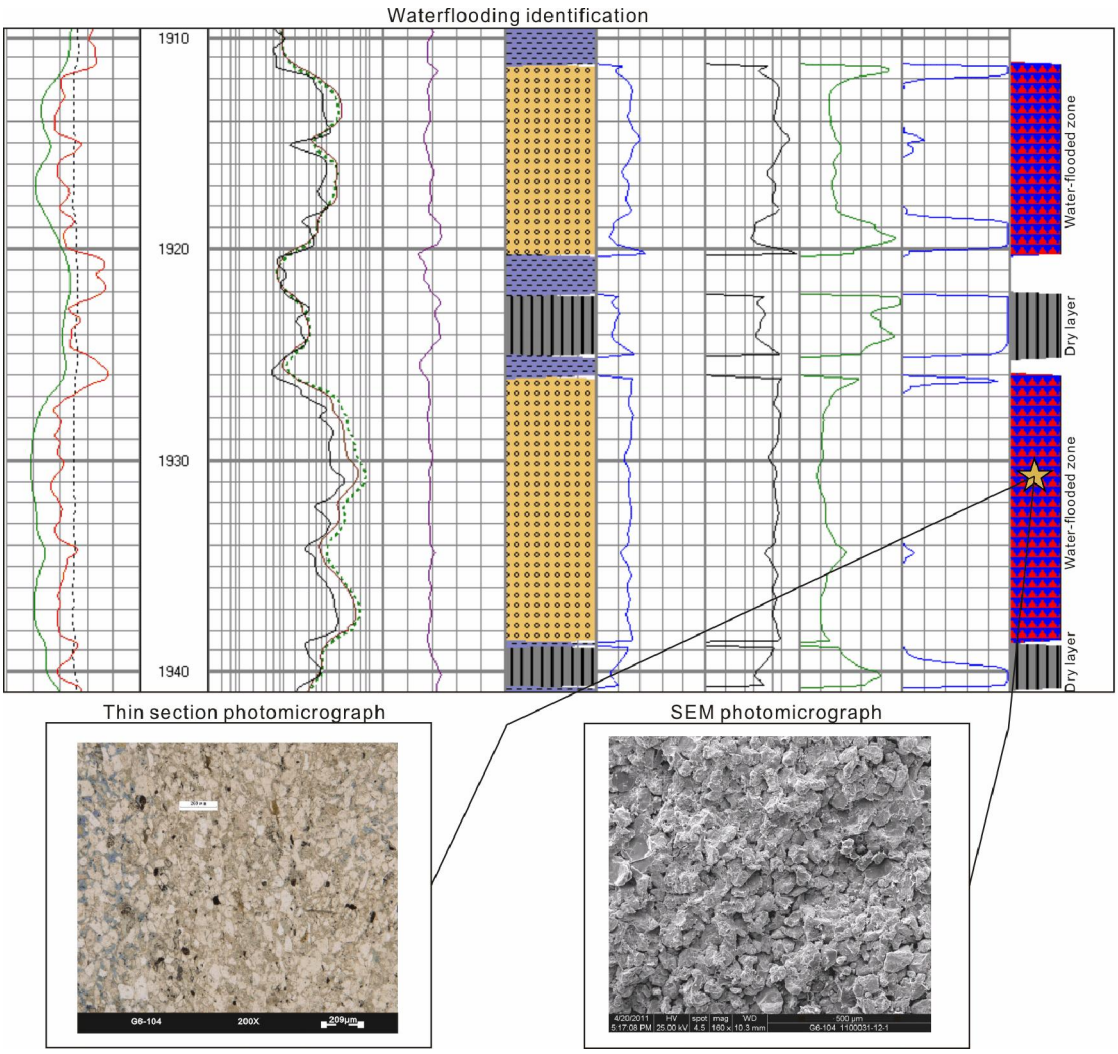

Fig. 2. Waterflooding identification of the well G6-104 of Gao 6 fault-block in gaoji oilfield and photomicrographs of the waterflooded zones

Traditional methods of analyzing water flooded characteristics tend to focus on reservoir characteristics of one or a limited number of areas, which often leads to some exceptions phenomena or disturbances. Besides, it rarely involves microscopic comparative analysis, which is not conductive to explore regular pattern of reservoirs before and after water flooding. Thin section and SEM photomicrographs indicate that contact between grains of the waterflooded zone is looser, with secondary intergranular pores relatively developed. At the same time, local pore distribution is uneven. Waterflooding development causes major changes in the microscopic pore structure, which determines fluid flow and hydrocarbon migration and accumulation of the micro-pores. Microscopic phenomena of the photomicrographs show strong

waterflooded characteristics (Fig. 2). Meanwhile, we should clarify changes of the common cement constituents in the study area, whether they are carbonate cements or clay minerals.

A comprehensive analysis of parameter variations, such as physical properties, pore structure, formation water salinity, oil saturation, and reservoir oil viscosity are used to conduct based on the waterflooded identification. Thus, a system parameter comparison method is formed from a multi-angle between macro and micro (Fig. 3).

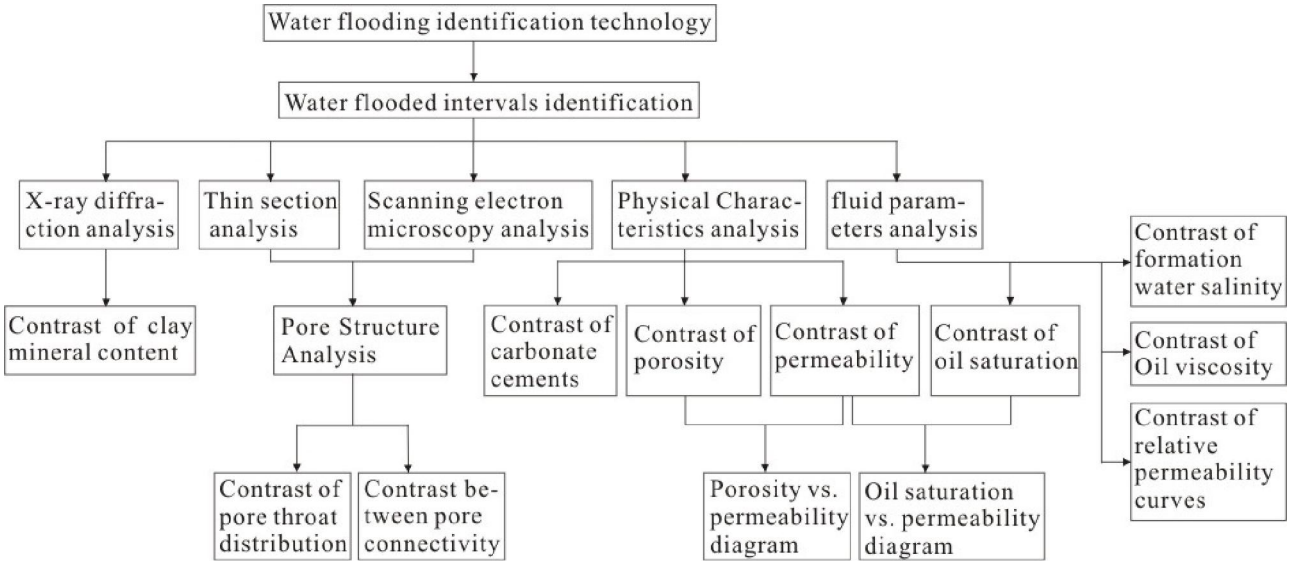

Fig. 3. Pathways of a system parameter comparison method based on the water flooding identification technology

On the basis of waterflooding identification during the development process of the continental oilfield, analyzing the changes in characteristic parameters of the waterflooded reservoirs helps to summarize the waterflooding regularity. The characteristic parameters are due to oilfields, there is no universal adaptability. It is normal that anomaly regularity phenomenon in certain oilfield. Reservoir heterogeneity has a strong control of the waterflooding regularity [11]. However, the method is generic, and each oilfield can analyze and summarize waterflooding regularity of its own to guide the production.

A proper understanding of the waterflooding situation and grasping the flooding of regularity can further provide guidance of remaining oil, so that the development of adjustment will achieve the best results. Therefore, semi-quantitative to quantitative evaluation is needed to perform after determining the specific waterflooded zones. Interpretation models of log parameters could be established, including porosity, permeability, shale contents, water (oil) saturation, and moisture contents. By establishing the interpretation models, especially the model of moisture contents (Mc), we can determine the level of water flooding. And the level of waterflooding is divided as follows: (1) oil reservoir: Mc<10%; (2) weak waterflooded zone: 10%<Mc<40%; (3) medium waterflooded zone: 40%<Mc<80%; (4) strong waterflooded zone: Mc>80%.

Further development of the fine interpretation of the waterflooded zone could be carried out on the basis of waterflooding identification to increase the recoverable reserves of the continental oilfield. Using neural network technology for logging analysis to provides a new means of interpretation of waterflooding, so as to serve further reservoir distribution and dynamic monitoring.

5 CONCLUSIONS

(1) In this study, a back-propagation neural network consisting of the combination of well logs and the fluid zone codes are used to estimate waterflooded zone. The network is trained to adjust the network weights and thresholds according to the network prediction error to minimize the network error. Excellent correlation is acquired between the network output values and the oil production conclusions after training. And it also further validates the accuracy of the neural network algorithm, utilizing well logs combination perfectly. Thus, a crossplot plate is acquired to identify waterflooded reservoirs in the study area.

(2) Combining characteristics of continental oilfields, it is necessary to produce different types of crossplot plates in different blocks or oilfields. It also helps to carry out fine interpretation of the waterflooded zones and to ensure high and stable production of oilfields.

(3) Based on the waterflooding identification, in-depth analysis of the waterflooded characteristic will help to master the waterflooding rules, and to further improve the waterflooding identification system.

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Geophysical Surveys for the Characterization of Landfills

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ABSTRACT: Landfills are the classical solution for waste disposal. During the last years there has been a growing concern about the effect of landfills in public health, because leaching water can contaminate nearby aquifers. The conversion of the open dumps characteristic of many cities around the world to controlled and sanitary landfills is a critical step for protecting public health and the environment.

Landfill is not just a place where waste is disposed, but it is a technological plant designed, realized and managed to obtain a minimization of negative effects. Sanitary landfilling is a fully engineered disposal option that avoids the harmful effects of uncontrolled dumping by spreading, compacting and covering the waste on land that has been carefully engineered before use.

Geophysical surveys are increasingly filling this need, by responding to vertical and lateral variations of the fill material. The non-invasive geophysical methods which measure a different physical properties, specifically Electrical Resistance Tomography (ERT), Frequency-Domain ElectroMagnetic (FDEM) and Infrared Thermography methods (IT), could overcome a problems of the landfill in study.

The combined use of these geophysical methods therefore allows to better characterize the properties of the land and to map the subsurface in landfills and their surroundings.

KEYWORDS: Landfill, Electrical Resistance Tomography, Frequecy-Domain ElectroMagnetic, Infrared Thermography, Plan of contamination.

1 INTRODUCTION

The problem of environmental contamination is, today, one of the main concerns of earth scientists and researchers from other related fields of science around the globe. Fast industrial development and the uncontrolled growth of the urban population result in the production of toxic solid residues [1]. Urban waste materials, mainly domestic garbage, are usually disposed of in-adequately in waste disposal sites placing the underground water resources at high risk. Pollution of ground water happens mostly due to percolation of pluvial water and the infiltration of contaminants through the soil under waste disposal sites. The contaminant is a fluid that results from the decomposition of organic matter, rich in dissolved salts, containing a substantial amount of polluting substances. Contamination takes place when this liquid reaches the groundwater table, thus affecting the potability of underground water and putting the community that makes use of that

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resource under health risk [2]. The solution to the day-to-day problems of modern urban societies demands fast and effective geophysical methods. One of the most frequent demands in metropolitan areas includes detecting the location and extent of contamination patches in areas as small as landfill sites. In such context, the integrated use of geophysical methods provides an important tool in the evaluation and characterization of contaminants generated by urban residues (domestic and/or industrial). Among those geophysical methods, electrical, electromagnetic and infrared thermography methods have been found very suitable for such kind of environmental studies, due to the conductive nature of most contaminants [3, 4, 5, 6, and 7].

Ilbono landfill has been the disposal sites of urban solid waste for a long time. The negative environmental impacts caused by wastes deposition are manifested in the landfills, adjacent zones, namely, in the groundwater, because these structures are located above permeable and porous formations, which aid in contamination scattering.

It is well known that groundwater contamination can easily occur and carry on for a long time, because recovery is slow and difficult. The problems associated with municipal, abandoned or non-controlled landfills are of general concern, especially because of the interactions between the hazardous contents of the leachates derived from them and the groundwater [8]. Geophysical methods may be used to investigate the history of a landfill as different types of landfills have different properties.

2 METHODOLOGY

In view of the large number of poorly documented landfills, fast and inexpensive methods to investigate the shallow subsurface are becoming increasingly important. Non-invasive surface geophysical techniques are increasingly used for landfill characterization, particularly where intrusive methods are hazardous and pose significant risks to health and safety.

2.1 ERT METHOD

Geophysical methods measuring the electrical resistivity have been used to follow the leachate flows [9]. These methods essentially consist of injecting an electrical current (I) through two metallic electrodes and measuring the potential difference (ΔV) between two other electrodes. The apparent resistivity (ρa) is given by the following relationship (1)

$$\rho a = k\,(\Delta V / I) \quad (1)$$

With K a geometrical factor which only depends on electrode position. The ρa is the ratio of the potential obtained in situ with a specific array and a specific injected current by the potential which will be obtained with the same array and current for a homogeneous and isotropic medium of 1 Ω.m resistivity [10]. The apparent resistivity measurements provide information about resistivity for a medium whose volume is proportional to the electrode spacing. The larger the electrode spacing, the higher will be the investigated volume. The data point corresponding to this investigated volume is conventionally represented on a section at a depth equals to the electrode spacing. The apparent resistivity measurements do not allow interpreting the distribution of resistivity inside the Electrical resistivity (or its inverse, the electrical conductivity) depends on several parameters: water content, temperature, ionic content, particle size, resistivity of the solid phase, permeability, porosity, tortuosity, pressure and clay content [11]. Except for the moisture content and temperature, the influence of these parameters on resistivity in waste mass is unknown [12].

2.2 FDEM METHOD

Electromagnetic energy can be applied to the ground using transient current pulses instead of the continuous waves mentioned above [13]. The collapse of a steady state primary magnetic field will induce eddy currents to flow in a conductive earth, and these will give rise to a transient secondary magnetic field, which may be detected in a receiver coil as a time-dependent decaying voltage. The characteristics of this transient decay can be related to the conductivity and geometry of the subsurface geology [14, 15].

FDEM-induction instruments measure subsurface apparent electrical conductivity without galvanic contact using alternating electromagnetic fields to induce subsurface eddy currents [16].

The electromagnetic survey has been used for various near-surface applications including Landfill mapping.

This non-intrusive approach enables rapid mapping of conductive subsurface structures and can easily locate buried waste or contaminated areas. The magnetic susceptivity is particularly suitable for the detection of metals and helps a lot in the detection of buried drums or, for example, to recognize different waste type (foundry wastes from ferrous foundries).

2.3 IT METHOD

Anybody possesses a temperature greater than absolute zero emits, in agreement with the Planck law, energy in the form of electromagnetic radiation. For ordinary temperatures the maximum of the electromagnetic radiation is concentrated in the spectrum of infrared radiation characterized by a wavelength between 0.75 µm and 100 µm in agreement with the Wien's law [17].

$$W = \frac{2hc_0^2}{\lambda^5 (e^{\frac{hc}{\lambda KT}} - 1)} \quad (2)$$

$$\lambda_{\max} = \frac{2897,7}{T} \quad (3)$$

The thermal imaging devices are conceptually similar to a camera, but with the peculiarity to be projected, not to capture the electromagnetic spectrum in the visible light range, but the spectrum of the infrared band.

The electromagnetic energy emitted from the object in the field of thermal infrared radiation is focused through a system of special lenses on an element sensitive to infrared radiation, called microbolometer. This later converts the amount of infrared energy received into an electrical signal that appropriately converted to digital allows the software of the camera to reconstruct an image in false color is representative of the surface temperatures of the object framed (thermogram) [18].

IT is a process in which heat at any temperature can be converted into a thermal image, using specialized scanning cameras.

This method is being used increasingly in the aerial survey of landfill sites, as a result of advances in the development of portable, high-sensitivity thermal imagers to detect the leakage of methane gas and leachates escaping from the sites economically. The method produces an image of temperature variations over the ground surface. Ground investigations are essential to calibrate any temperature anomalies against the presence of methane leaks or the movement of leachates. The method should not be confused with infra-red photography, which is used widely in surface vegetation studies.

3 GEOPHYSICAL SURVEY

3.1 ERT SURVEY

The area available for the geophysical surveys is small, trapezoidal in shape with dimensions of the sides equal to 70, 60, 45 and 45 m. This limits the ability to perform investigations deep. We were made 4 ERT within the landfill, and one in environment not disturbed positioned as shown in figure 1.

Fig. 1. Aerial photography of the landfill with the positioning of the ERT profiles

For the acquisition of data we used Georesistivitymeter Advanced Geoscience Inc and it has been programmed a sequence of measurement of dipole-dipole type. This configuration, as compared to others, allows us to better determine the lateral variation of resistivity.

Although substantially different between them, the ERT from 1 to 4, realized internally to the landfill, show common elements that can be analyzed simultaneously. The ERT 5 was performed downstream of the retaining wall, located east of the perimeter of the landfill. The objective of this measure was to evaluate the distribution of the average resistivity of the material below the bottom of the landfill and the possible presence of water (Figure 2).

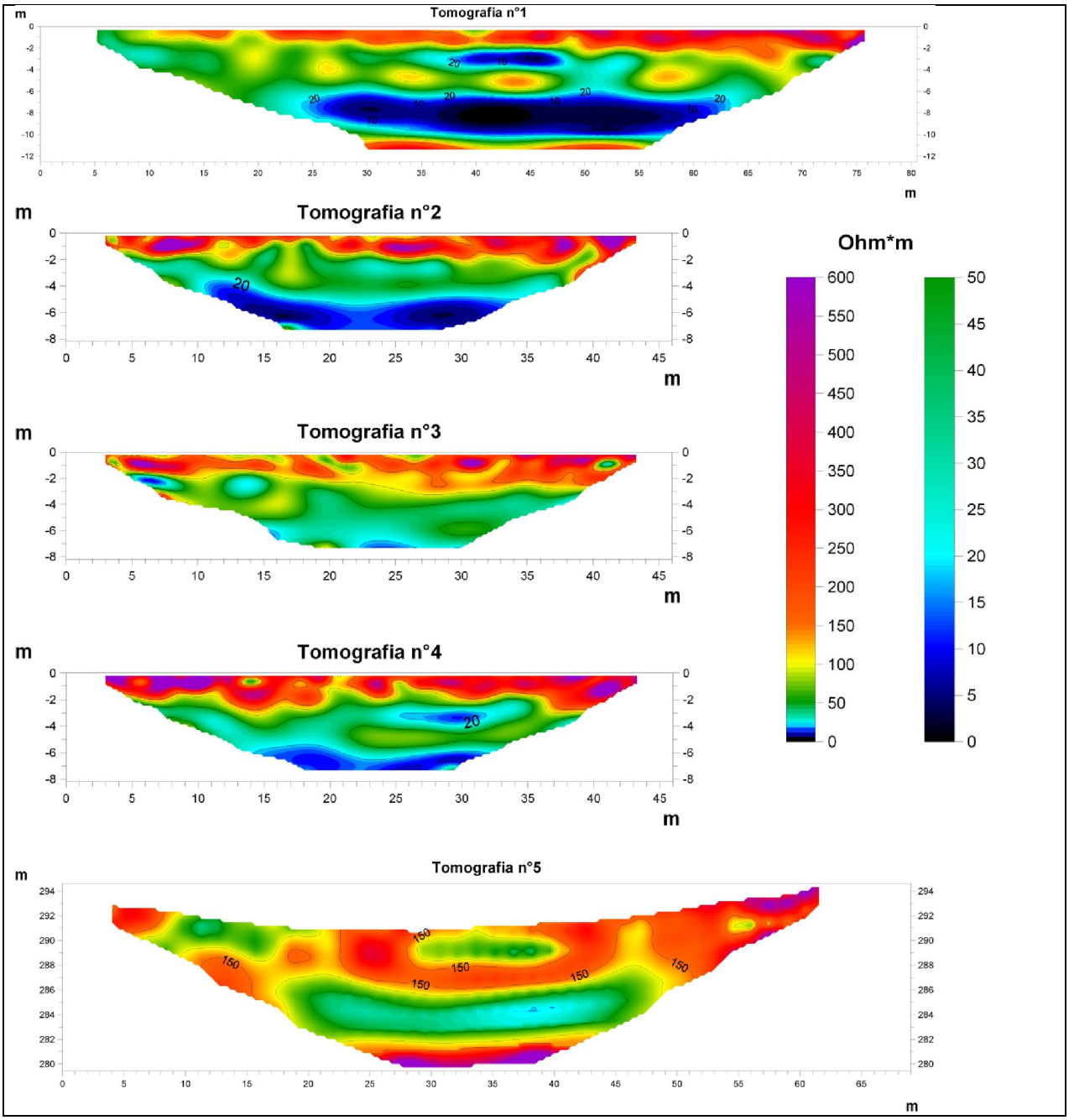

Fig. 2. Resistivity model for the Ovar landfill with contaminated areas

3.1.1 PROFILS 1-4

The spacing between the electrodes influence on the depth of investigation reached, the ERT n ° 1 shows the distribution of subsurface resistivity for about 12.00 m, while n° 2, 3 and 4 reach 7.50 meters depth

The results show the presence of three electro-main layers: resistive, characterized by values between 100 and over 600 Ohm*m, referable both to the presence of materials well draining (gravel) or similarly to compact materials and waterproof (rock), conductive, characterized by resistivity between 20 and 100 Ohm*m, related to bulk materials and wet, very conductive, with values less than 20 Ohm*m, related to organic materials wet.

3.1.2 PROFIL 5

The resistivity section shows average higher than those found within the site, with values always above 20 Ohm * m. Therefore, the very conductive layer is absent.

This profile marks the presence of the aquifer unpolluted

3.2 FDEM SURVEY

The electromagnetic data were acquired with a GF Instruments CMD electro-magnetometer with coils placed in vertical configuration. The spacing between the coils is equal to 3.77 m.

The data were acquired by running parallel profiles between them, with average spacing of approximately 1.5 m along two directions perpendicular to each other. The measurements were carried out with the use of a Differential GPS which has allowed the georeferencing of data and results. In total, we have gained 4800 data of electrical conductivity, and phase, distributed with a cover shown in figure 3.

Fig. 3. Aerial photography of the landfill with the positioning of the FDEM profiles

FDEM data do not require special processing, but are interpolated to produce maps that are then interpreted qualitatively. They do not allow the interpretation in depth, but show in detail the lateral variations of conductivity (Figure 4)

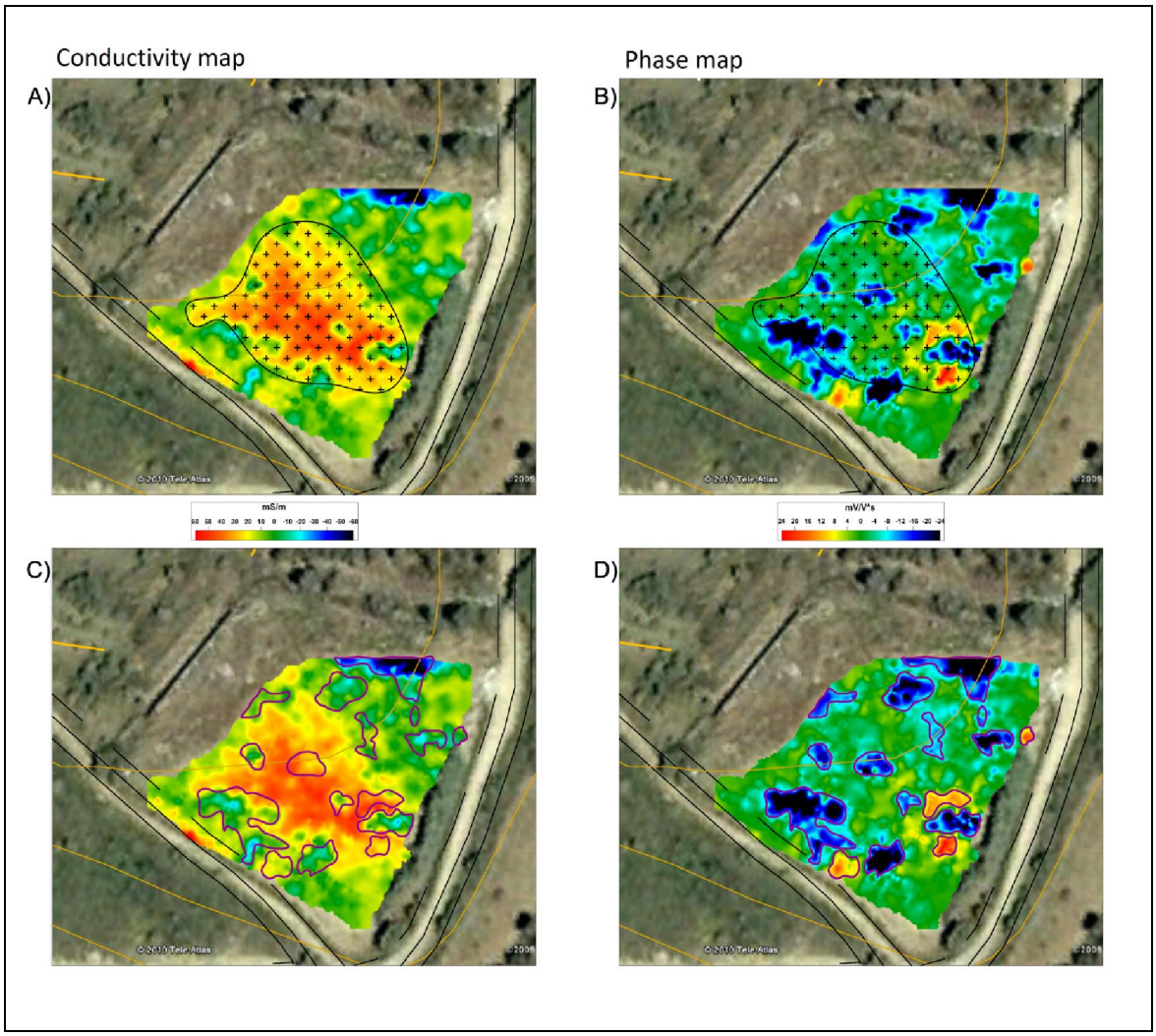

Fig. 4. FDEM results, A,C) Apparent conductivity maps, B,D) phase response maps

The results obtained show clearly apparent conductivity values and phase, positive and negative. The map of the phase is the result of the presence of metallic materials, very close to the ground surface. The map of conductivity shows the presence of a conductive area with conductivity values varying between 20 and 60 mS / m to which are associated phase values close to zero that indicates the presence of a conducting and non-ionic metal type. Inside the conductive area, we find the presence of a circumscribed areas characterized by maximum and negative values of phase, in these points, it is likely the presence of metallic surface and/or elements made by resistive materials and tires.

3.3 IT SURVEY

Management of landfill gas can be improved if leaks can be detected and rectified effectively; an infrared camera produced by Flir Model S65 has been used to detect gas leaks accurately by identifying them as anomalies.

The FLIR S65 operates in the electromagnetic band between a wavelength of 7.5 µm and 13 µm, using an uncooled microbolometer FPA sensor having a resolution of 320x240 pixels, with a spatial resolution of 1.3 mrad and an accuracy of 2°C. The visualization of the scene is done in real time on a display "LCD 4" placed on top of the camera, the thermogram can be stored on a memory card in standard Compact Flash, JPEG radiometric format. This thermocamera also has the ability to acquire color images in the visible spectrum.

The shooting in the site investigation were carried out from an elevated position along the dirt road that runs along the landfill in his south side Ovest.10 thermograms were acquired, disposed in such a manner as to cover the entire extent of the landfill (Figure 5).

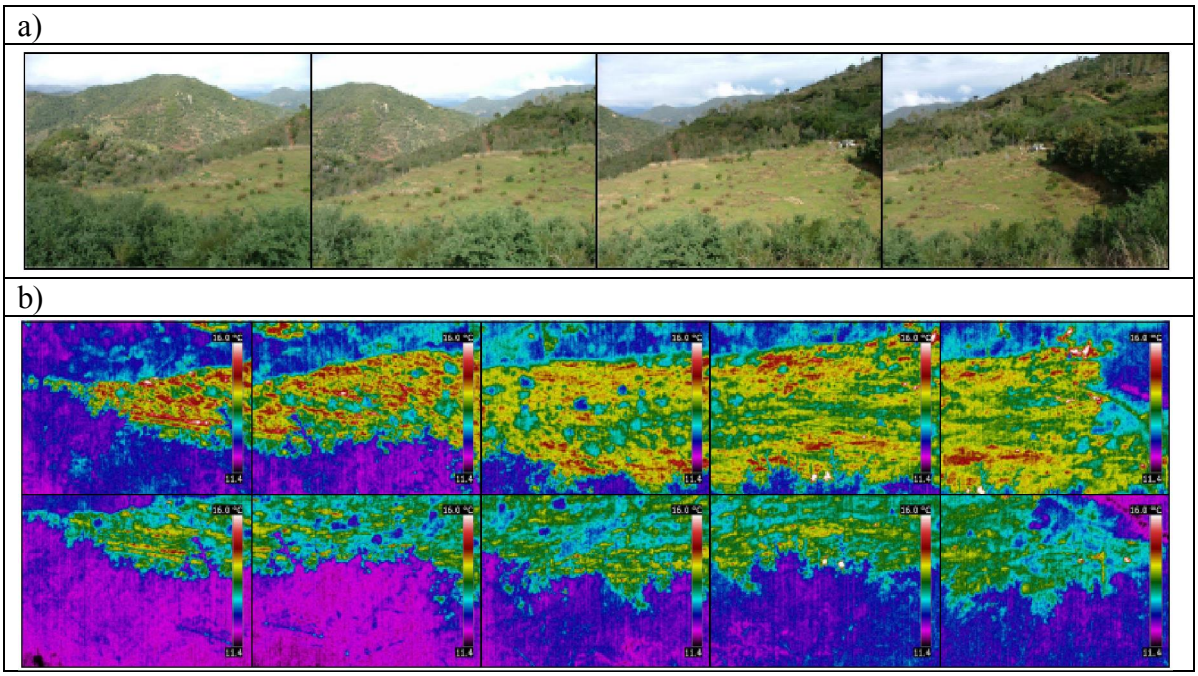

Fig. 5. IT results, a) Photography in the visible spectrum, b) Photography in the infrared spectrum

The thermography, showed a surface temperature of the soil of the landfill between 13°C and 15°C. The variability in the values of temperature is uniform over the entire area of investigation. The lift of biogas is the product of an exothermic chemical reaction that should heat the soil in correspondence of any buildup. The thermographic analysis did not detect significant temperature anomalies, and let not therefore be inferred that any biogas able to find a way to escape widespread in the superficial layers of the landfill little compacted, without giving rise to accumulation zones.

4 RESULTS ANALYSIS

The analysis of the results obtained allows to highlight important features of the landfill:

- **Geometrical characteristics of the landfill**

Based on the results obtained it is possible to assume a vertical distribution of waste in the landfill, characterized, in the surface (0 to 3.4 m), the presence of dry waste, not compacted, draining into the middle (3, 4 - 6 m), from waste more compacted, less draining, with a greater wet fraction, in the lower part (6 - 10 m), by the presence of compacted waste and liquid substances with a high saline content.

- **Volumes approximate**

Although the reconstruction of the volumes of waste requiring a higher spatial density of measurements performed, the results allow to estimate a quantity of material present in the landfill, below the surface investigated, excluding therefore the steep side, equal to about 32,000 m3.

- **Pockets of biogas**

The first meters below the surface of the landfill are characterized by abnormalities of high resistivity which does not allow to exclude the presence of biogas in the surface. As previously illustrated, the materials present in the first layers are poorly compacted and well draining, it is reasonable to infer that such a matrix in the gas would escape routes to the surface. The thermographic analysis shows a variation of the temperature, and does not highlight areas with anomalous values of temperature, compared to the surrounding context. On the basis of these considerations, it tends to exclude the presence of accumulations of biogas in bags, both in the surface layers which are absent in depth where resistivity anomalies related to these phenomena.

- **Ferrous materials / Leachate**

Are indicated in Figure 4, the areas in which it is the presence of ferrous materials. The electro-conductive layer is characterized by values attributable to the presence of leachate with depth between 4 and 6 meters.

- **Presence of aquifer water**

Tomography n° 5 (Figure 1) shows resistivity values that are compatible with the presence of clay materials, which a flow of groundwater at a depth of about 7 meters from the ground level, which is roughly about 12 meters below the base the containment wall.

5 CONCLUSION

The combined use of geophysical methods is being used for contaminant and landfill mapping with great success [19].

The geophysical characterization of industrial and urban abandoned waste disposal can allow to estimate the volumes of refuses that must be reclaimed and to know the pathways of leachate and pollutants and its connections with fresh aquifers or lagoon or salt water. The geophysical indications are volumetric and therefore the geophysical methods can give better than the direct method answers to the waste disposal site reclamation.

In particular, all the electric and electromagnetic data allowed to delineate the resistive and conductive trends of the waste disposal.

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Machine Learning based Question Classification Methods in the Question Answering Systems

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ABSTRACT: The Question Answering Systems (QASs) use method of information retrieval and Information extraction to retrieves documents that contain special answers to the question. One of the existence problems is finding the desired information from this very high variety. For this reason, it is necessary to find ways for organizing, classification and retrieving of information. Question classification plays an important role in providing a correct answer on QASs because giving a bunch of formulated questions to provide the correct answer from among the many documents will be highly effective. The aim of classification is selecting suitable label for questions based on the expected response. In this paper, we investigate the effect of automatically classifying questions on machine learning algorithms. In this paper, we will explain different types of algorithms and compare and evaluate them and next we will investigate the existence algorithms' weakness and advantage in question classification. As a result, in the past most classification was done based on sets of words that many studies show that to maximize the efficiency of the classification of algorithms we require semantics and in the questions we should looking for feature that be close to the meaning of questions. A great deal of research proposed to analysis and to classify emotions and to extract knowledge from them and to classify them using semantic and linguistic knowledge but it still requires a lot of research and development.

KEYWORDS: Support vector machine, classification, Question Answering Systems, machine learning, information retrieval.

1 INTRODUCTION

In the present era, that is called the information age; there is a lot of information available to users, and there is the vast expanse of the information on the World Wide Web (WWW) that to this vast volume add lots of users from all over the world every day. One of the existence problems is finding the desired information from this very high variety. For this reason, it is necessary to find ways for organizing, classification and retrieving of information. Another method is the use of systems for retrieving information which provide users with necessary documentation [1], [2]. Using a common information retrieval system, users are confronted with a large number of documents that the reading of all the documents to find the information is very time consuming and frustrating.

For example, when we present the question in search engines, information retrieval systems usually retrieve documents that contain the keywords, while the user desired to know the real answer to his question. For example, if you write a search engine "Who was the first Iranian woman to go into space?" The real answer of the user is "Ms. Anousheh Ansari," but retrieval system retrieves many documents that include the words "first", "Iran" and "space" [1], [3], [4]. Text retrieval conference (TREC), holding worldwide aims at comparing the information of retrieval systems by business groups and

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academic. Participating systems perform the same queries and retrieve relevant documents. Results are evaluated manually in a separate QAS and the assessment is carried in the so-called separate QAS. The Text Retrieval Conference has started with this purpose in [1], [4]. If search engines were able to receive the user ' question in the form of a question in natural language, understood with minimum redundancy and maximum precision, and respond to the massive volume of retrieved documents, we were not faced with the problems in the retrieval systems. In this regard question classification, which is categorized by putting questions in a sense, plays a key role in this system [3], [4].

Whatever questions be classified more accurately, QAS' comprehension of the question will be more understandable and thus achieving the correct answer will be easier. For example, the question "Who was the first Iranian woman to go into space?" If the system detects that the application is a name 1 –the search range is reduced due to this knowledge. 2 - Retrieved documents are also greatly reduced. Question Classification plays an important role in the performance of systems in most categories of QASs [5], [6].

This paper has been organized as follows: next section is introduction question classification concepts and its methods. Section 3 and section 4 discuss about question answering systems and machine learning and its techniques, respectively. Section 5 is a discussion and comparison of presented techniques such as decision tree, artificial neural network, support vector machine ant etc. In the section 6, we present the results of this research.

2 QUESTION CLASSIFICATION

Nowadays, the problem of classification is one of the issues and many of them can be solved under this classification. One of the issues raised by the issue of classification is machine learning. Different ways has been proposed to solve classification problems in machine learning. In these methods, algorithm learns to predict expected response of users based on packing. Questions classification is a Boolean value (true or false) as ordered pairs $< q_j, c_i > \in Q \times C$, where Q is a set of questions and $C = \{c_1, c_2, \dots, c_{|c|}\}$ is a pre-defined set. If question q_j belongs to group c_i it is dedicated to the Boolean value true (True) $< q_j, c_i >$. Otherwise it is dedicated to false Boolean (False) [3].

In other words questions classification, placing those classified items in several semantic categories, regarding the possible answer [1] is in fact, the prediction of expected response according to the type of user s' response [7]. If the algorithm is able to correctly identify the type of responding meaning, it will be reach accurately to the correct answer question classification can be classified into two main groups; one based on rules and features, and the other based on machine learning [7].

2.1 QUESTION CLASSIFICATION BASED ON RULES

This kind of question classification induces semantic and syntactic rules write the rules manually and give them to algorithm based on expected language. For example, the questions start with terms like 'who' or 'whom' replaced in 'human' group. question classification apply based on these rules and regarding the rules that written manually, and regarding the syntax and features of language, but these process need cost, extra time and hardworking which shows systems based on this method are not free from error [8].

2.2 QUESTION CLASSIFICATION BASED MACHINE LEARNING

Since presenting all syntactic and semantic rules of a language to algorithm is a cumbersome task, for this reason different types of algorithms are made that can receive different examples and have the learning ability and can preview the user' expected response easily. Using machine learning, we can generate systems that includes thousands features of questions and do classification those questions automatically. This action increases the productivity rate of QAS that will be discussed in the following briefly [4], [7].

3 QUESTION ANSWERING SYSTEMS

These systems are the systems that let users to say their answers in natural language and reach to their expected answers with minimum redundancy. Understanding natural language for computers is overwhelming, for this reason, in this field studies were carried and will be carried that became the reason for the emergence of methods and inventions in this area. The heart of every QAS is its question classification algorithm. The higher the precision of the taxonomy, the higher the performance of the system will be. The machine learning algorithms are of this type that shows the best operation in the field of question taxonomy which we will review the main algorithms in the following section [3].

4 MACHINE LEARNING ALGORITHMS

Machine learning is one of the major branches of artificial intelligence research. The aim of the research in this field is access to learning techniques that allow the simulation of human intelligent as an intellectual behavior by computers [9]. The main aim in machine learning is the improving of machine that its ability to do that in the machine is constructed. This manner of correcting or improving called machine learning that is based on evaluation and testing and also based on the rate of correctly doing that act, for example the amount of winners in chess. Machine learning using information theory of the mathematical models can be used for getting results. Through program writing you can tell the machine what to do. Through several showed examples, we will get the machine to learn. Machine will be able to learn by experience environments, when the agent is not known for certain machine and examples of instruction are not available; it can be trained through observation [10], [11].

Algorithms have the ability to learn in three ways: 1 - supervised learning 2 – un-supervised learning 3 - semi-supervised learning. In this paper, we propose the supervised learning algorithms. Many machine learning algorithms based on the observation have been constructed so far that following we will point to the most important of these algorithms.

4.1 K-NEAREST NEIGHBOR

K- Nearest neighbor algorithm is a simple type of supervised learning algorithm. Its approach is in the case that when a new training data enters system, it recalls a group of training data previously categorized in the system and categorized them based on new training sample [12]. One drawback of this method is its high computational cost for categorizing each new training data when entering to the system. Another drawback is that the new model will be considered the same based on the characteristics of new training scheme that are assumed the same and are recovered the same.

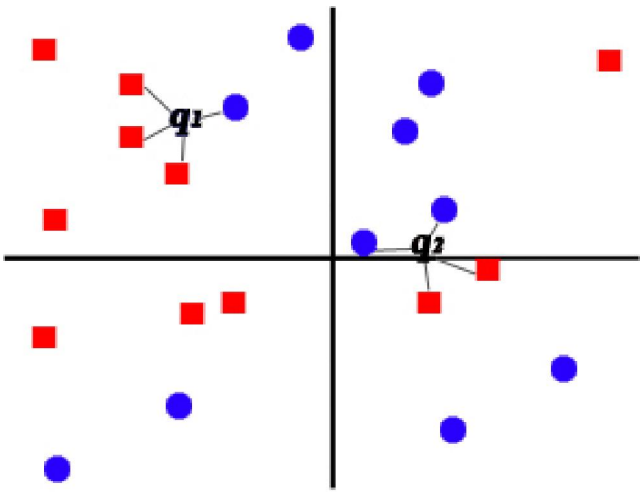

Fig. 1. K-Nearest Neighbor algorithm

In this algorithm, we assume all training data are n-dimensional space into Rn. Nearest neighbor distance between two points computed using the standard rules of the distance of two points [12], [13], [14].

$$d(x_i, y_i) = \sqrt{\sum_{r=1}^{n}(a_r(x_i) - a_r(x_j))^2} \quad (1)$$

In this algorithm calculations are different, given that space is considered to be two-dimensional or multi-dimensional training data. This algorithm will be categorized new training sample based on the prior training data. Different version of this algorithm is presented. One of the main problems of this method is that the distance of training data is considered the same based on their characteristics [15]. In the case that these extra and non- relevance characteristics be excessive, it becomes the main reason for algorithm' astray and as a result to algorithm' performance reduction. This algorithm is known as pattern recognition algorithm and it has many applications in this area. In this area, we have considered the assumption that the features of each training data should be similar [12], [15].

4.2 DECISION TREE

Decision tree reconstruct training data in the form of a tree using well-defined query is True / False. In a decision tree structures, leaves represent those of groups and the edges represent a set of features that these features leads to another special features in the groups. Decision trees are well organized in the case that with easily placing new data in roots and executing query model until reaching to special leave, we can classify new data that is the main aim of algorithm.

Decision tree is a good classification with several impressive advantages. The main advantage of decision trees is that it is simple and comprehensible for non-expert users. In addition, repetition of a mathematical algorithm can be easily explained and reviewed, and it can be revealed a comprehensive point of view containing useful information from the logic of the scheme. One of the major drawbacks of this decision tree method is that if training data have many features it wouldn't give good performances [16], [17]. As we know, when new data enter system decision tree algorithm with placing new data in the root restructure decision tree and tree replaces new decision with previous tree.

One of the major drawbacks of decision tree method is that maybe new tree is not better than the previous tree and it intensively reduces the performance of algorithm tree, and in addition to this issue, tree' structure will be very complex with increasing input [18]. One of the applications of recent decision tree is in the advertising of dynamic web pages. There is a variety of versions of decision tree algorithms such as ID3, ID4-hat, ID5, C4.5, and CART which the practical application of decision tree algorithms in the classification of answers will be addressed in the next section of [14].

4.3 SPARSE NETWORK OF WINNOWS (SNOW)

SNoW is a machine learning algorithm that is used for question classification according to the user expected response. This algorithm includes a number of features of the questions that are used in order to be classified as multi- class. The algorithm framework comprised of dispersed framework of linear algorithm containing one or some pre-defined feature space or feature spaces added step by step [8].

Table 1. Li & Roth's two-layer taxonomy for question classification

Coarse	Fine
ABBR	abbreviation, expansion
DESC	definition, description, manner, reason
ENTY	animal, body, color, creation, currency, disease/medical, event, food, instrument, language, letter, other, plant, product, religion, sport, substance, symbol, technique, term, vehicle, word
HUM	description, group, individual, title
LOC	city, country, mountain, other, state
NUM	code, count, date, distance, money, order, other, percent, period, speed, temperature, size, weight

Classification can be categorized into course and fine in the algorithm and it will be done in two steps. In the first step, the question will belong to one of the sixth coarse groups. Then with attention to coarse group, each coarse fine will belong to its sub-category [4], [8]. One advantage of this method is its simplicity and its low confusion at the moment of categorization. Input algorithm is a set of features that constructed semi-automatically. A part of features is automatically made with human intervention and with words meanings. The feature space was comprised of 200,000 features. Full description and results of the software and algorithm are available in [8].

4.4 NAIVE BAYES

Naïve Bayes (NB) classifier is a simple algorithm, which works based on probability and inference. We can make good decisions in this algorithm regarding the probability distribution and the shown data optimal decisions. Simple Bayes algorithm can be used to check the operation of the algorithm that have done previously and are likely to pay attention to algorithms which use probabilities. Bayes' theorem is based on Byes hypothesis provided that we are searching ways to find the probabilistic group for new training sample of input entering system. This is not possible without primary information. Bayesian model is the direct method for finding probabilities in the abstract space [12]. Given that the probabilities are precise, this algorithm operates with a minimal amount of training data to learn well and it will have the necessary parameters for a given rating category. It will calculate just the variables of each class rather than the entire set with taking into account the covariance matrix of the independent variables [12], [14].

Regardless of the simplicity of Bayesian algorithm, it can well perform in too complex categories and show too high performance in spite of what we expect. Software-based classification constructed based on simple Bayesian algorithms have shown an amazing performance in most cases. The main shortcoming of simple Bayesian algorithm is its relatively low efficiency compared with other so far made algorithms such as SVM algorithm which in this paper we will briefly take a look at it. The tests show that the performance of SVM algorithm is much better than that of the simple Bayesian algorithm. During the past years a lot of research has been done to solve performance problems and to increase its productivity. In some studies simple Bayesian algorithm has been combined with other classification algorithms in order to increase efficiency [12], [14]. The results were great with the combination of this algorithm with SVM algorithm [19], [20]. Of important applications of NB algorithms can be mentioned to filtering of spam in e-mails and categorizing of contents on web pages. Based on results, the performance of NB algorithm is high in these types of operations. Also setting NB algorithms on textual and numerical data is simple in comparison with other algorithms. But its performance is low in taxonomy texts, especially in texts close to natural language. One of the good advantages of NB algorithm is its short computational time for learning operates [14].

4.5 SUPPORT VECTOR MACHINE

A SVM is a subcategory of supervised machine learning algorithms used for classification data. In this way that machine learns to categorize input in pre-defined entries. This is a new technique and is shown a better performance than existing algorithms for classification of data such as neural networks. SVM works to the best possible for multi-dimensional data. Also it handles very well in classification questions automatically because it is non-linear and multi-dimensional [4].

Assume a set of training data (D), with n members with the assumption that those are linearly separable:

$$D = \{(x_i, c_i) | x_i \in R^p, c_i \in \{-1,1\}\}_{i=1}^{n} \quad (2)$$

There are two training data set, classes Ci=1 and Ci=-1. The aim is to find the best hyper plan separation for these two training data sets. The equation is in the following case. Look at formula (3).

$$w.x-b=0 \quad (3)$$

Where w is the vector normal to the sheet, and b is the intercept for the hyper plane separation. For each training data xi if $w_i.\mathrm{x_i} - \mathrm{b} \geq 1$ then training given to the class ci=1 and if $w_i.\mathrm{x_i} - \mathrm{b} \leq -1$, then the data can be related to the class ci= -1. The distance of hyper plane from the source is $\frac{b}{\|w\|}$. In the general case, the aim is to find the minimum value of b and w in a manner that it can properly classify the training data and maximizes hyper plane layout and margin.in order to an optimal batch scheduling done, we use the variable ξ_i. Then the equation (4) can be written.

$$c_i(w.x_i - b) \geq 1 - \xi_i, \quad 1 \leq i \leq n \quad (4)$$

In Classification of questions in optimal face the following relationship approaches to about the lowest level categories: $\min[\langle w.w\rangle + c\sum_i \xi_i]$ that in this relation the parameter c control for optimization that shows the number of accepted training errors. The main idea of this method is if the training samples be linearly separated, we will gain hyper plane with maximum margins that separates training samples in groups. If training samples are not linearly separated, we write them with more spaces and dimensions so that it can categorize training samples linearly in new space. The purpose in SVM is finding optimized hyper plane [4], [12]. SVM training classified sample into two groups of positive training samples and negative ones. The aim is to find the best separating hyper plane from these two samples. The closest training data to the hyper plane separator is called support vector [21]. The idea of SVM is to draw the two borders parallel to hyper plane separator and to apart two planes in a size that they press training data. The best hyper plane separator is those that have the further distance with training data. If the hyper plane is selected correctly, the classification will be applied in the least amount of error.

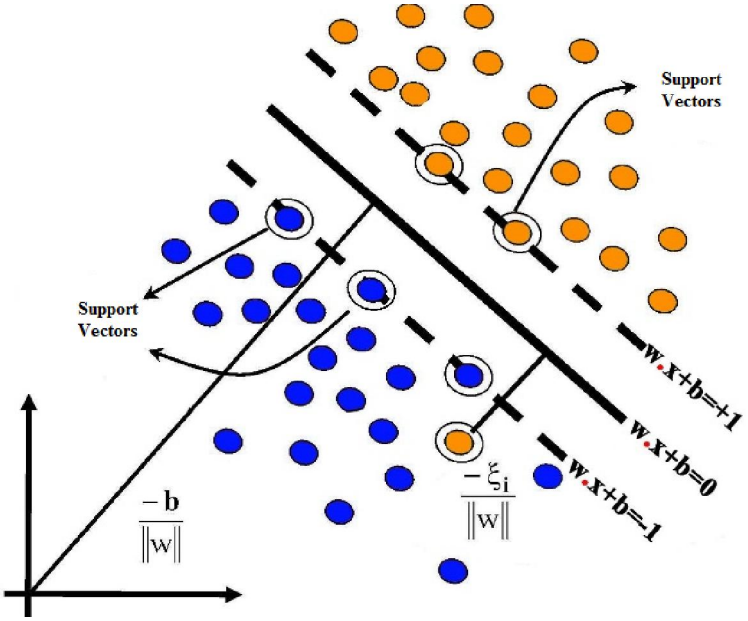

Fig. 2. SVM Algorithm

In SVM training is a relatively simple and efficient for multi-dimensional training examples and it shows a lot of features. Of its disadvantages are the complexity of the algorithm and its difficulty in understanding for non-expert users. The algorithm also handles the action with the high cost of computing at time and algorithms consume a lot of system memory too [14]. Among algorithms those supervised with SVM have shown excellent performance [22], [23]. In one conducted research, much has been done to evaluate the performance of the SVM algorithm using twenty training data set that was close to natural language texts using UCI. Also in order to achieve optimal SVM algorithm, much research has been done [24].

4.6 Artificial Neural Network

From general point of view, this system is composed of many interconnected units that each unit receives some input and computes output. Sometimes, an input is considered to be the output of a single unit. These units are known as neurons. Neurons can be used for storage in Artificial Neural Network (ANN). ANN methods are the comprehension of biological neural networks, but they cannot have many of the biological complexities [25]. According to conducted studies, biological network modeling is very complex and far from availability. But work on algorithms that simulates the behavior of biological networks for capturing better machine learning is more reasonable. A different version of the ANN for the classification of data is presented. But many researchers use single-layer Perceptron algorithm with an input layer and output layer since they are easy to use. In fact a perceptron is a network that neural networks made regarding their structure [12].

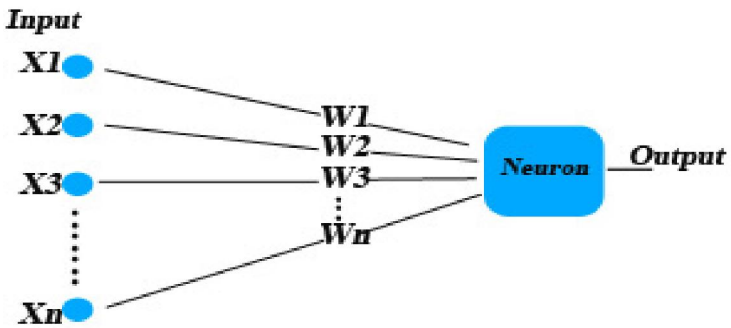

Fig. 3. ANN Algorithm

After receiving a real-valued vector, perceptron computes a linear combination of the set. If this amount was more than the determined amount, it is 1; otherwise outputs will be export the amount -1.

$$O(x_1, \dots, x_n) = \begin{cases} 1 & w_0 + w_1 x_1 + w_2 x_2 + \cdots + w_n x_n > 0 \\ -1 & Otherwise \end{cases} \quad (5)$$

Perceptron implement multi-layer perceptron with a single-layer or with a hidden layer or with an output layer that are more complex than one-single perceptron layer. One of the main advantages of the algorithms implemented regarding ANN is that they show good performance due to their multidimensional nature and much communication among elements on classification of data with a lot of features [12]. Their major drawbacks are high costs, high CPU use and high physical memory. Also understanding ANN is a problem for many users.

5 DISCUSSION AND COMPARISON

Using a decision tree, where the leaves represent categories and the edges represent a set of features, we can consider each entry as a new training sample and place the expected questions into its category with putting it in the root of the tree and reconstruction of decision tree. The act of ordering questions will be done with above-mentioned procedures. In an evaluation [12], DT algorithm with algorithm' software C4.5 that is used in placing of this algorithm performs better than the NN and NB learning algorithm but it shows poor performance versus Snow and SVM algorithm [4]. A conducted reassessment shows that the performance of DT with the feature set 0.5 is also higher than Snow [3]. KNN algorithm is one of the simplest machines learning algorithms and it is used more in classification of documents. Different versions of this algorithm are presented that are interesting [14]. According to studies, in evaluating it with other learning algorithms regarding the questions categorization its performance was poor and it had little use. When it is compared with the algorithm like NB, Snow, SVM, it shows efficiency of lower than 67% with experiments on the same dataset [4], [5].

SNoW classification algorithms will be implemented in two stages, first the coarse group of questions is selected and then according to the characteristics of the questions, they will be awarded to the desired component and subcategory. This algorithm has a good accuracy and it shows better performance than the algorithm like NN, NB and DT, but less than SVM [5]. It can cover lots of questions' features due to being multi-class. NB algorithm works regarding the probability inference to the case that when a new question is entering the system, the question dedicated to the "most probable" groups according to the probable answer. In a paper, Mr. Lee and Zhang [4] deal with the study of the categories of questions with the same training and the same tests on a number of learning algorithms. They compared and paid attention to so-called algorithms' performance in the test that the results demonstrated algorithm NB show fairly good performance in comparison with algorithms like NN [5], [14]. Also studies have shown that the algorithm is tagged after training with 5500 questions and showed approximately 83.2% of performance in categorization of the total group [15].

SVM algorithm was one of the most popular and most used algorithms for question classification in recent years. The idea of SVM is in the case that with creating hyper plan between training examples with maximum margin and with the assumption that they are linearly separated, they can be classified. After Zhang and the other researchers' successful studies [4] that studied SVM and the other 4 algorithms, this algorithm showed good performance in comparison with the others. Also in a study conducted to compare the optimized version of the algorithm of KNN and SVM with an improved version of the algorithm NB, it concluded that SVM will be far better. But they achieved the significance and important result that the SVM algorithm will not alone work best, but if the pre-processing step be performed by KNN algorithm, classification by SVM will give better results [32]. The SVM algorithm is combined with the genetic algorithm that in this method the pre-processing procedure and selection of the items and features were conducted by genetic algorithms and after questions were classified by SVM algorithm which has shown satisfactory results [33]. Also in a similar research, the SVM algorithm is used for question classification in Chinese language that the algorithm provided dataset after training. After that the algorithm is tested and outcomes observed we can claim with dare that SVM has done well in this area and has shown good performances [34]. ANN algorithm is a simulation of the biological behavior of neural networks in a way that it formed of a number of connected units that connects the input group to the output and works in harmony. We used neurons for storage in the ANNs [11], [12]. In studies on spam sorting algorithms ANN show low efficiency than learning algorithm such as SVM [35]. In [36] ANN algorithm used to categorize online test questions according to their difficulty level. The results show that the algorithm efficiency is near to 78%.

The main Problem of instance-based machines learning is computational time and access to required features. Whatever these two categories improve the accuracy and efficiency of algorithm' classification increases [14]. Classification of items has many applications and covers an extensive range of issues which a great deal of research has been done but it seems that we're still at the beginning and presented algorithms have many difficulties and shortcomings and there is a need to be

developed and debugged. For example, question taxonomy can be used in the area of e-government. as we observe that public services and government agencies daily are added and each organization has diverse sectors that each will also have their own laws and sometimes people are in trouble when they don't know to which part they must provide their questions. If each organization will have an online question and answer system and each user without aware of the various parts of the system can present their questions and the system intelligently present each question to its related sections, at that time we will find the true meaning of e-government. In the past most classification was done based on sets of words that many studies show that to maximize the efficiency of the classification of algorithms we require semantics and in the questions we should looking for feature that be close to the meaning of questions. If we be successful in this regard it will increase the efficiency of the algorithm. A great deal of research proposed to analysis and to classify emotions and to extract knowledge from them and to classify them using semantic and linguistic knowledge but it still requires a lot of research and development.

6 CONCLUSION

Literature demonstrates that the algorithms of the Support Vector Machine (SVM) have positive effect in a text when it is compared with other algorithms. The main Problem of instance -based machines learning is computational time and access to required features. Whatever these two categories improve the accuracy and efficiency of algorithm' classification increases. Classification of items has many applications and covers an extensive range of issues which a great deal of research has been done but it seems that we're still at the beginning and presented algorithms have many difficulties and shortcomings and there is a need to be developed and debugged. For example, question taxonomy can be used in the area of e-government. as we observe that Public services and government agencies daily are added and each organization has diverse sectors that each will also have their own laws and sometimes people are in trouble when they don't know to which part they must provide their questions. If each organization will have an online question and answer system and each user without aware of the various parts of the system can present their questions and the system intelligently present each question to its related sections, at that time we will find the true meaning of e-government. In the past most classification was done based on sets of words that many studies show that to maximize the efficiency of the classification of algorithms we require semantics and in the questions we should looking for feature that be close to the meaning of questions. If we be successful in this regard it will increase the efficiency of the algorithm. A great deal of research proposed to analysis and to classify emotions and to extract knowledge from them and to classify them using semantic and linguistic knowledge but it still requires a lot of research and development.

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Terrorist profiling as a Counterinsurgency Strategy: Applying the Concept to Law Enforcement

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ABSTRACT: The nature of terrorism is fundamentally psychological. Similarly, psychological profiling is widely accepted in detecting crimes in both law enforcement operations and the study of criminology. However, there is a need to transfer its appearance from old traditional criminal environment to the context of counterterrorism. This research argues that most prevalent method of interrogating suspects to achieve distinction between guilty and innocent is to establish a set of psychological attributes and factors. This paper proposes that terrorist's profiling is value-added intelligence that may add a new dimension in counterterrorism to identify the individual behind a terrorist act. It is important to constructs a terrorist profile before designing a paradigm that should determine the probability of terroristic trends within the individual as well as certain perceptible qualities with which an observed suspect can be likened to. This article proposes a personality-guided model of interrogation with different categories to steer clear of oversimplified thinking about individual terrorist or groups. The objective is to adapt the style and content of questioning to obtain a clear overall picture of the suspect's knowledge with appropriate interviewing and interrogation methods. This profiling will provide thorough understanding of the ideology that drives terrorism and more awareness of the likely means and likely targets used by terrorists. This paper is a shift in direction – focusing rather on the development of evidence-based methods that could lead to an effective counterinsurgency strategy and the extraction of innocent's involvement in the terrorism.

KEYWORDS: Psychological profiling, Interrogation, Terrorism, Interviewing, Law enforcement.

1 INTRODUCTION

Terrorism is a strategic political and primarily a rational vehicle for the accomplishment of political goals and for this cause terrorists seeks the public attention as the main motive with inducing fear and terror [1]. Other suggests that terrorism is an expression of violent individuals with rigid ideologies with particular psychological constructs such as pathological narcissism or psychopathy without particular political intents [2]. However, the attempt to create such definition and many other commonly used definitions of terrorism were parsimonious and largely descriptive. Thus, the Law enforcement agencies have failed to view the world from the terrorists' perspectives and these empathic failures invariably lead to inadequate use of preventive efforts. The effectiveness of investigations will be largely a product of how well an interrogator will read a suspected terrorist with logical reasoning and then modify his/her style and methods to best capitalize on the

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subject's personality traits and characteristics. Logical reasoning and common sense and are the main safeguards against error and to not use this technique tends to waste resources on interrogation techniques and triggers a knee jerk reaction. Logic helps reduce unknowns classifiable set of behaviors, portraits and motivations and common sense defines exclusion criteria which screen-out individual who would never be considered criminals or terrorists [3]. However, people are different with respect to human nature and social psychology and investigators have to utilize these facts routinely in a very direct and practical way to understand the psychology of an individual personality. There is a need to investigate behavioral profiling and refine the process of interrogation for the varied types of personalities that may be encountered in perfecting the art and science of interrogation. The current research literature in this paper has done well to evaluate the perils associated with terrorist profiling and argue that psychological profiling can be effective at predicting terrorism's next move. It discusses that profiling can be an effective counterterrorism tool and perhaps this is the most important reason law enforcement agencies ought to be engaged in profiling while interrogating suspects.

This paper argues that building terrorist profiling before designing an interrogation paradigm would be an irresistibly attractive method for detecting terrorists. It would increase the likelihood of the interception of a terrorist attack and maximize the efficiency of resource allocation of authorities. Psychological profiling can distinguish between the non-terrorist and the terrorist because of normalcy and diversity of the traits that constitute a terrorist group's membership. In order to acquire targeted and efficient results in terrorism prevention, the construction of reasonably appropriate set of correctly guided and scientifically derived psychological profiles are needed that have been collected and acquired over the years. For example, variables such as religious, psychological, psychopathological, racial-physical, political, social as well as behavioral patterns that will emerge as coherent protocols for interrogation [2]. Better profile definitions of terrorist and appropriate interviewing will engender the development of new techniques to handle the likely threats. Moreover, classifications of the psychological aims that drive terrorist behaviors will result in designing protocols will be targeted against challenges and real threats, not those that are heuristically derived. Profiling and personal histories of suspects could be used in observing parallels and similarities in the biographical records of terrorists [2]. It may be helpful in discovering that signposts individuals willing to commit terrorists acts or sabotage or would endanger national security.

We propose a professional framework that offers some recommendations for refining the technique of information gathering that based on the standard diagnostic categories of different personality types that may be utilized by interrogation agencies during interrogation in high-profile cases. This paper recommends that it is necessary to define terrorism from the terrorists' perspectives to explain the functional significance and predictive validity of the psychological profile of the terrorist. It is important to split individuals in terrorist organizations into different categories to scan varied types of personalities and characters we will encounter in real rather than focusing on a progressively narrowing or funnel-shaped model of information gathering. The framework in this paper is offered in conjunction with a thrust on psychological examination of multiple sources, scientific consideration of actuarial data and synthesis of existing recent reports from around the globe. The objective is to develop a set of interrogation protocols, which will effectively address the challenges presented by the threats of terrorism in international arenas. We propose that terrorist profiling requires a skill to forage through all the mixed research and contradictory evidence out there and working knowledge of how intelligence is gathered and analyzed about terrorism - without slavish devotion to any one particular line of research or any one database. We recommend that during interrogation the likely psychological makeup of extremists and terrorists should be based on the evidence of their selection of targets, public statements, selection of means, actions, and characteristic histories. The profile information should cover data about different terrorist personalities as well as applicable policies that can be engaged to guide to an investigation process from a wide spectrum of Jihadist and extremists. The aim of this article is to provide basic and sound information concerning the social and psychological core variables of the terrorist's personality that will reduce the scope of interrogation by positioning the counter-terrorism agencies toward a successful resolution to predict future possible terrorist's attacks. However, there is need to understand that different individuals respond differently to questioning as one approach may be effective for one terrorist and ineffective for another.

2 TERRORIST PROFILING

The psychological profiling of a terrorist is an 'educated attempt to provide investigative agencies with specific information about the type of individual who committed a certain crime' [4]. A profiler is able to offer counterterrorism agencies a psychological evaluation of the terrorist's possessions concerning the behavior, motives, and background information about a terrorist in an attempt to direct an investigation. A profile contains information (such as age, gender, family status, education, socioeconomic status, race, religion, citizenship, ethnicity, psychological attributes, political and religious affiliation, terrorist history and habits. These items act as reminders of a violent episode or terrorist act and develop some likely suspects or improve the target population pool. It alerts the investigators to the possible psychological traits present in a terrorist scene that can be further used in question evaluation of investigation. Through behavior based profiling

and analyzing a collection of items collected from a suspect, psychological profiling may able to offer an interrogator with an appropriate plan for interviewing strategies and gives suggestions about items the offenders may possess. It further defines that estimating a terrorist threat (what profiling does) is different from assessing a terrorist threat (figuring the risk) [4].

In the criminal environment, profiling is used as a process of identification of suspect, mostly in highly emotive cases involving sexual-orientated killers, rape offenders, and serial arsonists [5]. This psychological profiling may suggest items the suspects may have in their possession that serve as a reminder of the violent episode and offer investigator a plan to interview. Several criminologists have associated sexual deprivation, traumatic life experiences, violent behavioral patterns with the presence of mental trauma and an oppressive formative atmosphere in the criminal's past [5]. However, profiling terrorist is different than profiling criminals. Terrorists are indeed "uncommon" criminal as they are masters of evasion and disguise and take their religion, nationality and politics very seriously [6]. Terrorists profiling attached such proclivities as revenge, religious and social suppression, submission to conventionalism, the displacement of anger onto others, internal guilt, aspirations of toughness, bravado and authoritarian and attracted in the promise of virgins in the hereafter [6]. Their hardened belief system makes them immune from shame, regret, guilt and remorse and their way of seeing things ought to be the conventional way and try to impose their deviant attachments on others by force or by insisting. They are not loners and mostly supported by group of people or peer support. Sometimes they represent a perplexing mix of ethnic, economic, and social backgrounds and likely to be travelers or immigrants [6]. A study conducted by [7] reveals that among 242 terrorists who were involved in terrorist attacks from 2001 to 2006 in Europe were mostly from Arab countries and had been born and raised in Europe. These terrorists came from middle or lower-class backgrounds. At the time of their arrests their age range was from 16 to 59 with average age of 27. Only 1 in 4 terrorists had a formal criminal record. This inability may reflect poor police record keeping instead of low criminal involvement.

Interrogator can analyze the terrorist's habits by comparing the current and previous terrorist acts and much like what used to be called indications and warnings during scanning process that can predict future possible attacks as well as probable sites of terrorist attacks. [8] Has mentioned these terms in her classic book "Anticipating Surprise" for intelligence community. Indicators are series of events that are mostly suspicious. Warnings on the other hand are indicators which spread a critical mass and indicate an imminent threat looms. Investigators found that indicators are tougher than warnings to profile. It requires a working knowledge of how information or intelligence is collected and examined about terrorism for interviewing captured terrorists. It includes patterns of known behaviors, attack scenarios, warning signs, red flags and all the practices of risk assessment, to be capable of being negotiators and interrogators. The more sequential the indicators are, the more probable they are "precursor events" that fit a past pattern of known psychological traits that constructs a recognizable attack vector, which is a warning [8]. According to some criminologists, these patterns resemble with a term called modus operandi – which refers to the kinds of acts that a terrorist must or should do in order to be achieve the goals [1]. Through analyzing a collection of items possessed by suspected terrorists, it is expected that profiling during investigation will be a panacea to catch terrorist before they act. Similarly, as law enforcement agencies with criminal history- or behavior-based profiling, all you are trying to do is develop some likely suspects and/or improve the target population pool. It is possible to build good trait-based profiling of terrorists to catch the non-profileables such as recruits and converts, who do not fit any profile or those groups who attempt to infiltrate intelligence agencies. For instance, an al-Qaeda operative, dyes his hair blonde, may shave his beard and take a name like Martin Crow. In other words, profiling is a very proactive kind of intelligence gathering that guides law enforcement agencies to identify unknown and unpredictable perpetrators - when more questions than answers are raised in risk assessment.

3 PROFILING TARGETS

This research explores that before interrogating suspect it is important to understand that every terrorist and malicious insider is different that reflects a unique constellation of personality traits or psychopathology. Violent terrorists vary with their motives as well as their responses to interrogation. For one type of terrorist, one approach may be operative, but it is a drastic mistake to assume all terrorists will respond to the same interviewing strategy [2]. For example, not all potential suicide bombers kill themself for the same reason, and not all terrorist respond to the same type of interviewing design. This paper argue that terrorists is a complex phenomenon and picture of profiling should consistent with state-of-the-art information of ideological, psychological, religious, social, and political sets of motives and behaviors intertwined. The preventive effort by counter-terrorism agencies ought to be directed is lacking. However, a clearer picture should emerge out from this work that will illuminate some of the current flaws in the narrow view(s) of interrogators that is based largely on anecdotal information and actuarial and is guided by theory. Nevertheless this work calls for better implementation of psychological study with interrogation and empathic interviews. It can be tested against the realities such as interrogation technique like fMRI, which is currently under focus in prevention efforts, which will unfold in the struggle with terrorism in the years to come. Consequently, this article is offered with the urgent and earnest suggestions that existing efforts to

prevent terrorism for all domains be compared against these recommendations. Such as to divide terrorist profiling in different categories to steer clear of oversimplified thinking about individual terrorist or groups as either-or a psychological phenomenon or a political phenomenon in the creation of interrogation protocols. These categories are a) Individual profiling b) Group profiling and c) Organization profiling & d) Racial, gender and age profiling

4 INDIVIDUAL PROFILING

On the individual level, once a suspected terrorist is apprehended, a profile package for interviewing should contain profiling information regarding different strategies and different personalities in soliciting material from a diverse group of terrorists with effective methods of interrogating. People are attracted to particular terrorist group as a function of their own values, personality characteristics and attitudes. It is important to note that not all suspects react to interviewing questions in the same fashion. For instance, some terrorist peoples such as Al Qaeda members are very highly qualified. Statistics reveal that that nearly 10% of its members are very well educated, PhDs and post-graduate educations [9]. Testing and profiling individual targets is crucial in interrogation as many of terrorists are coming from very wealthy backgrounds. If an interrogator comes up with a profile of an Al Qaeda member, counter-terrorism agencies must know that there are many different types of individual involved in this organization and you can't come up with one single profile. However, it is challenging for law enforcement agencies to develop useful psychological profiles of those individual terrorists who are on the other side of a barricade or who haven't even identified. This category is further sub divided into various personality types such as:

4.1 NARCISSISTIC PERSONALITY

Firstly, narcissistic personalities are the extremist cult leaders, classic criminal and dictators who give the orders and expect them to be followed and convinced of their own authority and infallibility. Interrogators can extract information from these personalities by treating the person with a certain degree of respect and deference that can appeal to his self-inflated egotism. Interrogators should ask them a number of questions during scanning and act impressed with letting him know he/she is the "big fish" agencies have been after [2]. It is challenging to extract information from Underbosses and leaders at next level as they may only stiffen their resistance and may well view their apprehension as proof of their martyrdom. These Narcissistic lieutenants may cooperate with interrogators if they can be persuaded that their own well-deserved rise to influence in the organization has been unfairly thwarted by less worthy group members [2].

4.2 PARANOID PERSONALITY

These individuals comprise the other main category of cult leaders in the organization and their philosophy is more likely to have religious, racial or political motives in contrast to the narcissist's universalist philosophy. Paranoid people are a personality pattern of pervasive suspiciousness and distrust to invariably interpret as malevolent persecutory and deceptive. These members are not likely to alter their delusional beliefs and expected to remain silent during interrogation or may use countermeasure to avoid questioning. Investigators, should piece together some coherent threads of evidences by spinning a theory of the case in "yes" and "No" questions during scanning that can later be independently corroborated [5].

4.3 ANTISOCIAL PERSONALITY

This group of people may join extremist or terrorist organizations for the sheer thrill of power, and are often the soldiers, assassins or muscle of the group and capable of rise to positions of great authority within the organization. They are typically associated with substance abuse, criminal behavior, sexual promiscuity and impulsivity with parasitic, predatory and exploitive lifestyle with a pattern of consistent disregard for, and violation of, the rights of others. However, this group of people has no true loyalty, commitment or identification and can betray their group members to save their own skins. Investigators might try to exploit this self-serving character during scanning to reveal truth and support authorities by offering a deal in exchange for intelligence. These characters also generally tend to manipulate interrogators by using countermeasures to mislead information. Data obtained should therefore be validated as thoroughly as possible [5].

4.4 BORDERLINE PERSONALITY

These suspects are people of personality are self-damaging impulsiveness, a chronic feeling of emptiness, a pattern of erratic, intense and impaired interpersonal relationships. At the start, these people build influential relationship with the leader of the organization and its ideology that make them useful to expand their function and role for terrorist mission or

criminal operations. However, their changeable affiliations may work to investigator and to step in to change their fierce devotion into rabid resentment. These suspects can be easily scanned with their will with strong bond of rapport and by convincing the borderline that suspect's cooperation will "right the wrong" that's been done to them. Suspect can cooperate with interrogator that may reveal intimate details of the group's plans and activities that can be independently validated. The only alert here is that this suspect may later turn on authorities with equal intensity if she/he feels misused or rejected [5].

4.5 AVOIDANT PERSONALITY

Avoidant personality is individual with feelings of inadequacy, social inhibition and shunning of confrontation that would choose a vocation like terrorism on the basis of ideology and social justice philosophy drive by religious or political group. These suspects are unlikely to be on the front lines of the terrorist organization, but may provide valuable support and supply roles. Interrogators can earn their support and can get information in proportion to the amount of security provided to the suspect. This practice can also actually be relieved him to be out from under the thumb of the extremist organization. Interrogators should employ simple and non-confrontational style of questions in scanning and should focus on specific questions that allow the suspect to answer yes or no in a piecemeal fashion [4].

4.6 HISTRIONIC PERSONALITY

Histrionic personalities are attention-seeking, flamboyant theatricality in speech and behavior, excessive emotionality, an impressionistic and impulsive cognitive style and need for excitement. Criminals and extremists groups call them showboats and solicit these individuals as front-men in media or politics as they who enjoy being at the center of attention. Interestingly, these personalities are not willing as other group members to get their hands dirty with terrorist act or dangerous work. The concern is that these individuals are hunger for recognition that may eclipse their loyalty to the organization; interrogators may feel difficulty in interrogation as they may draw too much attention to the group's activities and thus become an expendable liability. However, smart investigation methods can induce the histrionic suspect to barter valuable intelligence for the promise of a positive spotlight. The information obtained with an investigatory asset should be independently corroborated due to suspect's tendency for self-aggrandizement and embellishment [4] [5].

4.7 SCHIZOID PERSONALITIES

Schizoid personalities are suspects with more serious delusional thinking and more bizarre behavior with aloof detachment and a restricted range of emotional expression. They are not typical members of terrorist group but their personalities may lead them on spiritual and philosophical quests that end up at the door of religious and social movements with extremist or criminal ties and show violent commitment if the organization's movement 's and its ideology appeals to their idiosyncratic world view. Practical psychologists can encourage schizoid suspects with simple and precise questions during interrogation to reveal useful information and intelligence. However, due to the bizarre and delusional nature these individuals, the information they provide may compromise its validity and usefulness. Effective screening is all about dealing and understanding human nature and behavioral sciences that can increase the overall effectiveness of this technology in all phases of the criminal justice process [5].

5 PROFILING GROUPS

On the group level, many of the same profiling methods that are used for classifying individual targets can be used to understand group of persons. It is also important to consider the social influence and motivational basis involved in recruitment of new members to terrorist organization and their indoctrination into terrorist ideology. For instance, primarily mercenary driven groups which include drug cartels, urban street gangs and Mafia-type organizations are involved in criminal activity purely for financial gain. In contrast, ideologically driven organizations, such as international and domestic terrorist groups, are driven by some political or higher religious cause, such as world socialism, Islamic jihad, white supremacy and radical environmentalism. Interestingly, many terrorists and criminal groups hold elements of both mercenary driven and ideologically driven elements such as recent Tahreek e Taliban Pakistan activities in Pakistan in bank robberies, tax scam by North American white power groups, religiously devoted narcotics or weapons smugglers in the Middle East. This profiling should address the shared reality construction and the use of language in creating terrorism warranting norms [1], [10].

6 PROFILING ORGANIZATIONS

Terrorism is, after all, an act of political theater and terrorist organizations achieved their targets with communicating with the rest of the world. On the organizational level, profiling should contain analysis of those communications as it is possible to work from written products of these groups to understand who the writers are as well as what the writers want. Other traits that must be considered are cost effectiveness, trainings and logistics launch or abstain from terrorist activities.

It is important to consider that profiling of all these organizations is mutually reinforcing and interdependent. The organization depends on group-level processes of socialization and indoctrination, which in turn operate on individual psychologies that contribute their motivation to the advancement of terrorist causes and for group survival. These three different profiles operate in concert to further boost the culture of terrorism [12].

7 RACIAL, GENDER AND AGE PROFILING

An effective terrorist profile must be created to clearly indicate of terrorist behavior and that lessen the malfeasor individuals to a plausible size for interrogation purposes. In critical situations, most egregious and the crudest method of investigation may be conducted on the basis of racial profiling, such as alienage and ethnicity is the logic that may be viewed as adequate demographic divisions for the scrutiny of the subjects [11]. This profiling is the logic and as a general rule that individuals of a certain race are more likely to commit crimes or acts of terrorism (such as Border areas of Afghanistan and Pakistan – e.g., Waziristan). After the 9/11 terrorist attacks, Border security agencies of many countries has implemented different interrogation techniques based on racial characteristics to identify potential malfeasors. Similarly, racial profiling may emerged as a viable option for detecting potential terrorists. [12] Writes that, '[to profile] on the basis of race and comparable factors, is both discriminatory and foolish. Arabs and Muslims - to name the two most obvious targets for such reactions today - are part of the American mainstream. Many are citizens. The vast majority… are altogether innocent of any connection with terrorism. Meanwhile, some people who are not Arabs… have apparently joined our enemies in Al Qaeda'.

Another immutable dimension to scan suspects is biological gender. The dominance of male terrorists should not be overstated as male-centric profiling, however, numerical superiority show that 19 hijackers of 9/11 and mostly terrorist attacks in Pakistan are done by male terrorists [13]. Additional dominate factor in terrorist profiling is an age factor that can be considered as to limit the filtering of a large population into a manageable group for interrogation. There is no definitive age group that terrorists fall into but statistics reveals that the average age of suicide bombers and terrorists are considerably lower in Afghanistan and Pakistan. Furthermore, the suicide bombers in Pakistan during last 5 years were also in their early twenty's (16 to 19 years) [13]. The LTTE (Liberation Tigers of Tamil Eelam) had many members who were preteens [1] [6]. However, at the other extreme, it is clear that age is a problematic measure of profiling potential terrorists as FBI's Most Wanted Terrorists list was published in 2001, the average age of the 22 individuals listed was 37 years-old [13]. The most wanted terrorists of the world - Osama bin Laden was also in his late 50's when he was killed [13]. Secondly, relying on race, gender and age factor for terrorist profiling may not be a practical solution for an effective counter-terrorist measure and may be condemned as institutionally racist, unconstitutional or prejudiced by the general public. These profiling techniques may exploit individual liberties such as the routine searching of young black males by police patrols and may create the culture of terrorist stereotyping and climate of fear. It is not yet revealed that whether a psychopath's brain works as the same as someone else's in different kinds of terrorism. There are many different types of terrorism, each one with its own nature, approaches, models, theories and which can be related to different dimensions of terrorist profiling.

8 DIFFERENT TYPES OF TERRORISM

There are many types of terrorism with many different purposes. For terrorist profiling it is important to know the different types of terrorism to understand how to counter and deter it with interrogation. Different types of terrorism have been defined by security professionals, lawmakers, and scholars such as:

8.1 STATE TERRORISM

These terrorists are usually sponsored by state to use force or threat of force to achieve political goals. German under Nazi rule is the prime example in this way. The US considers Iran to sponsor its arm group such as Hezbollah to carry out its foreign policy objective. The US has also been called terrorist through its covert sponsorship of Nicaraguan Contras in the 1980s [1].

8.2 NATIONALIST TERRORISM

These terrorists use violence to get people's sympathy because they fight for national liberation. Kurdistan Workers' Party, Basque Fatherland and Liberty and IRA (Irish Republican Army) are the major examples of nationalist terrorism [1].

8.3 PATHOLOGICAL TERRORISM

Pathological terrorists use violence to terrorize for their own pleasure or because of personality disorders. They often operate alone rather than in groups and lack any well-defined political or religious motive. This violence is commonly seen in serial killing scenarios and school shootings. The shootings at Congresswoman Gabby Giffords and of Columbine High School serve as examples of pathological terrorism [1].

8.4 SEPARATIST TERRORISM

Separatists seek to cause fragmentation within a country and establishment a new state. This type of terrorism is typical of minorities within a nation-state that desire their own, commonly due to discrimination from the majority group. Civil disorder is a sometimes violent form of protest held by a group of individuals, usually in opposition to a political policy or action. They are intended to send a message to a political group that "the people" are unhappy and demand change. The protests are intended to be non-violent, but they do sometimes result in large riots in which private property is destroyed and civilians are injured or killed. For examples: The most prominent examples are the ETA Basque separatists in Spain, the Chechen terrorists in Chechnya, the Tamil Tigers in Sri Lanka, the Kurdish PKK in Turkey, and the Quebec Liberation Front in Canada [15].

8.5 BIOTERRORISM

Bioterrorism is a type of terrorism describing violence in the interests of toxic biological agents to terrorize civilians in the name for the political or other cause. The bacteria, viruses and toxins could be used in an attack and most likely to do the most damage. They include:

- Smallpox (Variola major)
- Hemorrahagic fever, due to Ebola Virus or Marburg Virus
- Tularemia (Francisella tularensis)
- The Plague (Yersinia pestis)
- Anthrax (Bacillus anthracis)
- Botulism (Clostridium botulinum toxin)

Eco-terrorism is a recently coined term has been added in Bioterrorism. Environmental terrorists sabotage property to inflict on industries, economic damage or actors they see as harming animals or the natural environment. The best documented illustration of this ecoterror group is the ELF (Environmental Liberation Front) due to their attacks on logging operations and ski resorts [15].

8.6 CYBER-TERRORISM

Cyber-terrorists use information technology to orchestrate a traditional attack on state and civilians and draw attention to their cause or to show off their technical abilities. Cyber-terrorism would radically disrupt networked services; hack into networks housing critical financial information, could disable networked emergency systems dams or power plants or can allow disruptions in military communications. Groups like Tamil Tigers and Aum Shinrikyo are identified as cyber-terrorists [16].

8.7 NUCLEAR TERRORISM

This term originally refers to nuclear materials that might be exploited as a terrorist tactic. It includes purchasing nuclear weapons, attacking nuclear facilities or building nuclear weapons [15].

8.8 NARCOTERRORISM

Narcoterrorism is another type of terrorism that has several meanings since its coining in 1983. Terrorist organizations such as Liberation Tigers of Tamil Eelam, Shining Path, Kurdistan Workers' Party, Revolutionary Armed Forces of Columbia, Real IRA, the , United Self-Defense Forces of Columbia, Basque Fatherland and Liberty, Al-Queda (Taliban),National Liberation Army and Hezbollah use narco-terrorism. Experts think that nearly every terrorist group today uses narc-terrorism to fund their other operations, to influence governments or prevent state efforts to stop the drug trade [17].

8.9 RIGHT WING TERRORIST

Right wing terrorism is one of the disorganized terrorists groups that aims to combat preserve traditional social orders and liberal governments. These terrorists characterized by gangs and militias. Mostly these organizations are racially motivated and they attack refugees and immigrants. They also aim to marginalize minorities within a state. The Neo-Fascists and the Klu Klux Klan are modern right wing terrorist groups. Many groups are also present in the US, Russia, Germany and others [2].

8.10 LEFT WING TERRORIST

Left wing terrorism activities limit the use of terror stay away from harming victims, however, seek to overthrow capitalist democracies and take over with communist or socialist regime in their place. Examples are: the Red Brigades, Japanese Red Army, the Weathermen, the Baader-Meinhof Group and are all examples of left wing terrorism. These groups still exist, however, they are not as active as they were during the Cold War. The Liberation Party-Front in Turkey, the Revolutionary People's Revolutionary Organization, and the Revolutionary Armed Forces of Columbia (FARC) are all current examples of left wing terrorist groups [2].

8.11 RELIGIOUS TERRORISM

Religious terrorism is a type of terrorism that use violence as their strategy and attack large numbers of their enemy. Religious terrorism has a long history from Muslim-Hindu tensions in India and Pakistan to Catholic-Protestant violence in Ireland. Recent examples are Hezbollah, Hamas, Aum Shinrikyo, Tahreek e Taliban Pakistan and Al-Qaeda. This terrorism can be motivated by grievances and religious ideologies and particularly dangerous due to the fanaticism of those groups or individuals who practice it and their willingness to sacrifice themselves for the cause, such as suicide bombings. Religious teaching made it possible to encourage and even justify this kind of self-sacrifice [18].

It is a matter of urgency that overt steps of terrorist profiling with different kinds of terrorism have to be taken before any inchoate offense is suspected. We call these steps as indicators. In a current scenario these indicators are necessary as they refer to those threats which would have to happen and those that would likely occur as a scenario unfolds, such as intention, capability and target vulnerability [18].

9 PUTTING THEORY INTO PRACTICE

Presented a research on the behaviors and motivations of bombers [19]. The authors compared the similarities and differences between the terrorist behavior of bombing and the psychopathic personality. Authors noted that ''Priests and gangsters, police officers and criminals, bricklayers and psychologists, men and women of all trades and professions have been arrested for these crimes. The personalities of bombers are as varied as their explosive devices''. Ref [20] added a new dimension to terrorism investigation with using his knowledge of psychopathology. He wrote that ''by studying a man's deeds, he could deduce what kind of man he might be''. Ref [21] applied profiling as the basic principle in his book, Bombers and Firesetters. In his research, he interviewed more than 100 arsonists and 30 bombers and identified different types of bombers.

Also hypothesized two classes of repetitive bombers, such as nonpsychotic bombers whose motives are based on desire for revenge and animosity [22]. Second type is psychotic bomber whose motives are based on three possible explanations such as life stress, intoxication, and intense emotional states. Ref [22] explored that psychotic are generally reflecting socially deviant behavior, personality disorder and the personality traits widely considered to be descriptive of the syndrome. This type of bomber is also 'obsessed with explosive devices and can go to any extent to secure technical information and materials. These profiles are occasionally reported with sexual or other emotional arousal or gratification associated with explosions. Ref [13] Found that the greater the degree of psychopathy terrorists, the less likely he is to be genuinely

motivated by political beliefs. In similar sense, all terrorists and suicide bombers are not psychotic but there are certainly psychopathic terrorists. The dilemma is - none of the profiles of bombers are empirically tested with previous investigative procedures, technologies and typologies. It is recommended that investigator should consider psychopathy profile as genotype that may be phenotypically expressed, in kind and degree, in bombers.

Psychological profiling can be conducted by succeeding the previous psychological studies and with their amalgamated results that are widely distributed in a population. A study done by [23] focusing on American terrorist profile in the 1980. They identified that these terrorists could be categorized as right or left wing with noticeable difference between the two. For instance, Right wing: anticommunist; Religious/Christian identity ideology; natural networking structure; based in rural areas; Targets state agencies and opposing religious and racial groups. Left Wing terrorists are: procommunist; political/Marxism ideology; cellular structure; based in urban areas; target government or government buildings. Smith & Morgan also found that these two groups are differed in their demographic characteristics. Such as Right Wing are: 97% white; 93% male; Average age 39; rural residence; 12% with college degrees; many unemployed or self-employed. Left Wing is: 29% white; 73% male; Average age 35; rural residence; many in professional occupations and 54% had college degrees. We argue that this research is a better methodological approach then previous studies, however, these profile many not have much operational even if accurate.

Once investigator accepts the notion that terrorist profiling makes it possible to elicit a behavioral signature, now the next question is what counter-terrorism agencies should do to pick up on these psychological clues? What to do with this information once they have it? We recommend that law enforcement agencies have to work through a series of systematic phases.

9.1 PHASE 1: PSYCHOLOGICAL PROFILING INPUTS

The first step involves collecting as much terrorism related information as possible, photographs of the terrorism plan, maps, routes, weapons used, key places, terrorist scene, autopsy reports and essentially anything that is likely to indicate what happened, why it happened and how it happened.

9.2 PHASE 2: DECISION PROCESSING

Armed with the evidences from phase 1 the next phase involves finding whether the terrorism in investigation can be found within a number of profiles and behavioral classifications within a particular case the terrorist will be assigned that classification, for example, suicide bomber. This phase will also generate a number of multi-dimensional descriptions of bomber in more general classification, such as, person involved (man, women, gangster, criminals, serial killer), bomber type (psychotic or non-psychotic) and the primary motive (religion, political, revenge, financial, emotional etc).

9.3 PHASE 3: TERRORISM ASSESSMENT

The key objective of this phase is to piece together the chain of terrorist act before, during and after the terrorism. In phase three, investigator has to reconstruct the terrorist act from the perspective of both the state and the terrorist and the damage being done.

9.4 PHASE 4: THE TERRORIST PROFILE

On the basis of investigator's assessment and information he or she has collected from the previous phases the interrogator is now in a position in phase four to hypothesize for interviewing question with different techniques with a suspect who has committed or planning to commit terrorist act. The primary description will usually comprise details relating to terrorist age, sex, ethnicity, religion, education, IQ, skills, affiliation with any organization and family background.

9.5 PHASE 5: INTERROGATION PROCEDURE

This phase will generate detailed report that will be made available for interrogation team so that they can concentrate their efforts on suspects who appear to match the profile. Another great strength of this phase is the potential to minimize the information overload as there are obvious cases that are more appropriate for psychological profiling than others. For instance, in the United States, the search for the "green river killer" in the Seattle caused 18,000 possible suspects. In another case in the UK, in the Yorkshire Ripper inquiry, generated 268,000 named suspects and the police conducting 27,000 house visits [24]. This whole process have a direct effect on the number of months and weeks spent on the cases by positioning the

law enforcement agencies toward a successful resolution. However, psychological profiling traditionally employed in investigation process will only follow the arrest of a prime suspect that can be used to help develop and inform appropriate interviewing strategies [24]. The successful investigator will keep in mind his role and blend his expertise to assist and offer insight into the type of person who would commit the terrorism currently under investigation by fulfilling fundamental processes in the profiling endeavor [31]. This phase will be helpful in developing appropriate interviewing strategies and follow the arrest of a prime suspect.

Psychological profiling can also be conducted by succeeding the previous psychological studies and with their amalgamated results that are widely distributed in a population. Some studies have been done to psychologically profile of European terrorists. For instance, [25] analyzed right-wing Italian terrorism. They define a term "authoritarian-extremist personality" categorized by ideological vacuity, pathological disturbance and a psychological disconnection with reality. On the other hand [26] characterized German terrorist leaders into two different psychological profiles. For instance, first category consists of hostile neurotic, paranoid and the intolerant terrorists. The apathetic extrovert, egotistic and the unstable terrorist lie in second category. Ref [26] terms the combination of psychopathological terrorist and logical reasoning influences as 'terrorist psychologic'. This personality trait is a system of warped cognition that legitimizes and rationalizes 'terrorists acts are psychologically compelled to commit'. This term is also indicated by [6] in the case of suicide terrorism. Palestinian suicide bombers are astounded by a life experience which has caused by hopelessness and anger due to losing of close relative at the hands of Israeli security forces.

10 ROLE OF PSYCHOLOGISTS IN INTERROGATION

This research recommends that psychologist should be involved in the interrogation process as they can use their scientific and professional expertise to address both the threat and the impact of terrorism and thus be a key element of the response. They are capable to assess how terrorist's organizations impact on different segments of our pluralistic society. Psychologists with relevant expertise can address the issue racial profiling, and the potential for the erosion of civil liberties and human rights [30]. Thus, it is necessary that interrogators investigating suspects should have a background in psychological and indirect assessment and willing to research in related discipline of investigating terrorists such as criminology, psychology and sociology. It is also important that investigator is willing to accord his top priority in critical situation and he should know the practical realities and a sincere interest in a police work [29].

11 DISCUSSION AND CONCLUSION

Some researchers claim that terrorist profiling is a highly contested practice that runs the risk of being biased and little benefit would be gained from it because of obvious discriminatory factors [27]. They claim that psychological profiling is a controversial racial profiling and some minorities are targeted on the basis of religion, ethnicity, race and political affiliation and limited to vague implications of irrationality and insanity. Ref [27] states that, behavioral scientists have not succeeded in identifying a unique "terrorist mindset"' due to the psychology of individuals drawn to the violent political behavior. Research shows that there is much proof that quick and tough measures often create false positives. Ref [13] also argues that no such definitive terrorist personality has been found to exist in the scholarly literature. Though, there is only mild evidence that these factors have behavioral counterparts but no proof that terrorist profiling causes any immense loss of civil liberties or human rights.

However, this research is a first step forward in this direction. It claims that it is possible to build good terrorist profiles for interrogation with our suggested framework. Investigators can use profiling equitably and wisely without creating any panic that terrorists are all around us. However, there are some figurative 'road blocks' that hinder the success of terrorist profiling, such as the absence of any apparent psychological dysfunction in the biographical records of terrorist profiling [29]. We suggest that psychological profiling of terrorist requires more primary data to provide considerable results. While little benefits are expected from including the discriminatory factors of citizenship, race and political incorrectness of using religion and psychological profiling that will intrinsically a fruitless endeavor. Investigator should note that terrorists groups and organizations are far from homogenous and the personalities of terrorists are diverse then criminal [30]. Profiling of terrorists require the skills to build profile not only bombers and hijackers but smugglers, bomb-makers, leaders, communicators, financiers and trainers, as these characters culminates in the overall terrorist movement. As [28] to write that; 'The personalities of terrorists may be as diverse as the personalities of people in any lawful profession. There do not appear to be any visibly detectable personality traits that would allow authorities to identify a terrorist'.

It is important to note that the information provided in our framework should be based on conjectures from analysis of biographical commonalities, media reports and biographical material in terrorism prevention. Law enforcement professionals

and their recognized responses to existing preventive efforts must established behavioral patterns, political maneuvers over decades as well as across various conflict areas [31]. The dilemma is, retired terrorists are not willing to join in these kinds of framework or studies. Apart from these challenges, the basic challenge in investigating the practices of profiling in interrogation process is to define the limits of the term terrorism. The definition within the field of terrorism research must be presented due to the significance of building operational boundaries in terrorist profiling [32]. The effort to further research for this obstinate stumbling block is necessary to discover the universal definition of term "terrorism" in order to achieve some clarity of meaning. This conceptual opacity is one of the most difficult obstacles in coping with terrorism as not all of the activities involved in terrorism are illegal [33]. Furthermore, not all individuals particularly those which support the ultimate action cannot be termed as terrorists such as a peripheral network of terrorist sympathizers, financiers and promoters. Those creating a terrorist profile in must do exactly to differentiate a terrorist from a non-terrorist to fill a gap of definitional unanimity.

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Application and Development Trend of Flue Gas Desulfurization (FGD) Process: A Review

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ABSTRACT: In 1927, the limestone desulfurization process was first applied in the Barthes and Bansside Power Plants (total 120MW) beside the Thames River in UK to protect high-rise building in London. Up to now, over 10 desulfurization processes have been launched and applied. Based on the desulfurizing agent being used, there include calcium process (limestone/lime), ammonia process, magnesium process, sodium process, alkali alumina process, copper oxide/zinc process, active carbon process, ammonium dihydrogen phosphate process, etc. The calcium process is commercially available and widely used in the world, i.e. more than 90%. Flue gas desulfurization processes, survey made by the coal research institute under the International Energy Agency shows that the wet-process desulfurization accounts for 85% of total installed capacity of flue gas desulfurization units across the world. The wet-process desulfurization is mainly applied in countries, like Japan (98%), USA (92%), Germany (90%), etc. The limestone-gypsum wet desulfurization process, the most mature technology, the most applications, the most reliable operation in the world, may have rate of desulfurization of more than 90%. Currently, the flue gas desulfurization technology used at thermal power plants at home and abroad tends to be higher rate of desulfurization, bigger installed capacity, more advanced technology, lower investment, less land acquisition, lower operation cost, higher level of automation, more excellent reliability, etc. This paper briefs current situations and trends of flue gas desulfurization technology also append short descript of different type of FDG and their category.

KEYWORDS: Desulfurization Process, FGD technology, Wet-process limestone, lime-gypsum, thermal power.

1 INTRODUCTION

It was in UK that the 1st test on flue gas desulfurization in the world was carried out, following London Smog Episode (Dec., 1952). Up to the middle of 1960s, sulfur dioxide pollution had become a major concern related to environmental impact in UK, USA and former western Germany. Later, large-scale research was initiated in the USA and Germany [1]. Information shows that 20-plus means on flue gas desulfurization were among the USA's list of research in 1960s, which were applied in nearly 100 projects, consuming investment of billions of dollars [2]-[3]. Germany, the biggest coal-fired country in the Europe, ranks 1_{st} on sulfur dioxide emission and leading to complaints from the neighboring countries. Thus, huge amount of human and material resources was made to address the problem. Japan, the 1_{st} country in the world to apply the flue gas desulfurization unit in a large scale, had started operation of such unit as early as in the end of 1960s so that sulfur dioxide pollution in Japan was put into control since the middle and late of 1970s [1]. Applications of flue gas

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desulfurization unit in a large scale in USA, Germany and Japan demonstrate good yields at proper control. Despite of increasingly rising total installed capacity of power plants in the above 3 countries over the past few years, total amount of emission of sulfur dioxide drops on a year-on-year basis [3]-[4].

2 DEVELOPMENT COURSE OF FLUE GAS DESULFURIZATION TECHNOLOGY

2.1 INITIAL STAGE

Between the early of 1970s and end of 1970s, the 1_{st} generation of flue gas desulfurization technology based on the limestone wet process started to be applied in power plants, which included limestone wet process, lime wet process, MgO wet process, dual-alkali process, etc. The 1_{st} generation of flue gas desulfurization units was mainly installed in the USA and Japan [2].

2.2 DEVELOPING STAGE

Between the early of 1980s and end of 1980s, the flue gas desulfurization technology based on the dry process and semi-dry process was shaped, including spray drying, limestone injection into the furnace and activation of calcium process, circulating fluidized bed process, pipe jetting, etc. Amid the period, the wet limestone cleaning process experienced rapid development. Particularly, great changes had been made on use of single tower, as well as design and general arrangement of the tower.

Japan Ebara proposed the dry flue gas desulfurization process as early as in the early of 1970s and made joint research with Japan Atomic Energy Research Institute (JAERI). In 1980s, a pilot plant of 24,000 Nm^3/h in the Indiana of USA was built for testing. Currently, over 20 test units and pilot projects have been put in place in Japan, USA, France, Russia, etc. For the semi-dry flue gas desulfurization technology, it is outcome of joint efforts made by the American JOY and Denmark NIRO [2],[5]. Since the 1st industrial unit adopting such process was built in the North America in 1978, the process has been experiencing rapid growth, which is thus utilized in 12 countries and market shares have arrived at 10.29%. The rotary spray dry process (SDA), suitable for medium and low-sulfur coal in the past, is now upgraded to be compatible with high-sulfur coal. Since the process may function with good economic return, it is recognized as the 1980s'FGD technology [6].

2.3 MATURE STAGE

With entry into the 1990s, many developing countries (especially the Asian countries) have stipulated some emission standards designed to control acid rain. After development of two generations, FGD technology has advanced into a new period, i.e. simplification of redundant system in the desulfurization process greatly benefits operation reliability.

3 CURRENT SITUATION OF FLUE GAS DESULFURIZATION TECHNOLOGY

With FGD technology experiencing development and application over the past decades, some processes have been eliminated for technical or economic reasons. On the other hand, main processes, such as limestone/lime humidification process, flue gas circulating fluidized bed process, limestone injection into the furnace and activation of calcium process, spray drying process and upgraded humidification ash circulation NID process, etc., have grown up and become more mature, which may be demonstrated in the following areas:

3.1 HIGH DESULFURIZATION EFFICIENCY

The optimized wet process may yield desulfurization efficiency of more than 95%, spray drying and NID process 85%-90%, improved limestone injection into the furnace and activation of calcium process 85%, circulating fluidized bed process more than 90% in the case of same rate of utilization of absorbent as the wet process.

3.2 HIGH UTILIZATION

With in-depth understanding of chemical reaction principle of desulfurization process, appropriate control of reaction process and correct selection of structure material, as well as quality assurance from the desulfurization unit manufacturer, a high efficiency of utilization for the desulfurization system is achievable to ensure that it operates with the boiler in a synchronized step.

3.3 SIMPLIFIED PROCESS FLOW

Taking the limestone-gypsum wet process as an example, the process was first proposed by British Royal Chemical Corporation. Since 1970s, the process experienced 3 generations of development in the industrial applications over the past 3 decades, as a result of which the wet-process limestone/lime-gypsum flue gas desulfurization technology has well developed and widely applied [7]-[8].

The 1_{st} generation of wet-process limestone/lime-gypsum flue gas desulfurization technology was put into the industrial applications since the early of 1970s. At that time, the desulfurization absorption unit was made up of 3 towers and 1 tank, i.e. Pre-scrubber, scrubber, oxidization tower and reaction interim storage tank [9], which is illustrated in fig.1

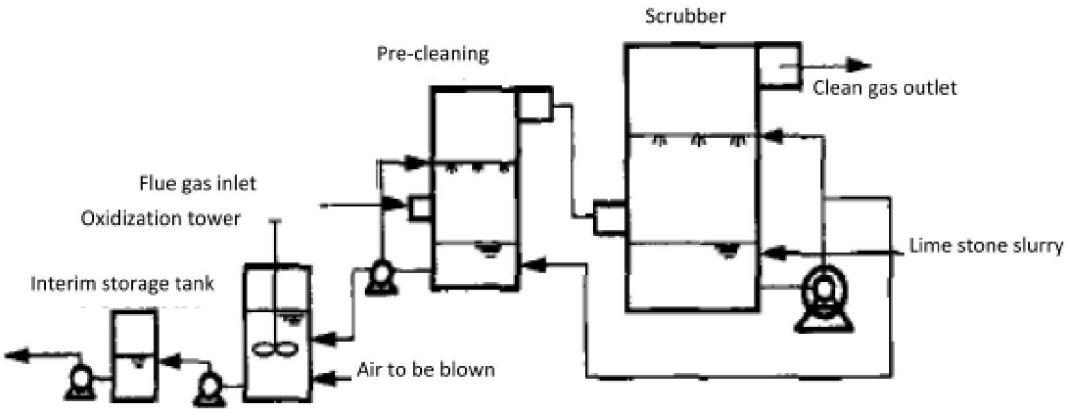

Fig. 1. 1^{st} Generation of wet-Process Limestone/Lime-Gypsum Flue Gas Desulfurization System Schematic

Approximately in the middle of 1980s, the 2_{nd} generation of wet-process limestone/lime-gypsum flue gas desulfurization technology occurred. The absorption unit using the technology puts the pre-scrubber and scrubber together and eliminates the interim storage tank [10], as illustrated in fig.2

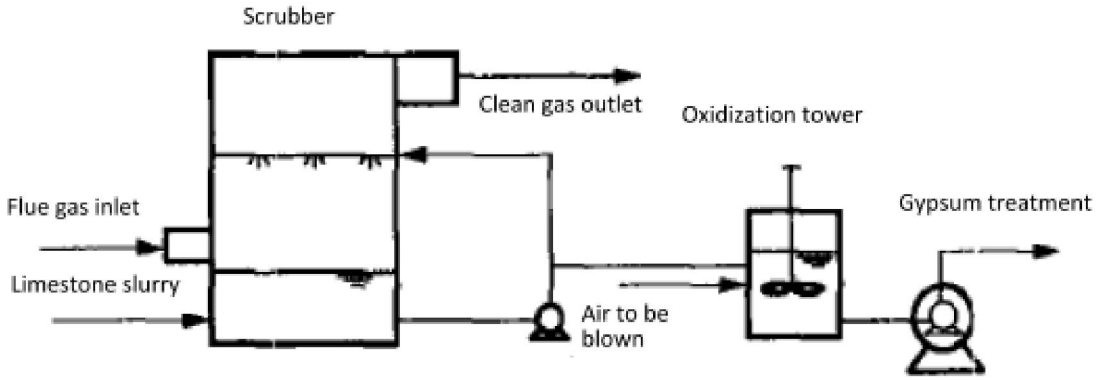

Fig. 2. 2^{nd} Generation of wet-Process Limestone/Lime-Gypsum Flue Gas Desulfurization System Schematic

In the 1990s, the 3_{rd} generation of wet-process limestone/lime-gypsum flue gas desulfurization technology took shape, in which such unit was configured to integrate the pre-scrubber, scrubber and oxidization tower together to increase the velocity of flue gas, reduce the diameter of tower and acquire less floor space, as shown in fig.3. Utilization of the process may greatly cut the investment of desulfurization unit, approximately down 30-50% for initial investment; essentially address fouling, blocking problems, and enhance the system safety and reliability (≥95%); improve exposure of gas to liquid in the tower by making improvement on tower's internal parts to bring the rate of desulfurization to a higher level; make wider the commercial application of desulfurization byproduct based on research and development on recovery and utilization of such byproduct [11]-[12].

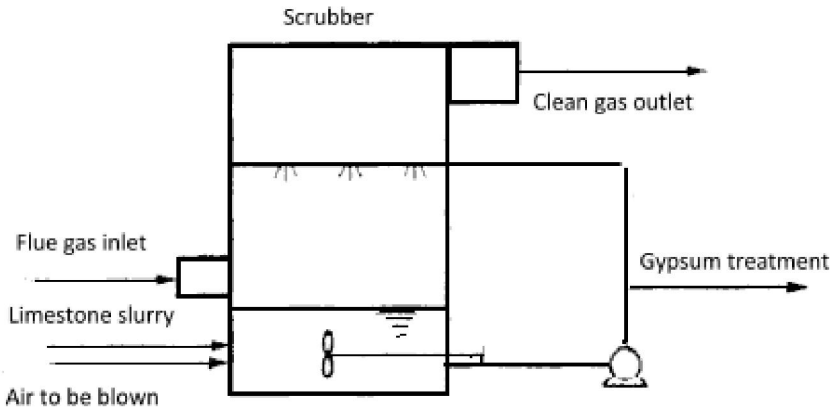

Fig. 3. 3rd Generation of wet-Process Limestone/Lime-Gypsum Flue Gas Desulfurization System Schematic

1）Lower system power consumption

2）Less investment and costs of operation

Over the recent years, simplified desulfurization process and optimized design parameters, system investment and operation costs are lowered by 1/3-1/2. Development and application of new wet desulfurization process such as integration of cooling tower with flue duct, deletion of GGH, multiple boiler with one tower, multiple tower with one boiler, etc. The flue gas desulfurization processes, survey made by the coal research institute under the International Energy Agency shows that the wet-process desulfurization accounts for 85% of total installed capacity of flue gas desulfurization units across the world. The wet-process desulfurization is mainly applied in countries, like Japan (98%), USA (92%), Germany (90%), etc. The limestone-gypsum wet desulfurization process, the most mature technology, the most applications, the most reliable operation in the world, may have rate of desulfurization of more than 90%. Its byproduct-gypsum may be reused, or disposed of [13]-[14].

4 DEVELOPMENT TRENDS OF FLUE GAS DESULFURIZATION TECHNOLOGY

With rapid progress in science and technology over the recent years, some new desulfurization technologies have been launched in foreign countries, but majority of which is still under test. Industrial applications in a large scale have not yet started [15]. Please see Table.1 for flue gas treatment technologies under R&D in foreign countries.

Table 1. Current Situations on Research of Desulfurization Technology in Foreigner Countries

Desulfurization process	Category	Research institute	Desulfurization	Current situations
NO_x SO technology	Dry process	US Department of Energy Pittsburgh Energy Technology Centre (PETC) and NO_xSO company	α-Al_2O_3 ball soaked with sodium carbonate	Industrial demonstration
SNO_x technology	Dry process	Demark Haldor-Tops Φ A/S company	Ammonia gas	Industrial pilot test
DESONO_x /REDOX process	Dry process	Germany Degussa A.G and Stadtwerk M ünster	Ammonia gas	Industrial pilot test
E-SOX process	Semi-dry Process	US Acurex company	Lime cream slurry	Industrial application in limited locations
Urea process	Wet process	Medeleev Institute of Chemical Technology of Russia	Urea	Industrial application in limited locations
LBL pHoSNO_x process	Wet process	US Laurence Berkeley Lab and Bechel company	Sodium sulphite	Industrial pilot test
Seawater desulfurization	Wet process	US Marilyn Bechtel Group	Seawater plus lime	Industrial pilot test

There tends to a diversified, comprehensive and resource-oriented development of flue gas desulfurization process.

4.1 DIVERSIFICATION

There are over 200 flue gas desulfurization technologies in place. Recently, some new ones have taken shape, including calcium process, sodium process, magnesium process, manganese process, ammonia process, carbon process, seawater process, biological process, plasma process, membrane process, iron process, amine process, etc.

4.2 COMPREHENSIVENESS

Dust collection desulfurization integration technology, simultaneous desulfurization and denitration technology, multi-pollutant-aid removal technology are also on the agenda.

4.3 RESOURCE-ORIENTED

Now, various flue gas desulfurization technologies tend to turn byproduct into useful resources, such as recovery and utilization of gypsum in the limestone-gypsum desulfurization technology, recovery and utilization of sulfur ammonium, phosphorus ammonium in the ammonia desulfurization technology, recovery and utilization of sulfuric acid and sulfur in the activated carbon desulfurization technology, etc.

The general trend of wet-process limestone/lime-gypsum flue gas desulfurization technology, which is applied in the most areas, is to upgrade and optimize the system and make the equipment smaller so as to reduce investment and operation cost. Turning byproduct into useful resources and producing no secondary pollution are also the objective of the process.

5 CURRENT SITUATIONS AND DEVELOPMENT TRENDS OF FLUE GAS DESULFURIZATION TECHNOLOGY IN CHINA

China‘s research on flue gas desulfurization technology started at an earlier date, around 1950s. However, its development falls behind and is limited to purification of nonferrous metallurgical off gas and sulfuric acid tail gas.

5.1 DEVELOPMENT COURSE OF CHINA’S FLUE GAS DESULFURIZATION TECHNOLOGY

As early as in the 1950s, the nonferrous metallurgical industry started to make acid with flue gas with concentration of sulfur dioxide of higher than 0.5% through a purification process; carried out purification and recovery of sulfur dioxide in tail gas in sulfuric acid units; recovered and produced ammonium sulfate in nitrogen fertilizer plants by purifying sulfur dioxide tail gas; built and put into operation a number of large-scale plants [16].

Flue gas desulfurization test in coal-fired power plants started in the early of 1970s. Test and research on 6 different flue gas desulfurization processes were carried out in Shanghai Yangpu Power Plant, Shanghai Zhabei Power Plant, Sichuan Baima Power Plant and Douba Power Plant, Hunan 300 Plant and Songmuping Power Plant. Up to now, pilot test on spray drying process in the Baima Power Plant, phosphorous amine fertilizer process in the Douba Power Plant and iodine-containing activated carbon absorption flue gas desulfurization in the Songmuping Power Plant have been subject to technical evaluation. However, pilot test on the rest of 3 flue gas desulfurization technologies has not made progress for technical, management and economic reasons [17]-[18].

Currently, there are 8 kinds of flue gas desulfurization technology available in the country, including iodine-containing activated carbon process, sodium sulfite circulation process, amine-acid process, spray drying process. However, such processes are applied in some medium and small-size flue gas desulfurization units completing pilot test and are not advanced to a level suitable for large flue gas desulfurization units in coal-fired power plants.

To stimulate research and development of FGD technology across the country, the government scheduled to import a number of advanced technologies and units in a controlled way during the 7th and 8th Five-year Plan, as shown in Table.2 Such demonstration projects involve varieties of mature process, such as wet process from Japan, dry process and semi-dry process from the Europe and USA. Despite of advanced equipment, reliable operation and high level of automation, such projects cost too much on investment and operation, making difficult to be widely applied across the country. Deficiency of proprietary intellectual property rights may not benefit sustainable development of China‘s desulfurization technology [18].

Table 2. List of China Imported FGD Units

Imported by	Process	Amount of flue gas from boiler/($Nm^3.h^{-1}$)	Desulfurizing agent	Efficiency (%)	Operation since	Licensor
Shengli Oilfiled	Ammonia sulfur/ammonium process	2,100,000	NH_3 H_2SO_4	90	1979	Japan Toyo
Nanjing Steel and Iron Works	Basis aluminum sulfate process	51,800	$Al_2(SO_4)$ $Al(OH)_3$	95	1981	Japan Dowa
Chongqing Luohuang Power Plant	Wet limestone-gypsum process	1,087,000	Limestone slurry	95	1992	Japan Mitsubishi Corporation
Shangdong Huangdao Power Plant	Simple spray drying process	300,000	Quicklime, Coal ash	70	1995	Power Development Co., Ltd of japan Inc.
Nanjing Xiaguan Power Plant	Limestone injection into furnace and activation of calcium process	795,000	Limestone	75	1997	Finland IVO
Taiyuan Generation Plant	Small high-velocity horizontal flow	600,000	Limestone	80	1996	Japan Hitachi
Guangxi Nanning Chemical Plant	Simple limestone-gypsum process	50,000	$Ca(OH)_2$	70	1996	Japan Kawasaki
Chengdu Thermal Power Plant	Electron beam process	300,000	NH_3	80	1997	Japan Ebara
Shangong Weifang	Simple lime	100,000	Hydrate lime	70	1995	Japan Mitsubishi
Chemical Plant	Gypsum process		slurry			Corporation

Over the recent decade, particular technological breakthrough was made on China‘s medium and small coal-fired industrial boiler flue gas desulfurization process, including direct injection of lime/limestone into the furnace and boiling bed limestone dry-process flue gas desulfurization, calcium alkali process, amine alkali process, sodium alkali process and magnesium alkali process, etc. Currently, there are over 40 coal-fired industrial boiler flue gas desulfurization processes, dozens of which operate well, with emission of sulfur dioxide up to the state permissible level. Please see Table.3 for China‘s own typical FGD technologies [18]-[19].

Table 3. Typical FGD Technologies in China

Desulfurization process	Developed by	Desulfurizing agent	Scale (Nm^3/h)	Rate of desulfurization (%)	Current situations
Sodium sulphite process	Hubei No.300 Plant, etc.	Pure caustic	10,000	90	Complete pilot test
Phosphorous ammonia fertilizer process	Xi'an Thermal Power Institute, Sichuan University, etc.	Slag coke/phosphate ore	10,000	70-95	Industrial demonstration
Basic aluminium sulfate process	Chongqing Tianyuan Chemical Plant Power Station	Basic aluminium sulfate process	100,000	95	Industrial application
Managanses dioxide process	Sichuan University	Manganese dioxide slurry	7,000	>80	Complete pilot test and evaluation
Phosphate ore desulfurization process	Hunan University	Carbonate ore	5,000	63-70	Complete pilot test
Venturi desulfurization process	Environmental Protection Research Institute for Electric Power	Alkaline solution	75,000	63-70	Complete pilot test
Rotary spray drying process	Tsinghua University	$Ca(OH)_2$	70,000	85	Complete pilot test and not in industrial application
Limestone injection into the furnace and activation of calcium process	Shenyang Liming Company	Limestone	50,000	75	Complete industrial test
Desulfurization flue gas circulation sulfurization	Beijing College of Light Industry, Tsinghua University	Limestone	20,000	>80	Industrial demonstration
Activated coke process	Nanjing Electric Power Automation Equipment General Corporation	Activated carbon	200,000	95	Industrial demonstration
Iron Process	Dalian University of Technology, etc.	Iron	100,000	95	Industrial application
Circulating process	Chengdu West China Chemical Research Institute	Lon liquid	10,000	98	Complete industrial test

5.2 CURRENT SITUATIONS ON CHINA'S FLUE GAS DESULFURIZATION TECHNOLOGY

Recently, following China proprietary R&D and import, digestion, innovation, China's flue gas desulfurization industry had made considerable progress and the units adopting our proprietary process are sized to meet the target on reduced emission of sulfur dioxide set for the 11th Five-year Plan [25].

5.2.1 CONSIDERABLE PROGRESS MADE ON FLUE GAS DESULFURIZATION INDUSTRY IN THERMAL POWER PLANTS

By the end of 2008, the total installed capacity of flue gas desulfurization units in thermal power plants across the country has gone beyond 379 million kW, accounting for 66% of total installed capacity in thermal power plants. In 2008, China put into operation 100,000-level kW and higher desulfurization units of thermal power generating units, totaling 110 million kW, down by 5.2% compared with that in 2007 [20]. Currently, over 10 flue gas desulfurization processes have been applied, including limestone-gypsum wet process, flue gas circulating fluidized bed process, seawater desulfurization process, desulfurization dust collection integration process, semi-dry process, rotary spray drying process, limestone injection into the furnace and activation of calcium process, activated coke absorption process, electron beam process, etc. Like the situation in foreign countries, the limestone-gypsum wet-process flue gas desulfurization technology takes a leading position. Statistics show that such process has been utilized for more than 90% of thermal power plant projects already in operation, being constructed and signed [19]. China's flue gas desulfurization industry has grown up to a level able to complete design, manufacturing and general contracting of desulfurization projects sized for 100 million kW level [20],[23].

5.2.1.1 LOCALIZATION RATIO OF DESULFURIZATION EQUIPMENT UP TO MORE THAN 90 %

Key equipment in the limestone-gypsum wet-process flue gas desulfurization technology, like slurry circulating pump, vacuum belt filter, cyclone, boost-up fan, flue gas heat exchanger, flue gas damper, etc., are able to be designed and manufactured in the country. For example, a series of desulfurization slurry circulating pump manufactured by Shijiazhuang Pump Company have been applied in 96 desulfurization projects; desulfurization boost-up fan manufactured by Chengdu Power Machinery Factory has been applied in 100 desulfurization projects; gas-gas heat exchanger manufactured by Shanghai Boiler Plant has been applied in 60 desulfurization projects. In terms of purchase cost, equipment and materials adopting the limestone-gypsum wet-process flue gas desulfurization technology have localization ratio of around 90%, some flue gas desulfurization projects more than 95% and equipment for other processes more than 90%.

5.2.1.2 PROPRIETARY INTELLECTUAL PROPERTY RIGHTS AVAILABLE FOR MAIN FLUE GAS DESULFURIZATION TECHNOLOGY

Technology through Chinese own R&D and import, digestion and innovation, China has boasted main flue gas desulfurization technology of proprietary intellectual property rights suitable for 300MW-level thermal power generating unit, which has been tested in real units for more than 1 year. For example, China Power Investment Corporation Yuanda Environmental Protection Engineering Co., Ltd. Has had full picture of MHI double contact flow scrubber wet-process desulfurization technology, AEE spray tower wet-process desulfurization technology and AEE dry-process desulfurization technology, and then created YD-BSP wet-process flue gas desulfurization technology of proprietary intellectual property rights, which has been successfully applied in Nanyang Power Plant 2×300MW flue gas desulfurization project and Huaneng Haikou 2×125MW units flue gas desulfurization project; limestone-gypsum wet-process flue gas desulfurization technology of proprietary intellectual property rights developed by Suyuan Environmental Protection Engineering Co., Ltd. has been successfully applied in Taicang Harbor Environmental Protection Generating Co., Ltd. Phase-II 2×300MW flue gas desulfurization project; Beijing Guodian Longyuan Environmental Protection Engineering Co., Ltd. has boasted limestone-gypsum wet-process flue gas desulfurization technology of proprietary intellectual property rights following digestion, absorption and innovation of German technology, which has been successfully applied in Jiangyin Sulong Generating Co.,Ltd phase-III 2×330MW flue gas Desulfurization project [20]-[21].

After two years 'operation, the above three projects have been subject to the post-project evaluation. Experts view that flue gas desulfurization technology of proprietary intellectual property rights owned by three companies is technically mature, operationally reliable and highly compatible and thus is up to the internationally advanced level [22]. Even though we also own other processes of proprietary intellectual property rights, they are only suitable for thermal power units of 200MW and lower. Some units of this kind are just put into operation or being constructed, thus requiring test for a certain period.

5.2.1.3 AVAILABLE CAPABILITY OF GENERAL CONTRACTING OF FLUE GAS DESULFURIZATION PROJECT

By the end of 2008, about 50 enterprises, based on their technologies, funds and human resources, have experiences in undertaking turnkey contracting of flue gas desulfurization project of 100MW and higher, in which more than 20 ones get involved in total installed capacity of more than 3,000MW and 13 ones in that of 10,000MW. Beijing Guodian Longyuan Environmental Protection Engineering Co., Ltd., China Power Investment Corporation Yuanda Environmental Protection Engineering Co., Ltd, and other five companies total contractual capacity of more than 40,000MW, respectively [23].

5.2.1.4 CONSIDERABLE DECREASE OF COST OF DESULFURIZATION PROJECT

With considerable improvement of localization ratio of flue gas desulfurization equipment and market competition, cost of flue gas desulfurization project drops by big margin. For example, the cost of new thermal power generating unit flue gas desulfurization project of 300MW and higher has dropped from previous RMB 1,000 Yuan or above to existing RMB 200 Yuan or above per kilowatt. The cost of existing thermal power generating unit flue gas desulfurization project of 200MW and lower has dropped below RMB 250 Yuan per kilowatt.

5.2.2 KEY ENTERPRISES WITH RENOWNED BRAND EMERGED

For top 20 desulfurization companies in 2008, their contractual capacity accounts for 90.8% of the total, operation capacity for 78.3% of the total, operation capacity of the same year for 87.1% of the total. Compared with 2007, the ranking of top 10 desulfurization companies happen to no change, with Tsinghua Tongfang Environment Co., Ltd, and China Datang Technologies & Engineering Co., Ltd. among top 10. Please see Table.4 for overview of main desulfurization companies in China [24].

Table 4. Overview of Main Desulfurization Companies (by the end of 2008)

Item	Unit name	MW Total capacity by contract MW	Technical source	Proprietary technology
1	**Beijing Guodian Longyuan Environmental Protection Engineering Co., Ltd.**	68,829	German Steinmüller limestone-gypsum wet-process desulfurization technology	Longyuan wet-process flue gas desulfurization technology
2	**China Boqi Environmental Protection Scientific and Technological (Holding) Co., Ltd.**	52,496	Japanese Kawasaki spray tower technology	None
3	**Wuhan Kaidi Electric Power Environmental Protection Co., Ltd.**	49,700	Wet-process flue gas desulfurization technology from US B&W Co.	None
4	**Fujian Longking Environmental Protection Co., Ltd.**	42,360	Limestone-gypsum wet process, flue gas circulating fluidized bed dry process desulfurization technology from Germany LLB	None
5	**China Power Investment Corporation Yuanda Environmental Protection Engineering Co., Ltd.**	41,822	AEE wet-process spray and MHI double contact flow scrubber	BSP wet process
6	**Zhejiang University Insigma Holding Electromechanical Engineering Co., Ltd**	39,300	France ALSTOM limestone-gypsum wet process	None
7	**Tsinghua Tongfang Environment Co., Ltd.**	26,872	AEE wet-process spray double contact flow scrubber	None
8	**Shandong Sanrong Environmental Protection Engineering Co., Ltd.**	26,420	Wet process from Lurgi Bishchev	None
9	**China Huadian Engineering Co., Ltd.**	23,662	Wet-process flue gas desulfurization technology from US MET Co.	None
10	**Zhejiang Tiandi Environmental Protection Engineering Co., Ltd.**	19,050	Wet-process desulfurization technology from US B&W	None

5.3 Development Trends of Flue Gas Desulfurization Technology in China

Compared with foreign flue gas desulfurization technology, China's flue gas desulfurization technology is challenged by deficiency of mature proprietary flue gas desulfurization technology not applied in an economic and large scale in terms of boiler in some large coal-fired power stations; less factor given to recovery of sulfur resource; less application of large amount of byproduct, i.e., gypsum. In general, in view of existing problems, our flue gas desulfurization technology tends to:

5.3.1 Enhance Capacity for Independent Innovation on Flue Gas Desulfurization Technology

Up to now, only minority of desulfurization companies in the country boast flue gas desulfurization technology of proprietary intellectual property rights for 300MW and majority has to utilize the foreign technology for digestion and absorption but lack of capacity of re-innovation. On the other hand, we have to pay technology-introduced and used fees to foreign company. Preliminary calculations show that about RMB 320 million Yuan have been paid to foreign companies on licensing and RMB 300 million Yuan on royalty. Thus, improvement on our own independent innovation capacity of flue gas desulfurization technology is one of the trends guiding the development of flue gas desulfurization technology in the country [25].

5.3.2 Reinforce Desulfurization Market Supervision

Recently, a great number of desulfurization environmental protection companies spring up like mashroom after rain to meet the requirements from dramatic expansion of desulfurization market. However, lack of supervision on market access, and detailed system in place to specify competence, talent, performance and financing for desulfurization companies lead to desulfurization companies of different quality mixed up together. Some flue gas desulfurization projects built by desulfurization companies are not acceptable. Furthermore, lack of or improper supervision on bid invitation or bidding process for flue gas desulfurization projects takes place. Some bid invitation or bidding processes are not put in place.

5.3.3 Raise the Operation Ratio of Desulfurization Device

According to the insiders, the operation ratio of existing flue gas desulfurization units already built is less than 60%, thus not functioning as expected on reduced emission of sulfur dioxide. The reasons behind it are: first of all, some desulfurization companies highly rely upon foreign technology and equipment, as a result of which they are not able to have full picture of the technology being utilized, some systems are not designed well at the initial stage and individual equipment is difficult to be repaired in case of failure; secondly, desulfurization electric power price system for some old power plants is not put in place; thirdly, supervision or monitor on routine operation of desulfurization equipment is lacked due to slack law enforcement; fourthly, some power plants shutdown desulfurization systems for their own benefits.

5.3.4 Resource-Oriented Utilization

China's reserves on sulfur deposit ranks the 2_{nd} in the world. However, in 2004, our production of sulfur resource amounted to 8.1 million tons and imported 7.34 million tons; in 2006, they are 9.16 million tons and 9.5 million tons, respectively. China also boasts of abundant supply of gypsum. Gypsum, byproduct of desulfurization process, is not well applied, thus leading to secondary pollution. Therefore, the limestone-gypsum desulfurization process commercially available in foreign countries may not be suitable for the country. Instead, due factor shall be given to proper utilization of byproduct resource [26].

In addition, deletion of bypass flue duct, selection of gas discharging methods after desulfurization, deletion of GGH, economic operation and continuous monitor of flue gas are also key topics on flue gas desulfurization process under research in the country.

Conclusion

Flue gas desulfurization (FGD), is a desulfurization technology widely applied and highly efficient and is recognized by developed countries as the most economic and workable solution in the future. Flue gas desulfurization originated from the wet process experiment in 1930s. The desulfurization unit adopting limestone cleaning process in UK London Power Company and ammonia cleaning process in Canadian Cominco Company an earliest industrial were the earliest units of this kind. Flue gas desulfurization is designed to use desulfurizing agent to remove sulfur dioxide in flue gas based on the gas

absorption, gas adsorption or catalytic conversion desulfurization mechanism. Amid the development and industrial application over the past few decades, over 200 desulfurization processes by making use of different desulfurizing agents or varying desulfurization mechanism had been made available in countries across the world, over 10 of which, however, are widely applied.

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Applied analysis and construction of Prevention, Monitoring and Early Warning System of Mountain Torrent Disaster

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ABSTRACT: To prevent from the hazards of mountain torrent disasters, today's monitoring and early warning system is widely used in mountain areas to keep alert from the rainstorm. Mountain torrent disaster caused by the rainstorm and is one of the most important reasons, resulting in transportation blocks and mass casualties. Mountain torrent disaster occurs frequently depends on the weather of mountain's country. It can be distinguished and predicted by monitoring and early warning system to provide the safety reference in disaster presentation and reduction. This paper presents the analysis and key management of monitoring and early warning system of mountain torrent which mainly includes monitoring system and early warning system of water and rain information. In order to achieve better effect of disaster prevention and reduction, establish an organization system of mass observation and mass prevention and enhance training propaganda. The monitoring system of water and rain information mainly includes network layout of water and rain monitoring station, information acquisition, information transmission and communication networking and configuration of devices. Early warning system of mountain torrent is composed of platform-based early warning system of torrent defense and early warning system of torrent mass observation and mass prevention. And also appended short description of publicity and training includes popularization of knowledge about disaster prevention; preparations of disaster prevention, maintenance and operation of monitoring and warning facilities, publicity and rehearsal of proposal.

KEYWORDS: Mountain torrent disaster, Monitoring system, Early warning system, prevention, reduction, training, rehearsal.

1 INTRODUCTION

The mountain torrent disaster burst out frequently and one of the most important reasons is rainstorm. And the solution is monitoring and early warning system of mountain torrent. The mountain torrent disaster early warning system chiefly focuses on three aspects: monitoring, early warning and response [1]. The monitoring and early warning system mainly include in monitoring system and early warning system of water and rain information. In monitoring system of water and rain information have a network layout of water and rain monitoring station, information acquisition, information transmission and communication networking and configuration of devices and as well as facilities [1]. Therefor to achieve better efficiency in disaster prevention and reduction, the organization system of mass observation, mass prevention and enhance training propaganda is also established in this paper.

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In most townships and villages, the simple and easy facilities are usually used for early warning and monitoring; while in areas above country level, it is possible to arrange some practical and advanced facilities with some technical content and high automation level according to financial situation and torrent features. The water and rain monitoring information converging into torrent prevention and early warning platform mainly refers to the automatic remote-metering information of areas above county level; while the water and rain monitoring information of mass observation and mass prevention focuses on information from simple observation in townships and villages. Based on wide range and complex formation causes of mountain torrent in our country, it is necessary to make existing monitoring stations of hydrological and meteorological department more intensive, so as to control water and rainfall information and release early warning information timely. Early warning system of mountain torrent is composed of platform-based early warning system of torrent defense and early warning system of torrent mass observation and mass prevention.

The information collection and early warning platform of torrent prevention in platform-based early warning system of torrent defense is core of data information processing and service of the system, which is mainly composed of information convergence subsystem, information query subsystem, computer network subsystem and database subsystem.

The platform-based early warning system of torrent defense mainly consists of information convergence subsystem, information query subsystem, forecast decision subsystem and early warning subsystem, which shall be erected in flood control headquarters of areas above county level and areas with serious torrent disaster, so as to obtain real-time water and rain information and timely prepare and release early warning of torrent disaster. Usually, the system is required to have functions as reporting of water and rain information, query of weather, water and rain, forecast decision, early warning, preparation and issuance of government files, generation of comprehensive materials and duty management and reserved with interfaces for prevention information of mud-rock flow and landslide. The whole process of Monitoring and early-warning system of torrent disaster is discussed and develops the task based on the analysis [2].

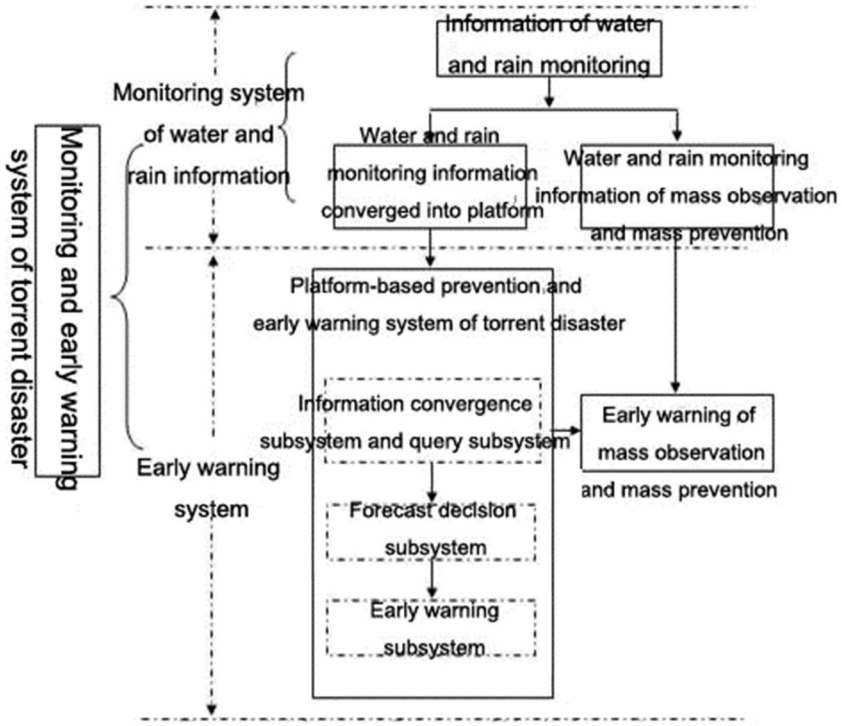


Fig. 1. Structure diagram of monitoring and early warning system of mountain torrent disaster

The early warning system of mass observation and mass prevention includes early warning release and procedures, early warning mode, communication network of warning transmission and information feedback and setting of alarm device, etc. The information, mode and signal of early warning shall be determined according to the concrete conditions of local area. Furthermore, the mode and signal of early warning shall be simple and be easily accepted by ordinary people.

The organization system of mass observation and mass prevention mainly refers to establishment of 5-level (county, township, village, and group, household) responsibility system of mountain torrent prevention and definition of organization, personnel arrangement and responsibilities of each level in prevention of torrent disaster. It is necessary to ensure the smooth transmission of information related to disaster prevention and implementation of measures for monitoring, early warning and disaster avoiding.

The content of publicity and training includes popularization of knowledge about disaster prevention, preparations of disaster prevention, maintenance and operation of monitoring and warning facilities, publicity and rehearsal of proposal, etc. This article looks at issue of mountain torrent disaster mechanism and pattern of early-warning and monitoring system for the majority of mountain torrent disaster users [3].

2 PURPOSE AND SIGNIFICANCE OF SYSTEM CONSTRUCTION

In recent years, based on the analysis of statistics and field survey the sudden and local torrent disaster caused by extremely strong rainfall has resulted to mass casualties [4]. The population of total death toll caused by mountain torrent is increasing and mass death or injury happens frequently. Since the torrent disaster has seriously hindered the economic development in hills and mountains, masses from casting off poverty to get rich and construction of harmonious socialist society and new socialist countryside, it has been a problem that needs to be solved in current flood control and disaster reduction of our country.

Make scientific development as guidelines; insist on people first and the scientific concept “harmony between man and nature”; focus on ensuring life and property safety of the masses; aim for furthest reducing disaster loss; base on special climate, landform, geology and other features of mountain torrent in various regions of our country, actual development situations of economy and society and document “Planning Report for Nationwide Prevention of Torrent Disaster ” approved by the state council; Combine torrent disaster prevention with geological disaster prevention and engineering measures with non-engineering measures; coordinate with economic and social development of local area. Then, carry out comprehensive prevention and treatment for mountain torrent based on all above measures to comprehensively improve local capacity and level for dealing with torrent disaster, providing important support and guarantee for flood control and sustainable development of economy and society in hills and mountains. The Basis of system compilation is following as

- Planning for Nationwide Prevention of Torrent Disaster
- Outline for Compilation of Torrent Prevention Plan
- Outline for Compilation of Implementation Plan about County-level Non-engineering Measures Construction of Torrent Disaster Prevention
- Technical Requirement for Construction of County-level Monitoring and Early Warning System of Torrent Disaster Prevention
- Other related standards, specifications, regulations and management methods

2.1 CONSTRUCTION OF GOAL AND TASK

In goal structure, Construct monitoring and early warning system, strength system of mass observation and mass prevention, perfect prevention plan, propagandize prevention knowledge and improve awareness of all people to disaster prevention and avoidance in townships and villages with task of torrent prevention and treatment, so as to effectively prevent disaster, change the situation of increasingly serious torrent disaster, reduce casualties and property loss and especially avoid mass death and mass injury.

In task structure, the construction of non-engineering measures for torrent prevention mainly includes general investigation of torrent disaster, demarcation of dangerous area, definition of early warning index of critical rainfall and water level, construction of monitoring and early warning system, establishment of responsibility system, compilation and perfection of prevention plan and rehearsal of publicity and training, etc.

2.2 INVESTIGATION AND EVALUATION OF CURRENT SITUATION

Generally investigate the basic information of nature, economy and society, population distribution, torrent type, information of historical torrent disaster, populations threatened by torrent disaster and distribution of main economic facilities in all small watersheds. The local government or flood-control headquarters organizes the investigation of torrent disaster and investigates the influence of torrent on affected areas based on existing documents of meteorological and territorial departments and according to planning of torrent prevention and related regulations and specifications, so as to

define threatened range and degree. Divide areas reasonably according to formation features of torrent disaster, investigation of historical torrent, conditions of climate, terrain and geology and analysis of possible type, degree and influence range of torrent. The dangerous area usually refers to area in river valley, channel, river beach, under steep slope, low-lying place and under unstable massif; the safe area often refers to flat area with high terrain or gentle slop which is shelter for people in dangerous.

2.3 DETERMINATION OF EARLY WARNING INDEX

The early warning index of torrent disaster is established with following purpose: assist to judge the possible risk and occurrence time with torrent forecast model before torrent arrives, so as to inform persons in protected areas to transfer timely, furthest protecting their life security. Two factors have to be considered for the index: 1. how much rainfall will cause torrent, i.e. critical rainfall; 2. whether the time from sending out early warning to torrent happening is enough for transfer of persons in protected areas, i.e. response time of early warning. The early warning index of torrent includes warning rainfall (water level) and dangerous rainfall (water level). The former one refers to the case, in which, it is very possible to have torrent and need to prepare for rain transfer in advance; the latter one refers to the case, in which, it is extremely possible to have torrent and need to transfer rainfall immediately.

2.4 CONSTRUCTION OF MONITORING AND EARLY WARNING SYSTEM

1.1.1 MONITORING WATER AND RAIN INFORMATION

Simple monitoring station: In monitoring mood and flood forecasting system, configure simple facilities for rainfall and water level monitoring according to actual conditions. The township, village and group monitor water and rain information with direct and feasible monitoring method and release information by means of early warning mode suitable for local area, so as to achieve the goal of mass observation and mass prevention. The simple rainfall and water-level station adopts rainy regular monitoring and intensive monitoring of rainstorm or water-level rising to timely report related information and inform related villages and groups at downstream.

Automatic monitoring station: In monitoring mood and flood forecasting system, adopt the management mode of manned watch and unattended operation to realize the automatic acquisition and transmission of water and rain information. The automatic monitoring station adopts combined remote-metering of automatic reporting and query – reply mode, regularly automatic reporting, and addition of event reporting and compatibility of measure calling.

1.1.2 ARRANGEMENT OF STATION NETWORK

The network of monitoring station is mainly arranged in small watershed easily suffered from torrent disaster with valley area less than 200km2. It is necessary to lay out the station network according to investigation of torrent probability zone, regional historical flood and social economy and with full consideration of existing monitoring stations. In layout of rainfall station when establishing rainfall station, it is necessary to fully consider zoning control (20～100km2/station), valley control, terrain control, communication, traffic and other conditions for management and maintenance of operation. In Principle, the simple rainfall station is arranged one in each natural village, but can be properly increased in quantity for villages with people scattered and with large possibility of torrent. Make full use of existing resources. All existing rainfall monitoring information of hydrological and meteorological departments shall be included into county-level monitoring and early warning platform. In the arrangement of water-level station, the automatic water-level monitoring station shall be erected in basin of area more than 100km2 with serious torrent disaster and county or township government or dense population, important industrial and mining enterprises and facilities along its banks. The simple water-level monitoring station shall be erected in small basin of area less than 100km2 with serious torrent disaster and residential area of concentrated population or important industrial and mining enterprises and facilities along its banks. Other small basins shall be also established with simple water-level monitoring station according to actual conditions. The Selection of information transmission communication network includes

- The communication mode commonly used for data transmission of water and rain information includes GPRS/GSM, ultra-short wave (UHF/VHF) and satellite, etc.
- Investigation of communication resources
- Principle for selection of transmission mode
- For areas covered by public network, usually select public network for networking (GPRS/GSM);

- For areas uncovered by public network, usually select satellite or ultra-short wave for communication;
- For important monitoring station and conditional areas, it is possible to select two different communication modes for mutual standby and automatic switching, so as to ensure smooth channel of information transmission.

1.1.3 MONITORING FACILITIES & EQUIPMENT OF SIMPLE MONITORING SYSTEM

Rainfall monitoring: The technical requirements for information acquisition device of simple rainfall monitoring station are as follows:

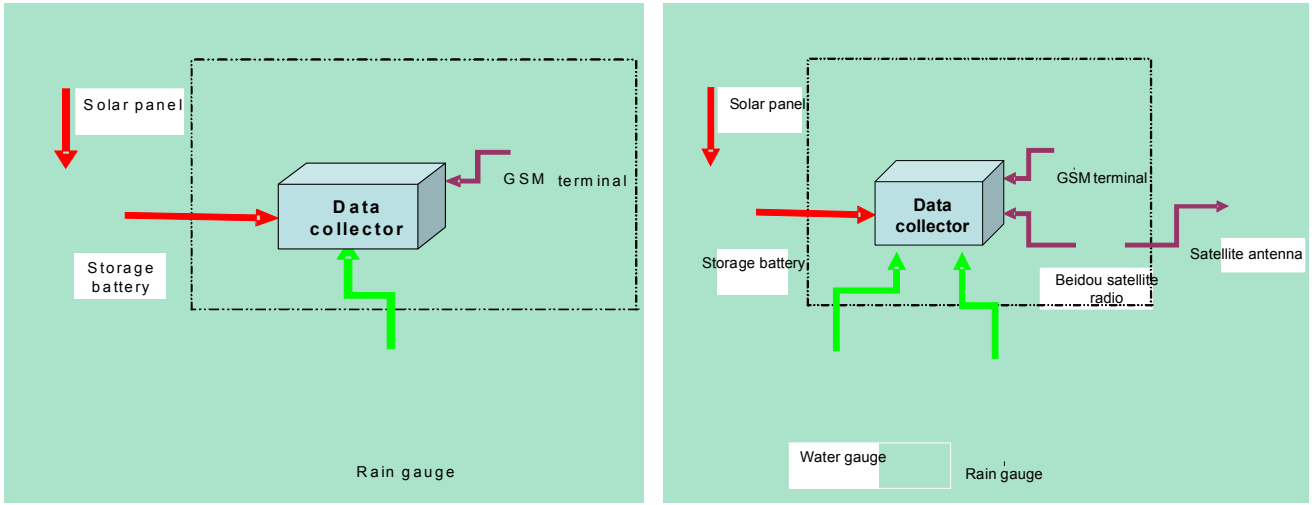
- Configure simple rainfall monitor; the diameter of water receiving mouth, which can be made of iron sheet and plastics, is Φ200+0.6mm.
- The simple rainfall monitor has to be fixed with bracket at the time of installation. After installation, the horizontal distance between the monitor and barriers (e.g.: building, trees) shall be twice of barrier height. It indicates the early warning value of rainfall in labeled area outside water receiving container.

Water-level monitoring: Monitor water level manually with simple and reliable method. The related technical requirements are as follows:

- Erect simple water-gauge pile on bank, which can be wooden pile or stone pile.
- For monitoring station which is impossible to be erected with piles, mark water-level scale on the fixed building or rock near river bank.
- Set the scale on water-level monitoring ruler for the purpose of convenient and direct reading by workers and mark the water level of early warning according to the actual conditions of each monitoring point.

1.1.4 MONITORING FACILITIES & EQUIPMENT OF SIMPLE MONITORING SYSTEM OF AUTOMATIC MONITORING SYSTEM

Rainfall monitoring: The design of rain information acquisition mainly includes the selection of rain monitoring place and rainfall sensor. The rainfall monitoring shall meet related requirements of Specifications for Rainfall Monitoring. In principle, no rainfall monitoring field is newly erected. For station which has been established with rainfall monitoring field, install automatic rainfall station into the monitoring field. For station which cannot be erected with rainfall monitoring field, it is recommend to use integration equipment, which can be installed on pole, roof and platform, etc. Water-level monitoring: The design of water-level information acquisition mainly includes the selection of water-level monitoring facilities and water-level sensor. Each county can select float, pressure, ultrasonic or radar water gauge for monitoring according to actual conditions. Besides, every area can also carry out supporting civil works or installation construction as per selected water-level sensor.



(1) Rainfall Automatic Monitoring Station *(2) Water-level Automatic Monitoring Station*

Fig. 2. (1),(2) Devices Layout in GPRS/GSM/Beidou Satellite Automatic Monitoring Stations

3 MONITORING AND EARLY WARNING PLATFORM

As center of data information processing and service of torrent monitoring and early warning system, the monitoring and early warning platform is mainly composed of computer network, database and application system with main functions as information convergence, information service and module of warning information issue. It explains the working principle of the real-time monitoring and early-warning system [5].

3.1 DATABASE MANAGEMENT SUBSYSTEM

The database system of torrent early warning system stores and manages lots of historical data and real-time data and provides information convergence, information service, consultation, query and forecasting by means of application software. It is required that the system must be able to not only effectively manage lots of long-term historical data for convenience of analysis, calculation and query, but also give rapid response to above applications, so as to ensure the real-time performance of system. In order to ensure the safety and reliability of database, the database management subsystem shall have following functions:

- database generation
- Online modification of database
- Backup and recovery of database
- Monitoring and management of database

Structure classification of database subsystem:

- Basic information management database
- Real-time rain information database
- Thematic database of torrent early warning
- Forecast information database
- Temporary database

Information service subsystem:

- Real-time monitoring (selected sensors) [6]
- Data query, display and printing
- WEB browser service
- 2-dimensional GIS monitoring
- Man-machine interface maintenance
- Access control
- Information exchange

The information received and processed by information convergence subsystem mainly can be classified into following several types. Monitoring management information: including observation and reporting parameters of each monitoring station, station position, station files, station identification and features and station watch, etc. Information about monitoring of water and rain: the monitoring station network established through system automatically acquires water level and rainfall information of monitoring station and collects actually observed information through other means.

Meteorological information: real-time meteorological information, result of meteorological analysis, numerical forecast output and rainfall forecasting result from automatic meteorological station and meteorological and territorial service system. Information related to forecast and system operation management generated from processing and calculation also has to be stored in system. Information service subsystem is supported by GIS monitoring and network techniques, the system is capable to providing the information exchange [7]. The module of warning information issue online monitors all real-time status, water and rain information, each node and network, carries out related analysis, determines the limit and level of early warning as per index of early warning model and automatically alarms once any abnormality is detected.

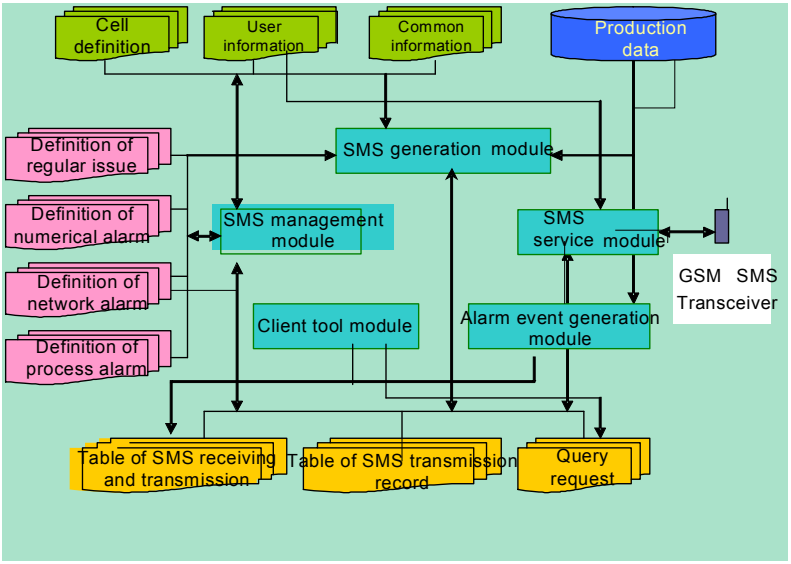


Fig. 3. Module of warning information issue online monitors all real-time status

4 SOFTWARE AND HARDWARE CONFIGURATIONS OF MONITORING AND EARLY WARNING PLATFORM

- In order to ensure the reliable operation of torrent early warning system, the corresponding requirement is also proposed for the response index and reliability of computer, so as to fully play the role of computer in torrent early warning system. The computer of central station is configured with switching fast Ethernet and dual redundancy and structured of C/S and B/S with flexible and variable scale.
- Based on meeting above configuration requirements, the model selection of devices still has to comply with following principles:
- Ensure the reliability and advancement of system;
- Full consider the safety and reasonability of system;
- Adopt technologies which conform to international tendency;
- Support network function;
- Have good expansion capacity;
- Ensure convenient maintenance and management of hardware devices;
- Comprehensively consider cost performance.

5 EARLY WARNING SYSTEM

The early warning information can be obtained from two channels, i.e., from county-level monitoring and early warning platform or from mass observation and mass prevention. The early warning information is mainly issued by torrent prevention command department at each level or monitoring persons on monitoring point of mass observation and mass prevention through transmission network of early warning information and other means.

5.1 EARLY WARNING PROCESS

The early warning information can be prepared and issued through monitoring and early warning platform. The county-level flood-control headquarters issues early warning information to county, township, village, group and principals of related departments and units through monitoring and early warning platform. Then, each township, village, group and related unit organizes to take measures according to prevention planning. The early warning process based on platform is as shown below in fig.4.

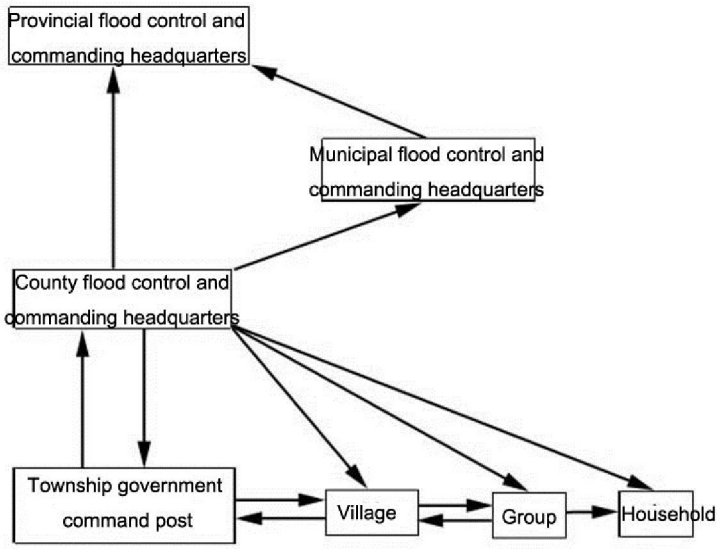


Fig. 4. Early warning process based on platform

The early warning information of mass observation and mass prevention is obtained from county, townships, villages or monitoring points. Observers issue early warning information according to experience, technologies and monitoring information of monitoring facilities mastered from publicity and training related to torrent prevention. In addition to warning information issued or released by county-level flood control department, each township also receives the information from monitoring points of mass observation and mass prevention, villages, reservoirs and hilly ponds. The early warning information of townships, villages and groups at upstream shall be timely transmitted to the corresponding ones at downstream. The warning process of mass observation and mass prevention is as shown in fig.5.

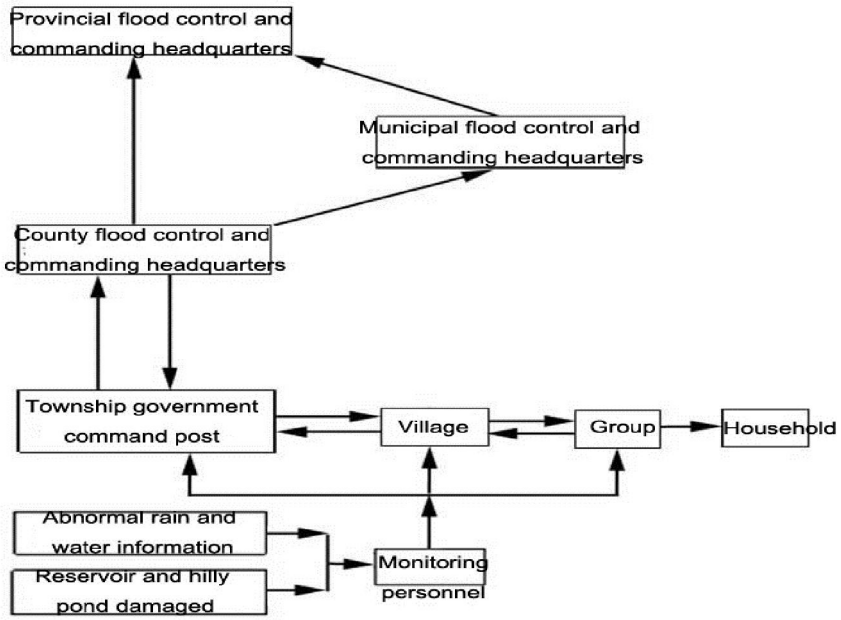


Fig. 5. Warning process of mass observation and mass prevention platform

5.2 ISSUE OF EARLY WARNING INFORMATION

- Authority of early warning issue: The authority of early warning issue belongs to different persons in charge of flood control according to different obtaining channels of early warning information.
- Content of early warning issue: Mainly include flood forecast, rainfall, water-level information of rill, river, reservoir and hilly pond, warning level, notice for transfer preparation and command of emergency transfer, etc.
- Object of early warning issue: The object may refer to cities, towns, villages, residential areas, schools, industrial and mining enterprises and scenic spots and so on which may be threatened by mountain torrents.
- Mode of early warning issue: The early warning can be divided into two stages: internal early warning (to flood-control persons and related principals) and external early warning (to publics).

5.3 COMMUNICATION DEVICE FOR EARLY WARNING

- The county-level torrent prevention headquarters has to transmit the warning information to townships and villages through following means and communication modes;
- The county monitoring and early warning platform automatically transmits warning information to townships and villages threatened by torrent disaster through SMS and fax;
- Issue warning information through radio and TV;
- Transmit warning information to townships through PSTN and mobile phone.
- Early warning communication between townships and villages
- The warning information between towns and villages is transmitted mainly through following method:
- Transmit warning information by means of PSTN, mobile phone and wireless warning broadcast.
- When all communication facilities are damaged by torrents, resulting to be unable to contact with outside, townships and villages can make use of existing vehicles and equipped wireless warning broadcast to inform residents threatened by torrents to evacuate and transfer.
- For villages and groups with scattered populations, the traditional warning means as wireless warning broadcast, interphone, loudspeaker, manual alarm, gong, drum, trumpet, torch, signal flare and manual transfer can be used to issue warning.

6 RESPONSIBILITY SYSTEM

In order to ensure the smooth and orderly prevention of torrents disaster, it is necessary to establish organization and commanding headquarters of torrent prevention, build necessary systems and regulations to define responsibilities and arrange tasks and carry out 5-level (county, township, village, group and household) responsibility system of torrent prevention. The organization and commanding headquarters is usually established in county, town and village.

6.1 ORGANIZATION AND COMMANDING HEADQUARTERS

Composition of county-level organization and commanding headquarters: Set up headquarters in county, which handles official affairs jointly with county headquarters of flood control and drought relief. Both of departments are uniformly commanded by county headquarters of flood control and drought relief. Set offices and 5 working teams (monitoring team, information team, transfer team, dispatching team and safeguard team) under the headquarters. Besides, it is necessary to establish emergency rescue team (more than 10 people) in each county, town, Sumu and office and arrange 1 or 2 information messengers and senders for each Gacha and village.

Composition of township organization and commanding headquarters: Set up torrent prevention headquarters in township, which is arranged with commander and vice-commander and is composed of principals of related functional departments, such as water sources, territory, civil affairs, meteorology, construction, transport, public security and sanitation and so on. Set 5 working teams (monitoring, information, transfer, dispatching and safeguard) and emergency rescue team under the headquarters.

Composition of village organization and commanding headquarters: Set torrent prevention headquarters in each administrative village, which is taken charge by village director; establish emergency rescue team composed by primary militia for each village; define persons in charge of monitoring and early warning; prepare registration book and submit it to township and county headquarters for future reference.

6.2 WORK DIVISION AND RESPONSIBILITIES

1. Work division

The county headquarters of torrent prevention uniformly leads and organizes the work related to torrent prevention. Each related department is respectively responsible for own task. The office of county headquarters is responsible for daily work of headquarters. The township headquarters of torrent prevention carries out torrent prevention work under the unified leadership of county headquarters, reports to related department if any abnormality is detected and takes corresponding emergency measures. The village headquarters of torrent prevention is responsible for water and rain monitoring, early warning, person transfer and rescue work of its own administrative village and assists neighboring villages to carry out torrent prevention work if necessary.

2. Responsibilities

- Responsibilities of monitoring team
- Responsibilities of information team
- Responsibilities of transfer team
- Responsibilities of dispatching team
- Responsibilities of safeguard team
- Responsibilities of emergency rescue team
- Responsibilities of information messenger and sender

6.3 COMPILATION OF PLAN

The content compiled into plan of county torrent prevention includes:

- Investigate basic conditions of nature, economy and society, torrent type and loss caused by historical torrents in the county and analyze the formation causes and features of torrents;
- Define responsibilities and principal of county headquarters of torrent prevention;
- Define townships with task of torrent prevention and measures for torrent prevention;
- Establish monitoring communication and early warning system; define process and mode of early warning; timely issue warning information of torrent disaster according to forecasting;
- Formulate requirements for transfer and relocation; make various measures related to rescue relief work and post-disaster reconstruction; arrange daily publicity and rehearsal, etc.

7 PUBLICITY, TRAINING AND REHEARSAL

7.1 PUBLICITY

Propagandize knowledge related to torrent prevention in village, household and even to individual by means of meeting, radio, TV, newspaper, bulletin board, pamphlet, wall map, compact disk and card issue, so as to continuously improve the consciousness of active prevention and legal defense and enhance the self-rescue awareness and ability.

Organize residents to be familiar with transfer route and relocation place, erect clear warning board in striking place of dangerous area and indicate transfer object, transfer route and relocation place to make all people in dangerous area know related measures.

The publicity materials are uniformly compiled by torrent prevention headquarters at or above county level with concrete requirements as follows: Print Pamphlet of Knowledge about Torrent Prevention, Fabricate compact disk and audio tape to propagandize knowledge of torrent prevention, Prepare Understanding Card of Torrent Prevention, Prepare bulletin board and propaganda column; fabricate warning board.

7.2 TRAINING

Train commanders, principals, monitoring persons, warning persons and regional responsible persons of county and township torrent prevention headquarters in aspect of professional knowledge to define respective responsibilities, so as to ensure the normal and effective operation of commanding system.

Train them in aspect of technologies and operation maintenance of torrent monitoring and early warning system, so as to ensure the effective operation of system.

Train related person to make them understand composition and technology of torrent monitoring and early warning system in current county, use and maintenance of monitoring and early warning platform or information terminal, diagnosis and processing method of computer network fault, operation, maintenance and management of automatic monitoring station, simple monitoring station, flood information and other technologies, so as to ensure the normal operation of monitoring and early warning system.

Train workers of simple monitoring station to make them understand monitoring method of rainfall and water level and transmission method of torrent early warning information, so as to improve the reliability and correctness of torrent monitoring. For information messengers and senders of village and groups, it is necessary to train them in aspect of method for information collection and sorting and mode of warning signal issue, for the purpose of ensuring the orderly and effective development of mass observation and mass prevention

7.3 REHEARSAL

The torrent prevention area carries out once or twice rehearsal of disaster avoidance to make all people clearly know transfer route and relocation place, ensuring calm and safe transfer even in case of power off and communication outage. The content of rehearsal includes emergency response, emergency rescue, disaster relief, transfer, logistics support, personnel transfer and relocation, etc. Describe object, range and content of rehearsal in brief.

8 INVESTMENT EVALUATION

Give brief introduction of principle and basis for compilation of investment evaluation and referred expense standard and related specifications. The price level adopted is price level of that very year. Costs for equipment installation facilities and civil work (labor cost and material cost); the equipment cost mainly refers to expense for purchase of hardware equipment. For main allocated equipment and some damageable accessories, prepare spare parts of them according to 10 ～15% of quantity allocated; the cost of software development mainly refers to expenses for development of monitoring and early warning platform software and purchase operating system, GIS and database related to the platform, etc. Freight and miscellaneous expense, communication expense, installation and debugging expense and taxes are all charged independently according to corresponding standard of fee collection. Evaluate the cost for plan compilation, publicity and training according to actual work amount. Construction management fees, survey and design fees, supervision fees and other fees are controlled as per 6%～8% of total investment for project construction.

8.1 UNIT PRICE AND INVESTMENT REFERENCE SCALE

All regions shall reasonably determine the unit price of all equipment according to actual situation of local pilot. The investment reference scale for each part of torrent prevention non-engineering measures are as shown in table below. The scale can have proper fluctuation when each region compiles estimate cost. The costs of installation and maintenance, and improve the system reliability and expansibility is involved [8].

No.	Item	Construction Content	Proportion in Total Investment
1	Monitoring system	Construction of automatic/simple rainfall/water level station, including monitoring information receiving part in platform	27% around
2	Early warning system	Configuration of equipment for implementation of early warning in county, township, village and groups	35% around
3	County monitoring and early warning platform	Hardware purchase, software development construction and transform of computer room and conference environment, etc.	18% around
4	Mass observation and mass prevention system	General survey of torrent disaster, designation of dangerous area, determination of early warning index, plan compilation, publicity, training and rehearsal of torrent disaster, etc.	20% around

Fig. 6. Table of Unit price and investment reference scale

9 CONSTRUCTION AND OPERATION MANAGEMENT

The water administration department of county where project is shall establish specialized agency, appoint specially-arranged person and carry out project implementation work according to arrangement or requirements of superior department. After project completed, the provincial water administration department shall organize to formulate operation management system. The outlay for operation management is included into provincial, municipal and county financial budget. The operation management is taken charge by county and township. Management of automatic monitoring station and business guidance shall be entrusted to corresponding hydrographic office (sub-office). Related information is included into flood-control and command system to realize information sharing define management system, outlay and personnel to ensure normal operation of system and produce the best possible result

10 CONCLUSION

In this paper, we analysis current condition of key research and establish the requirements for monitoring and early warning system to improve the reliability and expansibility of the system [9]. Since many years, Monitoring and Early Warning System of Mountain were studied with good rick management performance by monitoring research institution bodies and keeps numerous achievements from the research scholars over the world. In conclusion, what article is illustrated that the monitoring system and early warning system is a very effective research measure for mountain torrent disaster reduction and mountainous flood disaster reduction, only after full-filled following these several points [10]:

- Reasonable observation points distribution of disaster warning
- Management risk & analysis system which can get a relatively accurate observations result
- Being accuracy and timely warning signal dissemination mechanism process
- Reasonable research institutional structure, based on the administrative structure plan
- Awareness and perfect emergency response system and planning
- Training, Practices, rehearsal evacuation system based on Public community
- Planned construction and operation management projects

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Genesis, identification and distribution of the interlayer in rhythmic layering in continental low permeability reservoirs

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ABSTRACT: Study on the interlayer has developed associated with in-depth exploration and development of oil fields, which is an indispensable part to characterize reservoir heterogeneity. This study relates to a comprehensive research method of interlayer in rhythmic layering in continental low permeability reservoirs. During the process of waterflooding development, distribution characteristics of interlayer in the single well, plane, cross-well, and well group should be analyzed based on identification and genesis of interlayer. And thus the three-dimensional model of interlayer could be constructed in order to reveal its spatial distribution characteristics in continental reservoirs. Practice in continental oil fields has shown that the type and distribution of interlayer play an important role in controlling remaining oil. Mastering the distribution rule of interlayer can better explore the distribution of remaining oil. Through in-depth analysis on the interlayer, better development results could be achieved by taking different measures to trap the potential. Also, utilizations of interlayer results for the analysis of injection connectivity could facilitate petroleum engineers to adjust the injection layers, and thereby increasing the efficiency of oil field development.

KEYWORDS: Interlayer, continental reservoirs, low permeability, distribution, remaining oil.

1 INTRODUCTION

During the waterflooding process of continental oil fields, it is difficult to evaluate reservoir flow distribution and seek favorable distribution of remaining oil zone because of the relatively severe reservoir heterogeneity. Given the influence and constraint of the tectonic evolution, sedimentary patterns and diagenesis, the genesis and distribution of interlayer become complex in rhythmic layering. Interlayer occurrence to a certain extent, affects the direct configuration relationship between the sand and interlayer, and thus affects the fluid movement of reservoir sandstones. Flow barrier and seepage discrepancy caused by interlayer are the major factors of the unswept water injection, which is especially evident in continental reservoirs [1]. Therefore, carrying out study on interlayer is of great significance and practical value.

Interlayer is a kind of relatively non-permeable layer, which is distributed unstably within sandstones and has a barrier effect of the non-permeate rocks in the oil field development process [1,2,3]. In fact, the interlayer within sandstones is also an internal interlayer within flow units, with an area usually less than half of the area of flow unit and often only a few

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centimeters thick. Despite an increase in the heterogeneity of the reservoirs owing to generally small extending and poor stability of interlayer, however, interlayer has played a favorable role in EOR process.

The traditional interlayer analysis and identification methods tend to focus on logging identification or plane distribution of interlayer. It rarely involves interlayer modeling in low permeability reservoirs, which is not conducive to the effective characterization of interlayer during the development of low permeability reservoirs. This study introduces integrated approach combining qualitative and quantitative, which contributes to understand fine characterization of reservoir geology by causes, characteristics, distribution and identification of interlayer in rhythmic layering of continental low permeability reservoirs for the first time. Also, study on interlayer helps to explore for the distribution of remaining oil. And the methodology has been already widely used in Bohai Bay Basin, Songliao Basin, Subei Basin, and Junggar Basin in China.

2 METHODS

Abundant logging data, combined with core observation, thin sections, scanning electron microscopy and other analysis assay technology for interlayer identification provided an important basis, and also provided a favorable condition for the genesis analysis of interlayer. Samples were selected for thin sectioning and scanning electron microscopy, which were taken for the habits of diagenetic minerals in selected samples.

By characterization from lateral side to vertical direction, from single well to the plane, from two-dimensional (2-D) to three-dimensional (3-D), it could determine frequency and density of interlayer more easily. Thus, a comprehensive characterization method was formed to improve the accuracy of cross-well identification (Fig. 1), to provide a reliable basis for oil-water movement and remaining oil distribution, and to enrich heterogeneity theory of continental reservoirs.

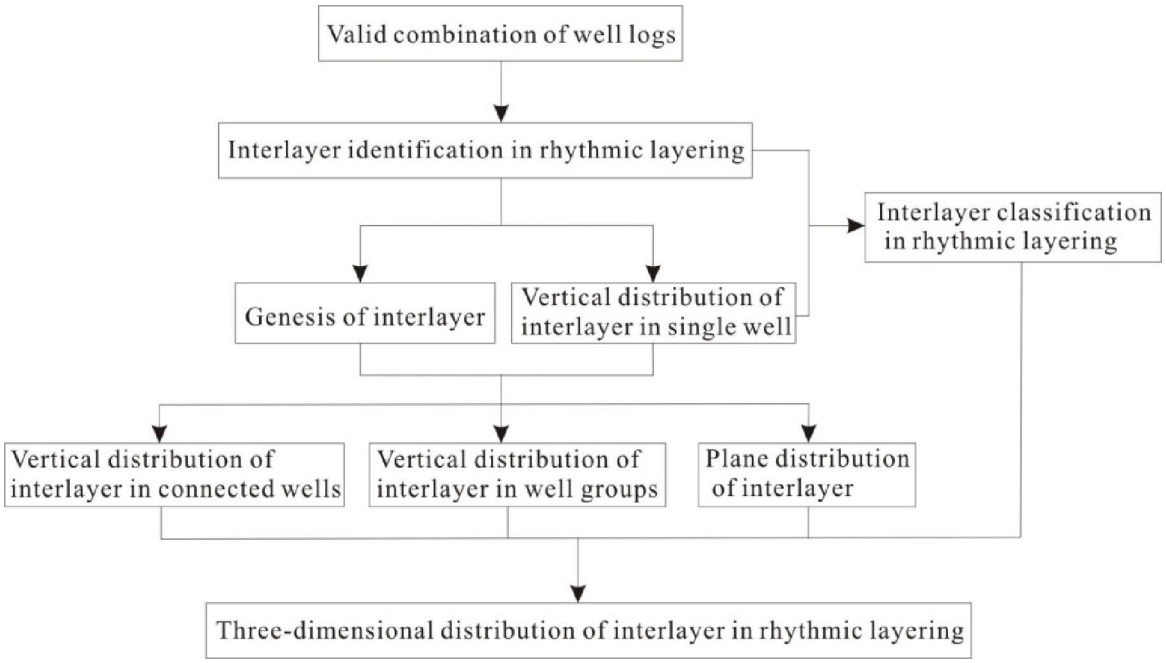

Fig. 1. Flow diagram showing a comprehensive characterization method of interlayer in rhythmic layering

3 RESULTS AND DISCUSSIONS

3.1 IDENTIFICATION AND GENESIS OF INTERLAYER

Considering that different types of interlayer corresponding to different logging response characteristics, it is necessary to select effective combination of well logs preferably. In general, the relative abundance of logging data provides a reliable foundation to carry out interlayer recognition in rhythmic layering. Combining core calibration, we can identify and analyze interlayer exactly on the level of single well.

Because of different study areas experiencing different depositional environments, coupled with the complex transformation by late diagenesis, it causes of different types of interlayer [5,6]. In accordance with the general consensus about continental reservoirs, interlayer comprises three types: muddy interlayer, calcium interlayer, and physical interlayer.

Muddy interlayer is formed by depositional environments under hydrodynamic conditions, including mudstone, silty mudstone, muddy siltstone and gravel mudstone. The emergence of muddy interlayer mainly consists of muddy wave layer, side laminated layer, and muddy bands within beddings. The main characteristics of this type of interlayer are small thickness, extremely irregular distribution, and strong reservoir heterogeneity, which increase the difficulty of the recovery from oil and gas reservoirs [4]. Well logs of muddy interlayer show low values of deep lateral resistivity, stable low microelectrode and neutron gamma values, high values of acoustic time, and spontaneous potential closing to the baseline. Conditions of muddy interlayer formation include: (1) semi-deep lake or deep lake depositional environments; (2) high-density turbidity currents converting to low-density ones [1].

The main rock types of calcium interlayer contain fine - coarse gravel sandstones, followed by sandy conglomerates, medium - fine conglomerate and medium - fine sandstone, which show dense lithology, impermeable or poor permeable. Clay matrix contents in interstitial materials are rare, but calcareous cement contents exceed 10% with mainly calcite, ferrous calcite, and small amounts of dolomite and ankerite (Fig. 2). Well logs of calcium interlayer manifest as higher deep lateral resistivity values, spikes of microelectrode curve, and apparent low values of acoustic time. Conditions of calcium interlayer formation include: (1) the evaporation of pore water or CO_2 degassing in meteoric environments; (2) carbonate cementation development from combination of released CO_2 by diagenetic thermal evolution of organic matters and Ca^{2+} or Mg^{2+} within formation water [1]. This type of interlayer is more prone in thin sandstones, contact parts between top or bottom of reservoirs sandstones and mudstones, muddy clumps attachments in internal reservoirs [4].

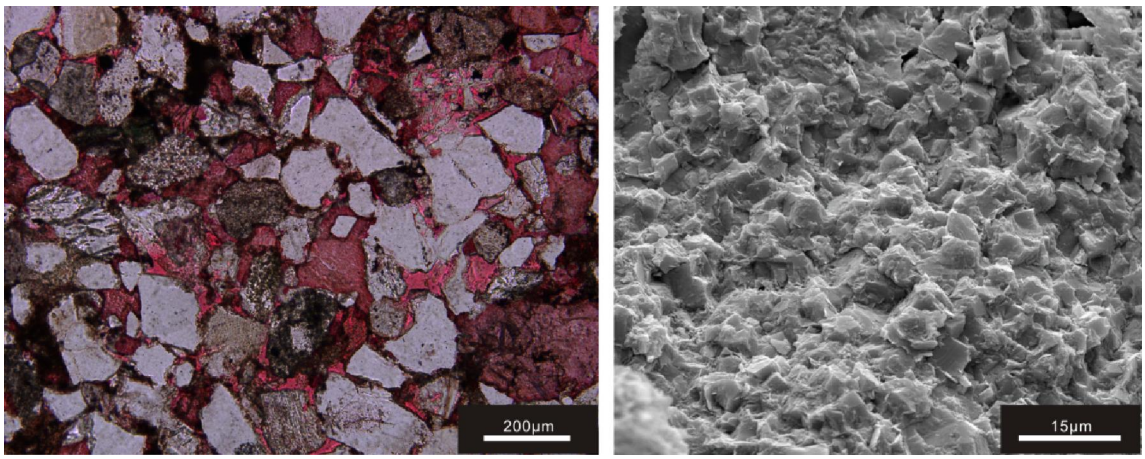

Fig. 2. Thin section and scanning election photomicrographs showing calcareous cement contents of calcium interlayer

Lithology of this type of interlayer mainly denominates in grease mark fine or silt sandstones, with high muddy contents. It has a certain porosity and permeability, but generally it does not reach the lower limit of the effective thickness of properties. Logging curves are characterized by low values of deep lateral resistivity, medium acoustic time and neutron gamma values, and weak anomaly spontaneous potential curves. With scattered distribution and strong randomness, physical interlayer may be derived from clutter stacked or residence deposits.

3.2 COMPREHENSIVE CHARACTERIZATION METHODS OF INTERLAYER IN RHYTHMIC LAYERING

Figuring out the classification and genesis helps to predict the distribution of regional interlayer. So it requires for a comprehensive analysis of interlayer in rhythmic layering of continental low permeability reservoirs, which is more accurate, reliable, and systematic relying on laboratory analysis.

Cross-well forecasting and modeling are the cores of interlayer research. The longitudinal changes of high and low permeability layers inside sandstones constitute permeability rhythm [7,8,10]. Interlayer is distributed in the upper parts of positive rhythm and the lower parts of counter-rhythm.

Based on the identification of interlayer, we could classify interlayer in rhythmic layering and determine the development of interlayer by calculating the thickness, analyzing lateral continuity, plane stability, and cross-well comparability.

To understand the overall distribution of interlayer, it is necessary to analyze the distribution characteristics in rhythmic layering, mainly from vertical position, plane distribution, number, and area. In this case, cross-well sections (Fig. 3a), well group distribution (Fig. 3b), and plane distribution (Fig. 3c) maps about interlayer can be plotted, which is benefit to further analyze the influences of the deposition and diagenesis on interlayer.

Using depositional theory and geostatistical methods [9], 3-D model and 3-D fence model corresponding to the distribution of interlayer are able to establish (Fig. 4). This model is on the basis of 3-D fine structural model and constraints of distributed interlayer of single well. As a result, it reflects 3-D distribution charactistics of interlayer in rhythmic layering, achieving higher accuracy of interlayer distribution analysis. This method provides a more reliable geological model to guide the internal potential adjustments of oil fields.

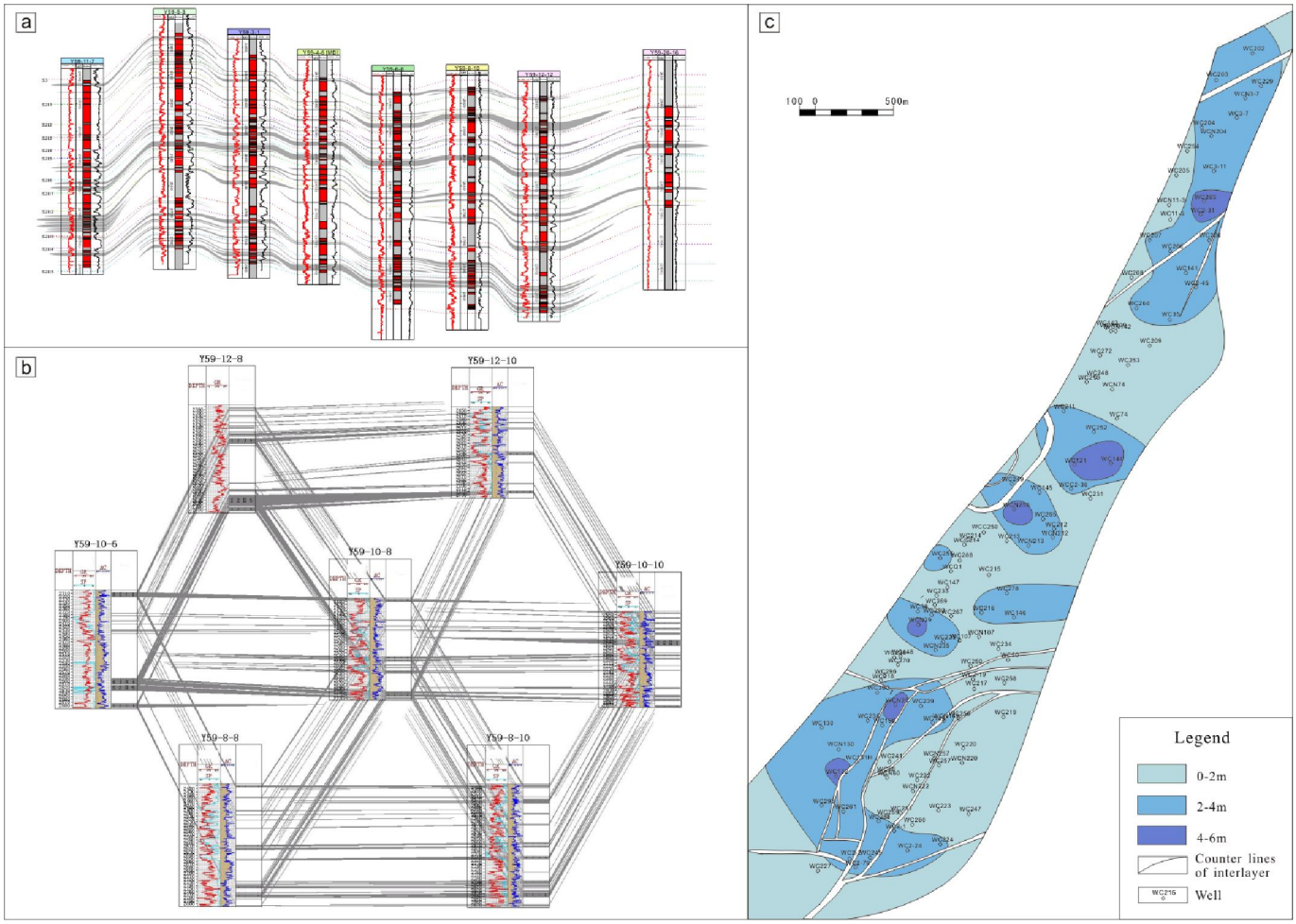

Fig. 3. Map showing the distribution characteristics of interlayer plotted on cross-well sections, well group, and plane

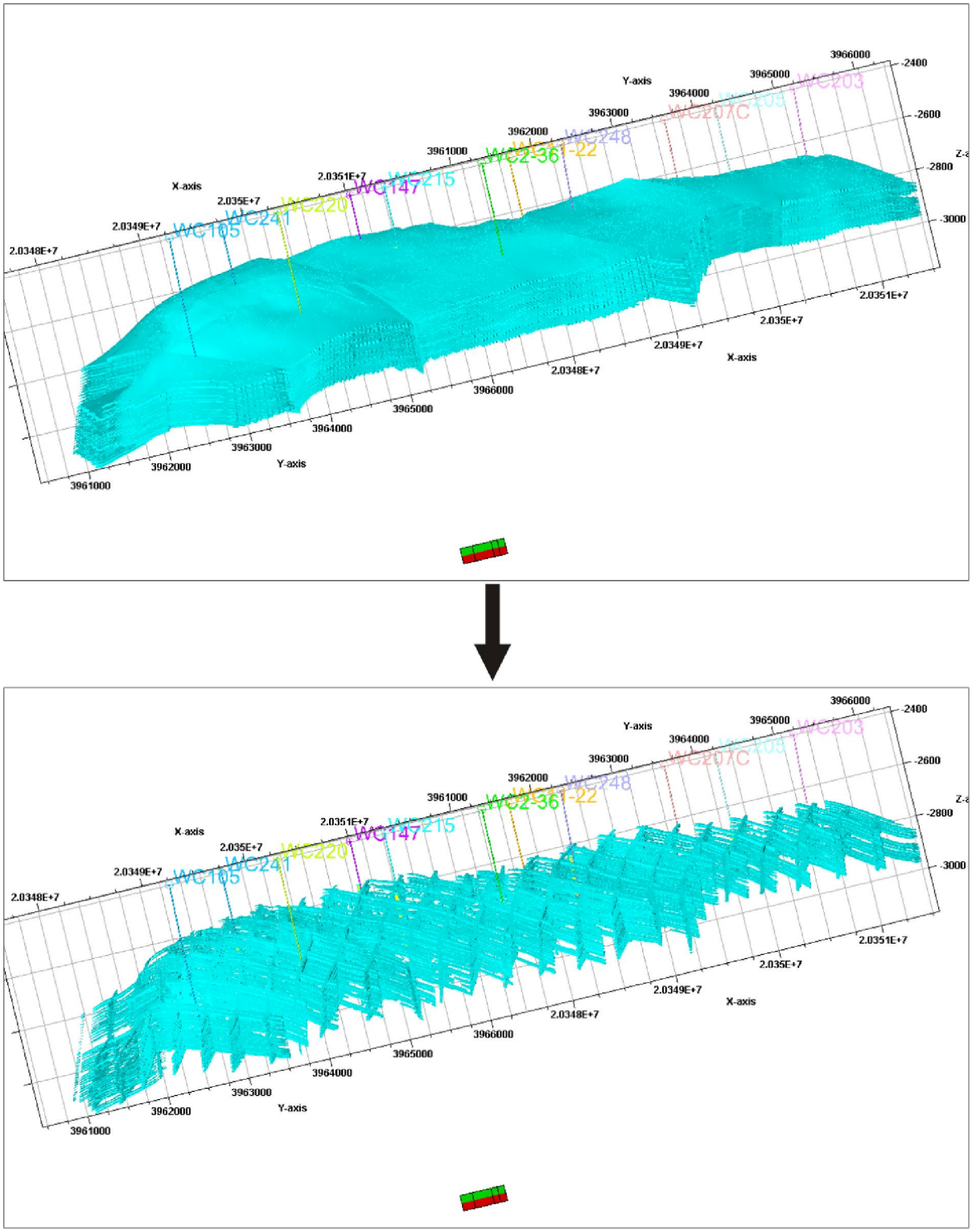

Fig. 4. 3-D model and 3-D fence model maps showing the distribution of interlayer

3.3 IMPACT ON REMAINING OIL OF INTERLAYER IN RHYTHMIC LAYERING

Since the presence of interlayer, the formation of seepage barrier could control the oil-water movement to a certain extent and have a greater impact on remaining oil distribution [11-15]. Remaining oil is usually distributed in the lower permeability part, which is considered as the top of rhythmic layering [16]. The major impact on remaining oil of interlayer is related to interlayer position, perforation location, and the relationships between injection wells and interlayer. The

appearance of interlayer, which makes multi-stage distribution of remaining oil within reservoirs, has changed the distribution patterns of remaining oil. The location where the distribution density and frequency of interlayer are greater, with better production potential, has a higher degree of remaining oil within the control of interlayer [17]. If the injection wells have drilled interlayer but only injection above the location of interlayer, the remaining oil will be enriched under the interlayer [18]. Mastering the development of interlayer can better propose targeted measures for remaining oil digging.

4 CONCLUSION

There are extensive muddy interlayer, calcium interlayer, and physical interlayer, which can be identified in continental low permeability reservoirs. Not only do the three types of interlayer have different causes, but also its lithology, distribution characteristics, and logging response characteristics vary with each other. Based on the recognition of interlayer, a complete set of comprehensive characterization methodology of interlayer in rhythmic layering is established, which can further analyze the impact of interlayer on the distribution of remaining oil. Carrying out studies on interlayer in rhythmic layering is particularly important in the late period in the oil fields development. Strengthening the research on the interlayer will be conductive to predict the case of oil and gas production and lay a more solid foundation for the law of oil-water movement.

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The Synergy Test of Solubilizing Phospate Highland Bacteria and *Azotobacter vinelandii* Lowland Bacteria on FLUFF Tea Compost as Solid Carrier Base

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ABSTRACT: Laboratory-scale experiments have been conducted to test the effect of FLUFF tea compost and mix it with zeolit as carrier base for Solubilizing Phosphate Highland Bacteria (BPF) and *Azotobacter vinelandii* as Nitrogen fixing lowland bacteria (BPN). The experiment was using a randomized block design, two factors, three repeated. The first factor is the carrier base (100% FLUFF Tea Compost; 90% FLUFF Tea Compost + 10% Zeolite; and 75% FLUFF Tea Compost + 25% Zeolite) and the second factor is the kind of inoculant (100% BPF; 100% BPN; and mix of BPF 50% + BPN 50%). The water content from FLUFF Tea Compost was 59,8% with pH after 2 days incubation was 6,3-6,7. The respons were total bacteria and temperature on 4, 8, and 12 days after incubation. The results showed that the total bacteria from the carrier base and kind of inoculants have significant on 4 days after incubation, but not significant on 8 and 12 days after incubation. The A3B3 (75% FLUFF Tea Compost + Zeo25%) & (BPF 50%+azoto50%) was the best treatment, but if compare from before, A3B1 (75% FLUFF Tea Compost + Zeolite 25%) & (BPF 100%) have the highest average percentage during observation. The temperature was stable, it means that the decomposition proccess was not occur. From the data, we can tell that the BPF highland more adaptable than BPN lowland on FLUFF tea compost. The BPF and BPN have synergy growth on each carrier base treatment.

KEYWORDS: *Azotobacter vinelandii*, BPF, FLUFF tea compost, Incubation, Zeolite.

1 INTRODUCTION

Biofertilizers is the living microorganism that provide into the soil as inoculant to facilitated or supply a particular nutrient for plants [1]. One of them is Solubilizing Phosphat Bacteria, that can increasing the phosphat solubilising by fosphatase and organic acid as secondary metabolite. Phosphat is the secondary essensial nutrient to the plant. Availability of phosphat around 0,01% from the total of phosphat on soil. Most of fosphate bounded by soil colloidal and chelated by Fe, Al, or Ca ion. [2] Only 15 – 20% fosphat could be absorb by plant from anorganic fosphate fertilizer [3].

Azotobacter sp is the rhizobacteria that can fixation the nitrogen from the air. Generally, it can use to increasing the nitrogen on the soil and also as PGPR by produce fithohormon [4], [5]. This bacteria also have a potential to excrate some eksopolisacarida (EPS) and organic acid [6]. *Azotobacter vinelandii* particulary can produced biosurfactant [6], sitokinin [7], nitrogen fixation superior bacteria, root growth stimulant [8], and contribute on soil fertility.

A carier should be need as a carbon sources to produce biofertilizer. One of the important thing to choice a material to carier is the capability to kept population of inoculant. Some of the material can be used a carrier base are compost, zeolit, bentronite, vermiculite, and peat. The FLUFF tea compost was offgrade from tea processing. It can use a organic fertilizer on tea plantation by composting first [9]. The mixture from compost and zeolit (9:1) on 28 ^{O}C was a better carier than peat [2], [10], [11].

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2 MATERIALS AND METHODS

2.1 MULTIPLIED INOCULANT

This experiment used BPF from Research Institute for Tea and Cinchona (RITC)'s collection and *Azotobacter vinelandii* (BPN) was Padjadjaran University (UNPAD)'s collection. The inoculant source of BPF from tea rhizosphere on RITC's experimental garden with elevation 1350 – 1600 m above sea level and BPN from agricultural food plants with elevation 600 – 800 m above sea level. Each of bacteria multiplied on each liquid medium, that was Pikovskaya and Ashby's medium. After two days incubation (TPC-0), the population of BPF was 10 x 10^7 population/ml and BPN was 185 x 10^7 population/ml.

2.2 EXPERIMENTAL DESIGN

This experiment used Randomized Blok Design Factorial with two factors and three repeated. The statistic analyxe used was Analyze of Variants (ANOVA) with Duncan different test. 100% BPF meaning that 10 ml BPF on 100 g carrier. 50% BPF + 50% BPN meaning that 5 ml BPF + 5 ml BPN on mixture of 75 g FLUFF Tea Compost and 25 g Zeolite as the carrier. Thw water content of FLUFF Tea Compost was 59,8%. The arrangement treatment were :

A. Carier Factor, the level was :
    1. 100% FLUFF tea compost
    2. 90% FLUFF tea compost + 10% Zeolite
    3. 75% FLUFF tea compost + 25% Zeolite
B. Inoculant Factor, the level was :
    1. 100% BPF
    2. 100% BPN
    3. 50% BPF + 50% BPN

The respons are :

a. Bacteria Population with Total Plate Count methode
b. The temperature of compost with thermometer

3 RESULTS AND DISCUSSION

3.1 TOTAL BACTERIA POPULATION

TPC-0 was the total bacterial population before treatment, after 2 days incubation that was 195 x 10^7 population/g. After each 4, 8, and 12 days after incubation the total bacterial population was counted. The total bacterial of population on TPC-1 (after 4 days incubation), TPC-2 (after 8 days incubation), and TPC-3 (after 12 days incubation) shown on Table 1 until 3.

Table 1. Total Bacteria on TPC-1

Treatment	Total Population (10^7 cfu/g)
A1B1 (100% FLUFF Tea Compost) & (BPF 100%)	151.67 a
A2B1 (90% FLUFF Tea Compost + Zeolite 10%) & (BPF 100%)	295 ab
A1B2 (100% FLUFF Tea Compost) & (Azoto 100%)	475 ab
A2B2 (90% FLUFF Tea Compost + Zeolite 10%) & (Azoto 100%)	706.67 abc
A1B3 (100% FLUFF Tea Compost) & (BPF 50% + Azoto 50%)	883 abc
A3B1 (75% FLUFF Tea Compost + Zeolite 25%) & (BPF 100%)	928 abc
A2B3 (90% FLUFF Tea Compost + Zeo10%) & (BPF 50%+Azoto50%)	1055 abc
A3B2 (75% FLUFF Tea Compost + Zeo 25%) & (azoto 100%)	1206.67 bc
A3B3 (75% FLUFF Tea Compost + Zeo25%) & (BPF 50%+azoto50%)	1633 c

Note : The ANOVA's analysis was significant on 5% level's. The figures followed by the same letter does not significantly on 5% level's of Duncan test

Table 2. Total Bacteria on TPC-2

Treatment	Total Population (10^7 cfu/g)
A1B1 (100% FLUFF Tea Compost) & (BPF 100%)	330
A2B1 (90% FLUFF Tea Compost + Zeolite 10%) & (BPF 100%)	1176,67
A1B2 (100% FLUFF Tea Compost) & (Azoto 100%)	523,33
A2B2 (90% FLUFF Tea Compost + Zeolite 10%) & (Azoto 100%)	686,67
A1B3 (100% FLUFF Tea Compost) & (BPF 50% + Azoto 50%)	1501,67
A3B1 (75% FLUFF Tea Compost + Zeolite 25%) & (BPF 100%)	636,67
A2B3 (90% FLUFF Tea Compost + Zeo10%) & (BPF 50%+Azoto50%)	1335
A3B2 (75% FLUFF Tea Compost + Zeo 25%) & (azoto 100%)	600
A3B3 (75% FLUFF Tea Compost + Zeo25%) & (BPF 50%+azoto50%)	1150

Note : The ANOVA's analysis was not significant on 5% level's

Table 3. Total Bacteria on TPC-3

Treatment	Total Population (10^7 cfu/g)
A1B1 (100% FLUFF Tea Compost) & (BPF 100%)	348,33
A2B1 (90% FLUFF Tea Compost + Zeolite 10%) & (BPF 100%)	425
A1B2 (100% FLUFF Tea Compost) & (Azoto 100%)	1513, 33
A2B2 (90% FLUFF Tea Compost + Zeolite 10%) & (Azoto 100%)	760
A1B3 (100% FLUFF Tea Compost) & (BPF 50% + Azoto 50%)	1066,67
A3B1 (75% FLUFF Tea Compost + Zeolite 25%) & (BPF 100%)	1386 ,67
A2B3 (90% FLUFF Tea Compost + Zeo10%) & (BPF 50%+Azoto50%)	1405
A3B2 (75% FLUFF Tea Compost + Zeo 25%) & (azoto 100%)	1093,33
A3B3 (75% FLUFF Tea Compost + Zeo25%) & (BPF 50%+azoto50%)	1301, 67

Note : The ANOVA's analysis was not significant on 5% level's

The A3B3 was the best treatment on TPC-1. After 8 and 12 days incubation, all treatment was not significant on ANOVA's analysis. With compare the present TPC with TPC before (TPC-1 with TPC-0. TPC-2 with TPC-1, and so), the trend of population bacteria each treatment shown on Table 4.

Table 4. Trend of Population Bacteria

Treatment		Percent of Compare Total Population (%)			
		TPC-0	TPC-1	TPC-2	TPC-3
100% BPF	100% FLUFF Tea Compost	0,00	1416,70	117,58	5,55
	(90% FLUFF Tea Compost + Zeolite 10%)	0,00	2850,00	298,87	***-63,88***
	(75% FLUFF Tea Compost + Zeolite 25%)	0,00	9180,00	***-31,39***	117,80
100% BPN	100% FLUFF Tea Compost	0,00	156,76	10,17	189,17
	(90% FLUFF Tea Compost + Zeolite 10%)	0,00	281,98	***-2,83***	10,68
	(75% FLUFF Tea Compost + Zeolite 25%)	0,00	552,25	***-50,28***	82,22
50% BPF + 50% BPN	100% FLUFF Tea Compost	0,00	352,82	70,06	***-28,97***
	(90% FLUFF Tea Compost + Zeolite 10%)	0,00	441,03	26,54	5,24
	(75% FLUFF Tea Compost + Zeolite 25%)	0,00	737,44	***-29,58***	13,19

Although A3B3 was the best treatment on TPC-1, but if compere with TPC-0 the highest percentage was A3B1 and A3B1 have the highest average percentage for three times observation, that was 30,89 times multiplied population from TPC-0. From the data, we can tell that the BPF highland more adaptable than BPN lowland on FLUFF tea compost as a solid carrier base. The BPF and BPN have synergy growth on each carrier base treatment, although BPN more lately growth than BPF. The 75% FLUFF Tea Compost + Zeolite 25% tratement influence the growth of both bacteria after 8 days incubation and reduce the bacteria population. Azotobacter was the nitrogen fixing microorganism that can growth on huge range of pH [12].

3.2 TEMPERATURE OF COMPOST

The average temperature of carrier before treatment was 21 ^{O}C. Temperature was measurable at the same times with population of bacteria counted. The each temperature of TPC-1, TPC-2, and TPC-3 was shown on Tabel 5 until 7.

Table 5. Temperature on TPC-1

Treatment	*Repeated 1 (°C)*	*Repeated 2 (°C)*	*Repeated 3 (°C)*	*Average (°C)*
A1B1	19.80	19.90	20.20	19.97
A1B2	20,00	20,00	20,00	20.00
A1B3	20,00	20.20	20.10	20.10
A2B1	20,00	19.90	20.20	20.03
A2B2	20,00	20,00	20.10	20.03
A2B3	20,00	19.80	20,00	19.93
A3B1	19.90	20,00	20,00	19.97
A3B2	19.90	20,00	20.10	20.00
A3B3	20,00	19.90	20.50	20.13

Table 6. Temperature on TPC-2

Treatment	*Repeated 1 (°C)*	*Repeated 2 (°C)*	*Repeated 3 (°C)*	*Average (°C)*
A1B1	21.25	21.15	21.00	21.13
A1B2	21.50	21.05	21.50	21.35
A1B3	21.10	21.10	21.10	21.10
A2B1	21.50	21.20	21,00	21.23
A2B2	21.40	22,00	21,00	21.47
A2B3	21.75	21.75	20.85	21.45
A3B1	21.30	21.40	21.55	21.42
A3B2	20.95	21.20	21.05	21.07
A3B3	20.80	21.05	21.40	21.08

Table 7. Temperature on TPC-3

Treatment	*Repeated 1 (°C)*	*Repeated 2 (°C)*	*Repeated 3 (°C)*	*Average (°C)*
A1B1	21,00	22,00	22.40	21.80
A1B2	21.40	21.60	21.60	21.53
A1B3	20,60	22.10	22.50	21.73
A2B1	21,00	20.40	22,00	21.13
A2B2	20.80	22.20	22.40	21.80
A2B3	21.60	21.40	22.70	21.90
A3B1	20.80	21.60	23,00	21.80
A3B2	21,00	22,00	22,00	21.67
A3B3	21,00	21.80	22.20	21.67

The table shown that the temperature was stable, it means that the decomposition proccess was not occur during the observation. The increasing of temperature on decomposition proccess as an indicator on metabolism of microorganism [13]. Beside of that, the range pH of refined compost was 6 – 7. Table 8 shown the pH after 12 days incubation (TPC-3).

Table 8. The pH on TPC-3

Treatment		Repetition			Average
		I	II	II	
100% BPF	100% FLUFF Tea Compost	6.6	6.7	6.7	6.7
	(90% FLUFF Tea Compost + Zeolite 10%)	6.6	6.6	6.6	6.6
	(75% FLUFF Tea Compost + Zeolite 25%)	6.3	6.4	6.4	6.4
100% BPN	100% FLUFF Tea Compost	6.7	6.7	6.8	6.7
	(90% FLUFF Tea Compost + Zeolite 10%)	6.6	6.6	6.6	6.6
	(75% FLUFF Tea Compost + Zeolite 25%)	6.3	6.3	6.4	6.3
50% BPF + 50% BPN	100% FLUFF Tea Compost	6.7	6.8	6.8	6.8
	(90% FLUFF Tea Compost + Zeolite 10%)	6.7	6.5	6.6	6.6
	(75% FLUFF Tea Compost + Zeolite 25%)	6.3	6.3	6.5	6.4

4 CONCLUSION

Biofertilizers is the living microorganism that provide into the soil as inoculant to facilitated or supply a particular nutrient for plants. For the best growth of biofertilizer, we can used a solid carrier base. To inoculation more than one microbe as a biofertilizer, we should do the synergy test of those microbes. The solubilizing phosphate (BPF) highland bacteria more adaptable than *Azotobacter vinelandii* (BPN) lowland bacteria on FLUFF tea compost as a solid carrier base. The BPF and BPN have synergy growth on each carrier base treatment, although BPN more lately growth than BPF.

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Impact des pratiques agricoles sur la stabilité structurale et la matière organique du sol dans les zones semi-arides Marocaines

[Effects of tillage and cropping systems on the structural stability and soil organic matter in semi-arid areas of Morocco]

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ABSTRACT: Soil degradation is becoming the major problem of Moroccan soils in semiarid areas. This deterioration is due to poor soil management through recurring tillage practices that cause a decline in soil organic matter and degradation of their structural state. This study aims to characterize the impact of tillage, residue management and cropping systems on the aggregate stability and the accumulation of organic matter in a Calcixeroll soil. Three tillage treatments were compared: conventional off-set disking, no-tillage system with two levels of residue: NT100 = full surface residue cover and NT50 = half surface residue cover, along with three rotations: continuous wheat, fallow–wheat and fallow–wheat–barley. The results showed that compared with conventional tillage, no-tillage allows an improvement of aggregation and organic matter content of the sampled horizons (0-5, 5-10 and 10-15 cm). The total coverage of plots by 100% of mulch residues (NT100) has helped to increase the level of organic matter in all soil fractions (aggregates <0.5 mm and> 8 mm). It was found also that the continuous wheat rotation has improved the structural aspects of the soil and allowed the accumulation of organic matter compared with rotations with fallow. In conclusion, soil quality (stability and organic matter) was improved in no-tillage condition, especially with a maximum contribution of surface residue (NT100).

KEYWORDS: No-Tillage, crop residue, rotation, aggregate stability, organic matter.

RESUME: Le recours à des pratiques de labours récurrents dans les zones semis arides Marocaines a eu des effets négatifs sur la qualité des sols agricoles qui deviennent peu fertiles et plus vulnérables à l'érosion. Cette étude a pour objectif de caractériser l'incidence des pratiques culturales sur la stabilité structurale et l'accumulation de la matière organique d'un sol calcimagnésique et ses différentes tailles d'agrégats. Trois types de travail du sol ont été comparés : le labour conventionnel, le semis direct avec 100% des résidus de récoltes retournés aux parcelles et laissés en surface (SD100) et avec 50% des résidus (SD 50). Ainsi que trois types de rotation céréalière : Blé continu, Jachère-Blé et Jachère-Blé-Orge. Les résultats obtenus ont montré qu'en comparaison avec le labour conventionnel, le semis direct permet une amélioration de l'agrégation et des contenus en matière organique des horizons échantillonnés (0-5, 5-10 et 10-15cm), et particulièrement avec le retour à la surface du sol des quantités importantes des résidus de récolte (SD 100). Le non labour avec 100% de résidus a contribué à une augmentation du niveau de la matière organique dans toutes les fractions du sol (agrégats < 0,5 mm et > 8mm). Il a été constaté également que la rotation Blé continu a amélioré les facettes structurales du sol et a permis l'accumulation de la matière organique en comparaison avec les rotations incluant la jachère. En conclusion, la qualité du sol (stabilité et matière organique) s'est améliorée sous semis direct, notamment avec un apport maximum de résidus en surface (SD100).

MOTS-CLEFS: Semis direct, résidus de récolte, rotation, Stabilité des agrégats, matière organique.

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1 INTRODUCTION

Dans les zones semi-arides Marocaines, la variabilité spatio-temporelle du climat avec des épisodes de sécheresse périodiques et fréquentes, ont abouti à une pénurie en ressources en eau qui influence la production céréalière [1]. Cette situation difficile s'aggrave par l'utilisation abusive des pratiques agricoles classiques [2]. En effet, le travail du sol et d'autres pratiques inadéquates (surpâturage, exportation de résidus, déboisement…), causent une déperdition du contenu en matière organique (MO) des sols qui deviennent peu fertiles et plus vulnérables à l'érosion [3]. Au vu de ces problèmes, l'agriculture de conservation est perçue comme une alternative viable contre les défis de la rareté et des dégradations des ressources naturelles de base [4]-[5]. C'est dans ce contexte que le plan Maroc vert a mis l'accent sur les systèmes agricoles qui sont productifs, rémunérateurs et en même temps respectueux de l'environnement [6]. Les travaux de recherche effectués dans les zones semi-arides marocaines, ont affirmé que, par rapport au labour conventionnel, le semis direct (système de conservatoire de gestion des sols et des cultures) permet des rendements élevés du blé [7]-[8]. D'autres recherches ont montré que cette pratique culturale améliore la qualité du sol [9], [10]-[11].

L'évolution de la qualité du sol est estimée indirectement via des propriétés physiques, chimiques et biologiques (la stabilité structurale, la MO...). La stabilité de la structure est considérée comme un bon indicateur de la qualité des sols et de leur sensibilité au ruissellement et à l'érosion [12]. Elle est le paramètre physique le plus étudié dans les expérimentations comparant le non-labour au labour [13]. Un travail du sol intensif détruit la cohésion des agrégats et affaiblit la structure, alors que le semis direct permet de restaurer l'agrégation du sol et d'améliorer sa stabilité structurale [14].

La MO a suscité l'intérêt de plusieurs chercheurs comme étant un indicateur important de la qualité du sol grâce à son rôle essentiel dans la protection physique de la surface du sol, la rétention d'eau, et la stabilisation de la structure [15], [16]-[17]. Les expériences à travers le monde indiquent que cette propriété inhérente du sol est influencée par les pratiques de production agricole. Parmi les approches permettant d'améliorer les apports de carbone, on retrouve les systèmes de réduction du travail du sol et la gestion de résidus de culture [18]-[19]. Ainsi, les réserves de la MO ont tendance à augmenter quelques années après la conversion en techniques sans labour [20]-[21]. Au Maroc, [10] et [22] ont indiqué que le semis direct (SD) a enregistré une meilleure séquestration en MO pour un calcimagnésique après 11 ans d'essais. Des résultats similaires ont été trouvés par [11] sur un autre essai de sept ans dans un vertisol. Selon les mêmes auteurs, l'élimination du labour et la présence de résidus de récolte en surface de façon continue représentent un facteur majeur d'accumulation du carbone organique et d'accroissement de la stabilité structurale des agrégats. Cette performance de la couverture végétale en régime de SD dépend du niveau de recouvrement du sol. Pour que celle-ci soit efficace, les chercheurs considèrent qu'il faut dépasser un taux de recouvrement du sol de 25 à 40 % [23].

La rotation et le type de culture agissent également sur le niveau de la MO. Les différents effets des rotations sur le taux de carbone organique reflètent l'importance des caractéristiques morphologiques des différentes cultures et le type de résidus dans l'amélioration du carbone organique dans le sol [24]. La référence [22] a montré que suivant les rotations, la rotation blé continu a présenté le taux de carbone le plus élevé dans les couches de surface, alors que les rotations incluant la jachère montrent les taux les plus faibles. Toutefois aucune tentative n'a été faite pour évaluer l'effet du travail du sol, de la gestion des résidus et de la rotation sur l'accumulation de la MO dans les différentes tailles d'agrégats du sol. La présente étude concerne un sol argileux gonflant en zone semi-aride marocaine (plaine de la Chaouia). Elle est inscrite dans une recherche de long-terme développée par le Centre Régional de la Recherche Agronomique de Settat afin d'évaluer les possibilités d'utiliser le SD comme pratique alternative visant à la conservation et à l'amélioration de la capacité productive des sols. L'objectif consiste à déterminer l'effet du travail du sol, de la gestion des résidus et des rotations de culture sur la stabilité structurale et la séquestration de la MO du sol et ses différentes tailles d'agrégats.

2 MATERIELS ET METHODES

2.1 DESCRIPTION DU SITE

Le site est situé à la station expérimentale de Sidi El Aydi du Centre Régional de la Recherche Agronomique de Settat, (latitude 33° 00'N, Longitude 09°22W), Nord de la ville de Settat (environ 15 Km). Le sol est un calcimagnésique à caractère vertique moyennement profond. Il est caractérisé par une structure faiblement développée et une teneur en MO relativement élevée sur les 10 premiers cm (tableau 1). Le climat est semi-aride à hivers froid. Les précipitations annuelles moyennes à long terme sont de 358 mm avec un maximum de 740 mm et un minimum de 113,5 mm [25]. L'essai mis en place en 1987 est un dispositif en split plot (bloc aléatoire incomplet) avec trois répétitions. La rotation est pratiquée en grande parcelle (20 m de long et de 12m de large), avec trois niveaux : Blé-Blé (BB), Jachère-Blé (JB), Jachère-Blé-Orge (JBO).

Chaque grande parcelle, est subdivisée en quatre sous parcelles (3 m de large et 20 m de long), dont une est labourée au pulvérisateur à disques et trois sont semées directement.

Le travail du sol consiste en un travail conventionnel (Cover Crop) effectué en parcelle labourée; c'est le labour primaire (10 à15 cm de profondeur) pour préparer les lits de semences et pour enfouir les résidus. La jachère est entretenue mécaniquement. Par contre en parcelle non labourée, la seule opération aratoire consiste en une ouverture de 2 à 3 cm du sol pour placer la semence à 5 cm de profondeur, réalisé par un semoir spécial semis direct. En condition de non labour, la jachère est entretenue par désherbage chimique.

Pour étudier l'effet de la gestion des résidus de récoltes sur les propriétés du sol sous semis direct, les trois sous parcelles sous SD ont été soumises à trois niveaux de résidus: à la récolte et dans la première sous parcelle, l'ensemble des résidus a été enlevé (SD0), dans l'autre sous parcelle, la totalité des résidus de récolte enlevée a été retourné et laissé en surface (SD 100) alors que dans la troisième sous parcelle, seulement la moitié des résidus récoltés a été gardé en surface du sol (SD 50). Les résidus ainsi repartis seront uniformément dispersés, avant le semis.

Pour notre étude, seuls les deux derniers niveaux de résidus sous SD (SD 50 et SD 100) ont été étudiés.

Tableau 1. Caractéristiques du sol à la station expérimentale de Sidi El Aydi (0-200mm) de profondeur [10]

Propriétés	Profondeur du sol (0-200 mm)
Argile (%)	51
Limon (%)	28
Sable (%)	21
pH (eau)	8,25
CaCo3 total ($g.Kg^{-1}$)	13
Carbone Organique (%)	1,4
CEC ($meq\ l^{-1}$)	50
Densité apparente à sec ($g.cm^{-3}$)	1,28
Na ($Mg\ kg^{-1}$)	154
K ($Mg\ kg^{-1}$)	319
Ca ($Mg\ kg^{-1}$)	8040
Mg ($Mg\ kg^{-1}$)	351

2.2 CONDUITE DE L'ESSAI

Au cours des rotations céréalières, le blé (variété Achtar ou Titila) et le fourrage (mélange de vesce et d'avoine) sont semés à l'aide du semoir direct à double disques semeurs, caractérisé par un simple disque ouvreur et des zones tisseuses. Ce semoir permet des espacements de 25 cm entre les lignes du semis. Les dates et les doses de semis sont : Blé: début Novembre de chaque année à 120 Kg ha^{-1}, Fourrage: début Novembre de chaque année à 100 Kg ha^{-1}.

Les apports de fertilisants sont appliqués chaque année et dont les quantités sont déterminés sur la base des recommandations des laboratoires de science du sol du Centre Régional de la Recherche Agronomique de Settat. Au moment du semis, les différentes cultures reçoivent un apport de 75 Kg ha^{-1} de Nitrate d'ammonium et 100 Kg ha^{-1} de phosphate super triple. 50 Kg ha^{-1} d'urée sont apportés au blé au début du tallage.

En condition de non labour, le désherbage, strictement chimique, est assuré par l'application de glyphosate à une dose de 3 à 4 l ha^{-1} pour contrôler les mauvaises herbes avant le semis et en condition de jachère. Le chloro-sulfuron à 10g ha^{-1} est appliqué avant le semis pour le blé, le fourrage et la jachère. Dans les parcelles soumises au labour conventionnel, le contrôle mécanique des adventices est réalisé au pulvérisateur à disques avant le semis du blé et d'orge et au mois de mars pour la jachère travaillée. Le Carbofuran (insecticide) est employé à raison de 25 Kg ha^{-1} au semis, dont le but de lutter contre la cécidomyie (mouche de Hess). Pour lutter contre les maladies foliaires des céréales, un traitement fongique préventif à base de Propiconazole est appliqué à une dose de 0,5 lha^{-1}.

2.3 LES MESURES DE SOL EFFECTUEES

Les échantillons ont été prélevés à trois niveaux de profondeurs (0-5, 5-10, et 10-15cm). Les mesures des paramètres du sol sur les six traitements ont été réalisées selon les procédures suivantes:

2.3.1 LA STABILITÉ STRUCTURALE

La stabilité structurale à l'eau est déterminée par la méthode proposée par Le Bissonnais [26]. L'objectif de cette méthode est de donner une description du comportement du sol soumis à l'action de pluie, et de permettre un classement relatif des matériaux. Les échantillons prélevés sont séchés à l'air libre, désagrégé puis tamisés pour sélectionner des agrégats de taille de 3 à 5 mm. Ces derniers ont subi trois traitements hydriques qui se différent par les conditions d'interaction eau/sol:

- Traitement d'humectation rapide par immersion : permet de tester le comportement de matériaux secs soumis à des humectations brutales, une prise de 5g d'agrégats de 3 mm est versée dans un bêcher contenant 50 ml d'eau distillée pendant 10 mn (observation visuelle de l'éclatement).
- Traitement d'humectation lente par capillarité : permet de simuler le comportement de matériaux secs à une humectation lente (cas de pluies modérées), une prise de 5g d'agrégats de 3 mm est disposée sur un papier filtre posé sur une table à succion pendant 30 mn (le temps de la réhumectation des agrégats par capillarité).
- Traitement de désagrégation mécanique par agitation après réhumectation : permet de tester la cohésion du sol à l'état humide indépendamment de l'éclatement, environ 5g d'agrégats de 3 mm ont été immergés dans l'éthanol pendant 30 mn, puis transférés dans un erlenmeyer d'eau distillée. L'étape suivante consiste tout d'abord à agiter manuellement l'erlenmeyer en effectuant 10 retournements, puis à laisser reposer pendant 30 mn (observation visuelle de la décantation).

Cette opération est suivie, pour chaque traitement, d'un tamisage à 50 µm dans l'éthanol pour fixer le premier état de désagrégation. Les agrégats restant (> 50 µm) ont été transférés dans un bécher à l'aide d'une pissette d'éthanol pour être séchés à 105°C pendent 48h. Cette fraction > 50 µm est ensuite passée sur une colonne de six tamis de maille décroissante (2000, 1000, 500, 200, 100 et 50µm) pour déterminer la distribution des différentes classes d'agrégats. La fraction < 50µm est obtenue par détection par rapport au poids initial. Le pourcentage de chaque classe de taille par rapport au poids total d'agrégats est ensuite calculé. Le résultat s'exprime sous forme de diamètres moyens pondéraux (DMP, mm) défini par [26] comme suit :

DMP= (∑ **(diamètre moyen entre deux tamis × (% pondéral des particules retenues sur le tamis)) / 100**.

2.3.2 LA MATIÈRE ORGANIQUE

La teneur en MO a été évaluée sur les trois horizons (0-5, 5-10 et 10-15 cm) selon la méthode proposée par Walkey et Black [27]. Pour connaitre la distribution de la MO selon le fractionnement des agrégats de l'horizon superficiel (0-5 cm), la méthode de tamisage à sec est utilisée, elle consiste à faire passer les échantillons dans une colonne de tamis de mailles < 0,25, 1, 2, 3, 4, 5, 6, 8 et > 8mm, animée d'un mouvement à 1440 vibration/ mn pendant 5 minutes. Le refus de chaque tamis a été sujet à une analyse de la MO.

2.4 ANALYSE STATISTIQUE

Pour déterminer l'effet des six traitements (LC, SD 50, SD 100, BB, JB et JBO) sur les propriétés du sol, les différentes mesures effectuées ont fait l'objet de comparaisons multiples des moyennes selon le test de Duncan (modèle linéaire général) au seuil de 5%. Le logiciel utilisé pour les traitements statistiques est SAS version 2009.

3 RESULTATS ET DISCUSSION

3.1 EVALUATION DE LA STABILITÉ STRUCTURALE

3.1.1 HUMECTATION RAPIDE PAR IMMERSION DANS L'EAU

L'humectation rapide est le mode de désagrégation le plus agressif et induit les DMP les plus petits (0.35 à 0.50 mm). Globalement, quelle que soit la technique du travail du sol adoptée, la structure du sol résiste mal à une humectation brutale. Cependant sous SD, un comportement relativement meilleur des agrégats vis-à-vis de cette contrainte (éclatement) est constaté dans les trois horizons (Fig. 1). Bien que l'effet de la gestion des résidus en condition de non labour ne soit pas significatif, la stabilité structurale est en moyenne plus élevée sous SD 100 que sous SD 50 le long du profil.

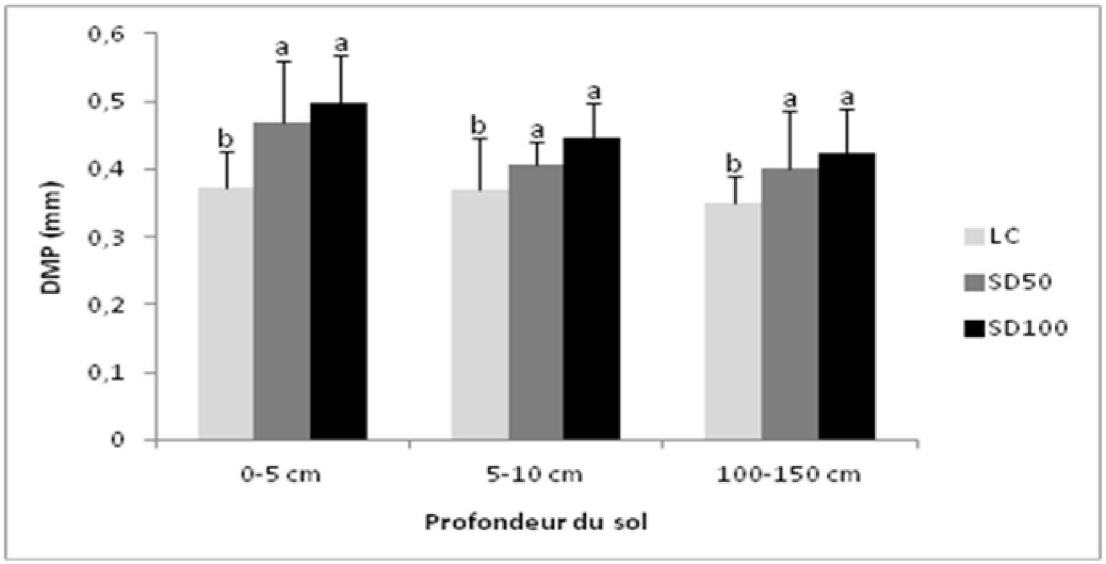

Fig. 1. Effet du travail du sol (labour conventionnel (LC), Semis direct avec deux niveaux de couverture du sol par les résidus : 50% (SD50) et 100% (SD100) sur le diamètre moyen pondéral (cas de l'humectation rapide). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

Les résultats de ce test de la stabilité structurale révèlent aussi qu'il n'y a pas eu de différence significative entre les trois rotations (BB, JB et JBO) (Fig. 2). Il apparait que la MO accumulée au niveau de ces rotations en SD n'était pas suffisante pour que le sol résiste à l'humectation brutale. Pour toutes les profondeurs, la rotation triennale JBO présente le DMP le plus faible (0,37 mm), ce qui montre que cette rotation est la plus vulnérable face à ce type de désagrégation. En référence aux normes établies par Le Bissonnais et Le Souder [28], les sols, avec des valeurs de DMP < 0,8 mm, sont considérés instables à très instables quand ils sont soumis à une humectation rapide quelque soit le mode de travail du sol adopté. Néanmoins, il y a une amélioration de la résistance du sol face à ce traitement destructif sous SD en raison de l'arrêt du travail du sol et de l'augmentation de la teneur en MO.

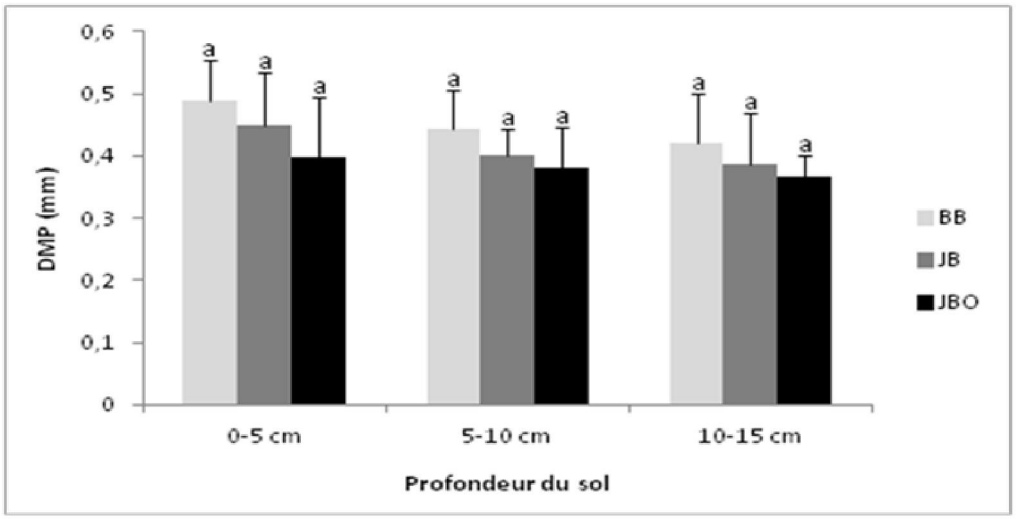

Fig. 2. Effet de la rotation (BB, JB et JBO) sur le diamètre moyen pondéral (cas de l'humectation rapide). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

3.1.2 HUMECTATION LENTE PAR CAPILLARITÉ

Dans ce test, caractérisé par un faible gradient hydrique apporté aux agrégats et des possibilités d'échappement de l'air plus importantes, la présence des résidus (couverture totale ou partielle) à la surface du sol sous SD a limité la vitesse de réhumectation en comparaison avec le LC. Dans les autres profondeurs, l'apport maximum de résidus (SD 100) a protégé de façon très significative le sol contre cette désagrégation en comparaison avec la couverture partielle (SD 50) et le LC (Fig. 3). L'augmentation de la résistance des agrégats sous SD face à ce mode de désagrégation par rapport à l'humectation rapide (plus destructif) est due à la bonne cohésion que garde le sol lorsqu'il est soumis à des pluies modérées. Ces résultats sont cohérents avec ceux de [11] qui ont confirmés l'amélioration de la stabilité structurale du sol en condition de SD avec maintien des résidus de récolte.

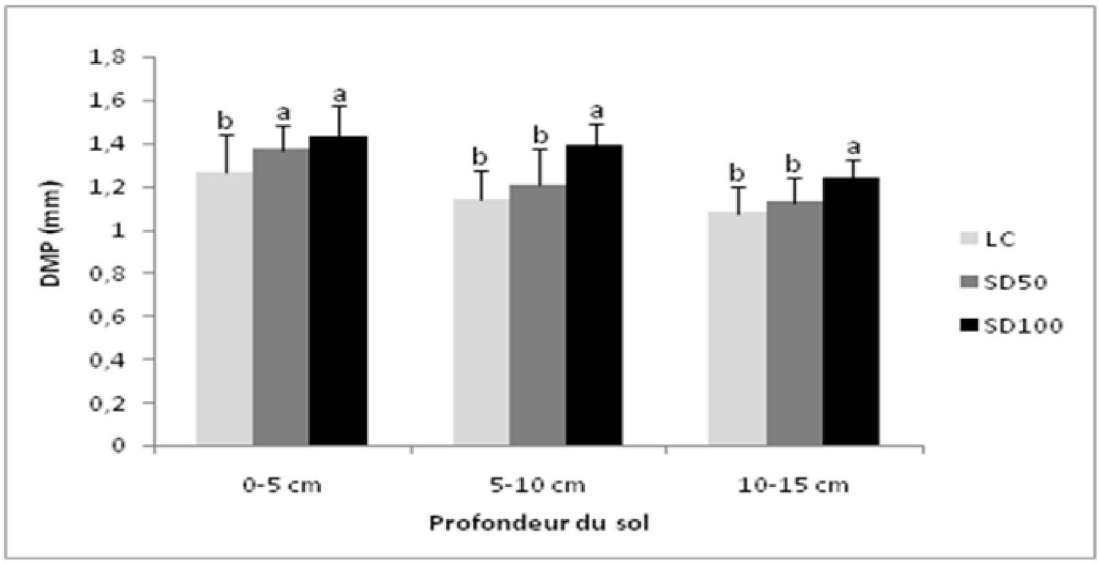

Fig. 3. Effet du travail du sol (labour conventionnel (LC), Semis direct avec deux niveaux de couverture du sol par les résidus : 50% (SD50) et 100% (SD100) sur le diamètre moyen pondéral (cas de l'humectation lente). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

Suivant les rotations, on constate que dans les trois couches (0-5, 5-10 et 10-15 cm), les rotations biennales (BB et JB) ont montrés des valeurs de DMP plus élevées significativement par rapport à la rotation triennale (JBO). Ce qui confirme que l'influence de cette rotation sur la résistance du sol contre l'humectation lente est moins importante (Fig. 4). Par contre

d'autres chercheurs suggèrent que l'intensification des systèmes de culture par le biais d'une réduction de la fréquence de la jachère améliore l'accumulation de la MO et par suite la stabilité structurale du sol [1].

La réalisation de ce mode de désintégration montre que le sol résiste mieux à une humectation lente simulant une pluie hivernale, avec un avantage du SD 100 qui présente une valeur de DMP = 1,43 mm entrainant un comportement plus stable des agrégats que le SD 50 et le LC.

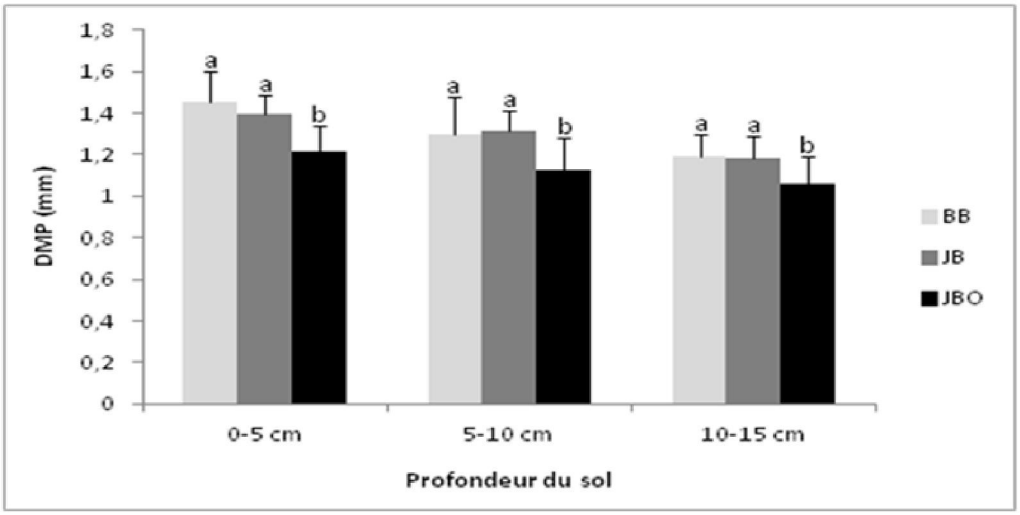

Fig. 4. Effet de la rotation (BB, JB et JBO) sur le diamètre moyen pondéral (cas de l'humectation lente). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

3.1.3 DÉSAGRÉGATION MÉCANIQUE

Les DMP présentés par ce traitement sont relativement importants en comparaison avec le premier test (0,79 à 1,13 mm). Vis-à-vis de ce test, l'apport des résidus à la surface du sol sous SD a abaissé la vitesse d'humectation des agrégats et par suite a réduit leur fragmentation par rapport au LC. Dans l'horizon intermediaire (5-10 cm), la stabilité des agrégats est supérieure sous SD 100 que sous SD 50 et LC (Fig. 5). Au niveau profond (10-15cm), l'influence des trois pratiques culturales (LC, SD 50 et SD 100) sur la cohésion du sol à l'état humide n'est pas significative.

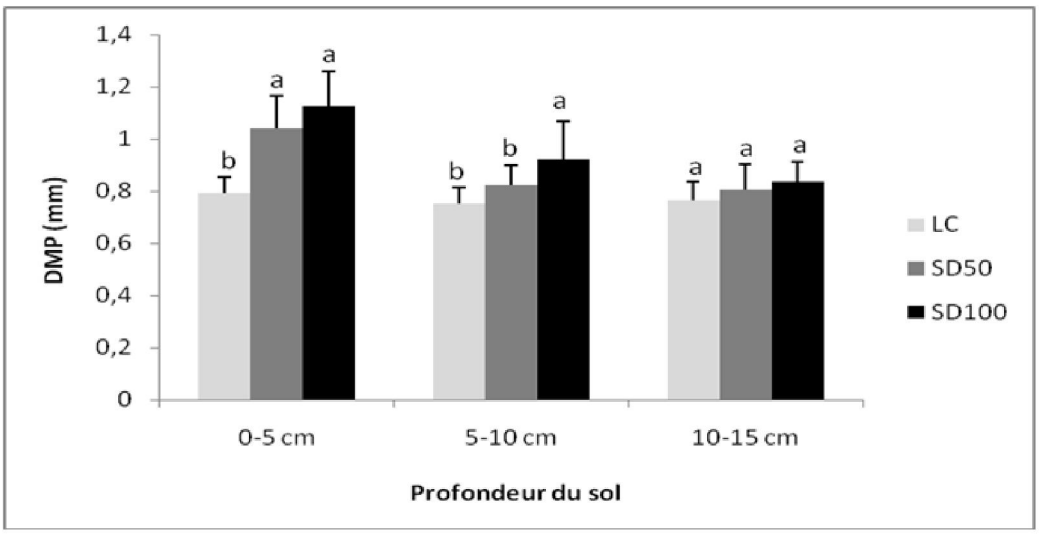

Fig. 5. Effet du travail du sol (labour conventionnel (LC), Semis direct avec deux niveaux de couverture du sol par les résidus : 50% (SD50) et 100% (SD100) sur le diamètre moyen pondéral (cas de désagrégation mécanique). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

Les rotations biennales BB et JB, avec respectivement 1,05 mm et 0,99 mm de DMP, ont tendance à améliorer la stabilité structurale à la surface du sol par rapport à la rotation JBO (DMP = 0,92 mm). Par contre, dans les autres profondeurs, les DMP présentés par les trois rotations sont presque similaires et plus faibles par rapport au premier horizon (Fig. 6). La supériorité de la rotation blé continu quant à l'amélioration de stabilité structurale peut être expliquée par le fait que les quantités de résidus retournées au sol différent d'une rotation à l'autre. En effet, le sol sur la rotation BB reçoit chaque année des résidus de blé, alors que la pratique de la jachère (sol nu) prive le sol des résidus de blé une année sur deux pour la rotation JB et une année sur trois pour la rotation JBO.

Avec des valeurs de DMP fluctuant autour d'une limite de 1,13 mm, le sol est considéré comme moyennement stable en surface, alors qu'il est instable en LC (DMP = 0,79 mm).

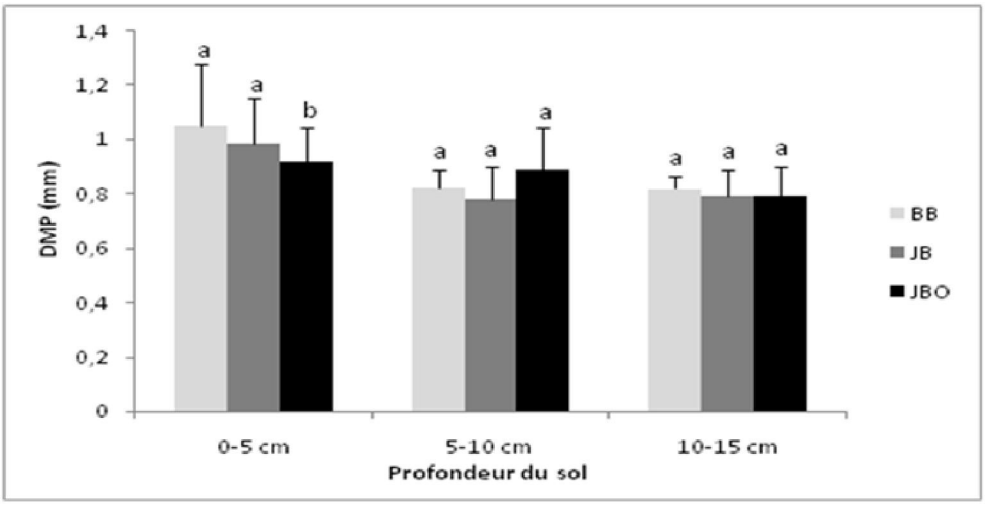

Fig. 6. Effet de la rotation (BB, JB et JBO) sur le diamètre moyen pondéral (cas de désagrégation mécanique). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

3.2 EVALUATION DES TENEURS EN MATIERE ORGANIQUE

Les résultats du tableau 2, montrent que, dans les premiers horizons (0-5 et 5-10cm), le niveau de la MO est plus élevé dans les parcelles sous SD avec apport maximum des résidus (SD 100) que dans celles soumises aux autres techniques culturales (SD 50 et LC). En plus, le maintien des résidus à la surface des parcelles non labourées a affecté la dynamique de la MO, en favorisant une accumulation de celle-ci à la surface du sol sans appauvrissement en profondeur. Dans le troisième horizon, Bien que le sol sous SD séquestre plus de MO que sous le LC, la gestion des résidus semble ne pas avoir un effet significatif. Ces résultats sont en accord avec ceux de plusieurs chercheurs [9], [29]-[2].

Tableau 2. Effet du travail du sol, de la gestion des résidus et de la rotation sur la teneur de la matière organique

Profondeur de l'horizon	0-5 cm	5-10 cm	10-15 cm
Travail du sol et gestion des résidus			
SD 100	3,36 (0.39) a*	3,00 (0.34) a	2,60 (0.18) a
SD 50	3,08 (0.27) b	2,68 (0.29) b	2,46 (0.11) a
LC	2,52 (0,17) c	2,45 (0.34) c	2,12 (0.27) b
Rotation			
BB	3.18 (0.57) a	2.63 (0.25) a	2.42 (0.23) a
JB	2.95 (0.42) b	2.84 (0.55) b	2.38 (0.29) a
JBO	2.83 (0.38) b	2.66 (0.30) a	2.39 (0.34) a
Moyenne générale	2,99	2,71	2,39

**La MO est en %. Les valeurs entre parenthèse sont l'écart type par rapport à la valeur moyenne présentée (n=3).*
Pour une même colonne les valeurs suivies de la même lettre ne sont pas significativement différentes selon le test de Duncan (P<0,05).

Cet avantage pour l'accumulation de la MO dans le sol du SD sur le LC est très largement observé dans les différentes classes d'agrégats de l'horizon de surface (Fig. 7). En effet, toutes les fractions relevant des parcelles non labourées ont enregistré des taux de MO plus élevés que celles des parcelles labourées, avec un effet hautement significatif pour les agrégats > 3 mm. Dans toutes les fractions, bien que l'effet de la gestion des résidus ne soit pas significatif, la MO est en moyenne plus concentrée sous SD 100 que sous SD 50. La faible séquestration de la MO dans les différents agrégats sous le LC peut être due à l'érosion ou au fait que lors du labour, les agrégats sont disloqués et le sol devient plus aéré, la MO ainsi déprotégée subit une minéralisation progressive par les microorganismes du sol empêchant, par conséquent, son accumulation [30].

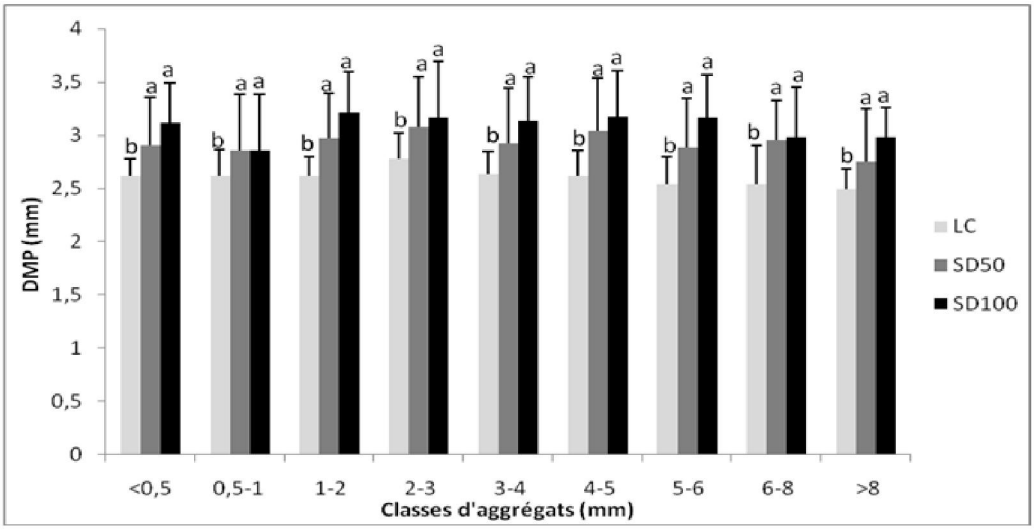

Fig. 7. Effet du travail du sol (labour conventionnel (LC), Semis direct avec deux niveaux de couverture du sol par les résidus : 50% (SD50) et 100% (SD100) sur la teneur en MO (%) dans les différentes classes d'agrégats de l'horizon de surface (0-5 cm). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

Suivant les rotations, la rotation BB a favorisé la meilleure teneur en MO par rapport à celles incluant la jachère au niveau de la couche superficielle (0-5 cm) (tableau 2). Dans l'horizon intermédiaire (5-10 cm), la rotation JB présente le taux de MO le plus élevé (2,84%), alors que dans la couche profonde (5-10 cm) les différences entre les trois rotations sont statistiquement non significatives.

Les valeurs de la MO enregistrées par la rotation blé continu sont supérieures à celles trouvées par les chercheurs [31] et [18] dans le même site. Néanmoins, après plus de 20 ans d'essai, cet effet bénéfique du semis direct sur la séquestration de la MO par cette rotation a été observé uniquement dans les 5 premiers cm du sol.

Pour toutes les rotations, l'horizon de surface montre un taux de MO plus élevé par rapport aux autres horizons. Ce stockage de carbone dans la couche superficielle se répercute sur sa localisation dans les 9 classes d'agrégats avec un effet significatif en faveur des rotations biennales BB et JB (Fig. 8). La classe d'agrégats 2-3 mm présente le taux de MO le plus élevé quelle que soit la rotation pratiquée (3,20 % sous la rotation BB, 3,18 % sous JB et 2,68 % sous JBO). Cette analyse a démontré aussi que tous les agrégats de surface issus de la rotation JBO montrent des teneurs faibles en MO (2,50 à 2,68 %), ce qui explique le comportement fragile du sol sous cette rotation vis-à-vis des différentes contraintes occasionnées par les tests hydriques.

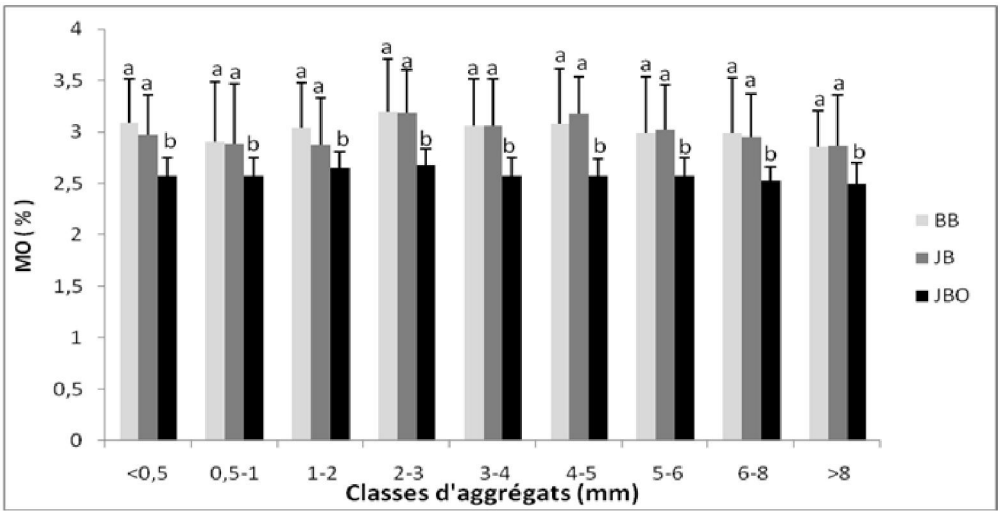

Fig. 8. Effet de la rotation (BB, JB et JBO) sur la teneur en MO (%) dans les différentes classes d'agrégats de l'horizon de surface (0-5 cm). Les traitements ayant la même lettre ne sont pas significativement différents selon le test de Duncan (P<0,05)

4 CONCLUSION ET RRECOMMANDATIONS

Le travail présenté consiste à déterminer l'effet des pratiques culturales sur la stabilité des agrégats du sol et l'accumulation de la MO dans les zones semi-arides marocaines. Nos résultats montrent que l'adoption des systèmes de SD a un effet potentiel de séquestration de la MO dans la couche superficielle du sol (0-5cm) sans appauvrissement des couches profondes, et que l'apport additionnel des résidus de récolte (couverture totale SD 100) a tendance à améliorer le niveau de carbone dans tous les agrégats du sol. Ces résultats indiquent qu'il y a effectivement un regain d'équilibre dans le sol en condition de non-labour qui se traduit par une résistance à la désagrégation par rapport au labour traditionnel quel que soit le test utilisé pour l'estimation de la stabilité structurale à l'eau. Nos données confirment aussi que la rotation blé continu affiche le meilleur taux de MO dans le sol et par conséquent elle a favorisé l'agrégation par rapport aux rotations incluant la jachère.

L'évaluation de la qualité du sol doit être complétée par d'autres analyses physiques et chimiques (densité apparente, humidité, pH, azote, potassium et phosphore). D'autant plus que les résultats obtenus aux stations expérimentales doivent être confirmés au niveau des exploitations agricoles dans les milieux semi-arides où l'expansion de ce système conservatoire de gestion des sols est retardée par un contexte défavorable : pression du pâturage sur les résidus de récolte, manque de connaissance sur le semis direct et infrastructures rurales inappropriées.

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Neuro-fuzzy Inference System for Modeling Equilibrium Ratio for Heptanes-plus Fraction

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ABSTRACT: Equilibrium constant has many applications in solving problems in reservoir engineering and petroleum processing. Various correlations are available for estimating K- values for heptanes plus fractions. These correlations can be classified into simple and complicated. However these correlations are not able to predict K values adequately for a wide range of conditions. They lose validity in specific range of pressure and temperature and exhibit some error. In this work neuro-fuzzy modeling techniques (ANFIS) is developed to predict K- values for heavy fractions. A large collection of K- values data points (more than 1340 data points) were extracted from experimental 570 PVT reports using the principal of material balance are used in developing the neuro- fuzzy model. 80% of the data points were used to train ANFIS model and 20% of data sets were used to validate, and test the model. Statistical analysis (average absolute percent error, correlation coefficient, standard deviation, maximum error, minimum error, etc.) is used for comparison the proposed model with empirical correlations. Graphical tools have also been utilized for the sake of comparison the performance of the new model and experimental data. Results showed that the new hybrid neural fuzzy model outperforms some available empirical correlations.

KEYWORDS: Heptanes plus, Neuro-fuzzy model, K- values, Empirical correlations, Equilibrium ratio.

1 INTRODUCTION

Equilibrium constant is an important factor in many petroleum engineering calculations such as simulation of enhanced oil recovery, design of surface oil and gas production operations. The basic phase equilibrium calculations include the dew point pressure, bubble point pressure and separator calculations.

Because the plus fraction is a complex mixture of different components, the equilibrium ratio for plus fraction often have different behavior from individual components of the hydrocarbon system. Several methods have been proposed for calculating equilibrium constant. These correlations ranged from simple to complicated with multiple dependent variables. Some methods use graphical procedure (Campbell's [6] and Hoffmann's [20] methods). Katz [17] suggests method for determining K-values for heptanes plus fraction by taking 15 % of K-value of heptanes. These correlations widely used because they are adapted to calculations, less costal time and time consuming. However they can't be used for wide range of pressure, temperature and fluid system parameters in addition to their inaccuracy. For calculating K-value these correlations was improved [11] by tuning them for practical reservoir fluid because of different composition of oil from region to region. But it still exhibits some error. This variation in the K-value of hydrocarbon fraction can cause error in phase equilibrium problems in reservoir and process engineering.

Due to advance in computer calculation of k- value is performed by equation of state (EOS) using powerful computer and modern software. For using EOS model it is necessary to use different correlation for calculating EOS parameters such as P_c,

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T_c, ω, etc.). EOS characterized by its simplicity, consistency, and accuracy when properly tuned. However EOS requires tuning the parameters against experimental data. Calculations with equation of state are limited by the large number of functions. Furthermore, calculating using EOS require extensive amount of computational time, may have the convergence problem, time consuming and complex where large number of K-values are required.

Several correlations may be used to estimate the critical properties of heptanes plus fractions. Selecting proper values for these parameters is very important because slightly difference in these parameters can cause significant difference in results. A genetic algorithm can be used as effective tool to determine the optimum critical properties of heptanes plus [19]. An increase in deviation of k-values of heptanes plus fraction from experimental data may be due to method of characterization.

In this study neural fuzzy model for predicting equilibrium ratio for heptanes plus fraction was developed.

2 WATSON CHARACTERIZATION FACTOR

The physical properties of the plus fractions in hydrocarbon mixtures are essential in performing phase equilibrium calculations. Characterization the plus fractions in terms of their critical properties and acentric factors can be provided by using one of the proper methods [16].

Three approaches commonly are used to generate properties of the plus fractions: generalized correlations, correlations based on the PNA determination, and graphical correlations. These three techniques of characterizing the heavy petroleum fractions are discussed in [18].

In many cases for the heavy fraction there are no boiling point or molecular weight distributions, and only specific gravity and molecular weight may be available. The characterization factor was introduced by Watson [13] to describe qualitatively the relative parafinicity of petroleum products. Physical properties, such as molecular weight and specific gravity, may be measured for the heavy fraction. Watson characterization factor can be used to describe heptanes plus fraction according to the equation [13]:

$$K_w = \frac{T_b^{1/3}}{\gamma}$$

This characterization factor was introduced to relate the molecular weight, specific gravity and boiling point temperature which considered the key properties of petroleum fractions. Thus Watson characterization factor can be an important parameter in the correlation of equilibrium constant.

In present work we use approach that Watson factor may be introduced as a correlating parameter which used as input for estimating K-values of heptanes plus fraction.

3 MATERIAL BALANCE

Material balance was performed for laboratory test (constant volume depletion(CVD), differential liberation (DL) and separation test for one, two, three, and four stage flash separation (sour and sweet gas). These calculations allow us to determine liquid composition at separator conditions and hence estimate the equilibrium K-values experimentally [14].

4 DATA ACQUISITION

More than 1340 Data points from 570 PVT reports collected from different regions in Middle East and published data in literature were used for developing the model.

Statistical descriptions of these data are given in the table below.

Table 1. Statistical summary of data used for model development.

Parameter	Maximum	Minimum	Average	ST-deviation
Separation pressure, psia	765	15	94.61	107.38
Separation temperature,^{o}F	195	70	108.6	21.22
Specific gravity	1.032	0.795	0.888	0.03
Molecular weight of heptanes plus	534	162	274	49.31
K-factor	0.066	1.310^{-7}	0.007	0.00793
Kw	12.75	11.03	11.8	0.12689
Heptanes plus, mole percent	86.10	18.50	46.62	13.80

5 NEURO FUZZY MODEL ARCHITECTURE

Fuzzy inference [7] is a process of mapping from a given input to an output using the fuzzy set methods. The basic idea behind neuro- fuzzy combination is to design a system that use a fuzzy system represents knowledge in an interpretable manner and have the learning ability derived from a neural network to adjust its membership functions and parameters in order to enhance the system performance. Neuro-fuzzy methods offer good capabilities to deal with high noisy data. Neuro-fuzzy approach combines the advantages of both neural network and fuzzy logic, have been emerged as a successful practical technology application including prediction of oil properties.

Neuro-fuzzy model can achieve a higher accuracy within a relatively shorter training time comparing with neural network system. The main disadvantages of both individual systems could be avoided, i.e., the black box behavior of neural networks and the problem of selecting suitable membership values for FISs. Architecture of ANFIS is determined by preliminary testing. ANFIS produced 42 fuzzy rules. The model was evaluated using the testing data by utilizing the approach, Takagi-Sugeno-Kang (TSK)[9]. ANFIS required 50 training epoch to reach a Root-mean squared error (RMSE) of 3.98 10-6. The stopping criterion is either completion of the given training epoch or reaching 0.00001 mean classification error for the training data set. Before training data pre-processing was performed to transform data into suitable form to the ANFIS input. All data were normalized, i.e. all values of attributes in the dataset has been changed to contain values in the interval (0,1).

The approach used in this study is Maximum- Minimum normalization techniques. This technique performs a linear transformation on the original data.

Subtractive clustering was performed on a dataset. The number of clusters determines the number of rules and membership functions in the generated ANFIS.

To generate a model from data cluster radius was specified. The cluster radius indicates the range of influence of a cluster when the data space as a unit hypercube is considered. The ANFIS could be optimized by adjusting cluster radius so as to reduce error between the actual and predicted outputs. This allows the fuzzy system to learn from the data for modeling so optimal structure of neuro- fuzzy model is obtained.

The input to INFIS is separation pressure, separation temperature, molecular weight of heptanes plus, specific gravity of heptanes plus and Watson characterization factor. Model has only one output K-values.

A total of 1344 data sets are used for building the model. Dataset partitioning was done by dividing the data into two different sets, training sets (80%), validation sets (20%). Statistical parameters for training and validation data sets are given in Tables (2) and (3).

Table 2. Statistical descriptions of the input data used for training

Parameter	Maximum	Minimum	Average	ST-deviation
Separation pressure, psia	759.31	14.90	92.03	107.04
Separation temperature, ^{o}F	183.63	69.49	105.44	17.59
Specific gravity	1.04	0.80	0.89	0.03
Molecular weight of heptanes plus	530.03	163.78	273.45	50.04
K-factor	0.08	0.01	0.02	0.01
Kw	12.67	10.96	11.72	0.13

Table 3. Statistical description of the input data used for validation

Parameter	Maximum	Minimum	Average	ST-deviation
Separation pressure, psia	511.17	14.90	101.72	105.01
Separation temperature, ^{o}F	193.56	74.45	116.62	29.19
Specific gravity	1.02	0.80	0.89	0.03
Molecular weight of heptanes plus	463.53	160.80	266.10	44.22
K-factor	0.06	0.01	0.02	0.01
Kw	11.92	11.36	11.71	0.08

6 RESULTS AND DISCUSSION

The best available empirical correlations were tested in this work to obtain prediction of the K-values for all data. Comparison of statistical analysis of the different used correlations for estimating equilibrium ratio against extracted K-values for the heptanes-plus is shown in Table 4.

Table 4. Performance of empirical correlations using all data

Correlation	Wiston-Torp	Standing	Wilson
ARE	99.84	-70.6	99.90
AARE	99.84	98.2	99.90
Minimum error	91.94	0.0	91.64
Maximum error	100	694.2	100
ST-deviation	0.544814	104.519	0.39
R	0.339	0.565	0.381

From Table 4 it can be observed that Standing correlation have best performance among all three correlations used for predicting K-values.

Calculation of K-values by standing was performed using Standing characterization factor [1] for heptanes plus fraction. For calculation by Wilson and Whiston-Torp correlation characterization of heptanes-plus was performed by Riazi and Daubert correlation [5] to calculate T_b, T_c, and P_c.

Wilson [2] and Whiston [3] models approximately have the same range of statistical error. The similarity in accuracy may be attributed to using a general correlation (Riazi and Daubert) to calculate T_b, T_c, and P_c.

Prediction of K-values by standing model also was performed using Riazi and Daubert instead of using the correlation indicated by Standing which characterize the plus fraction as a function of average carbon number, n. This resulted in absolute relative percent error equal to 99.7 %.

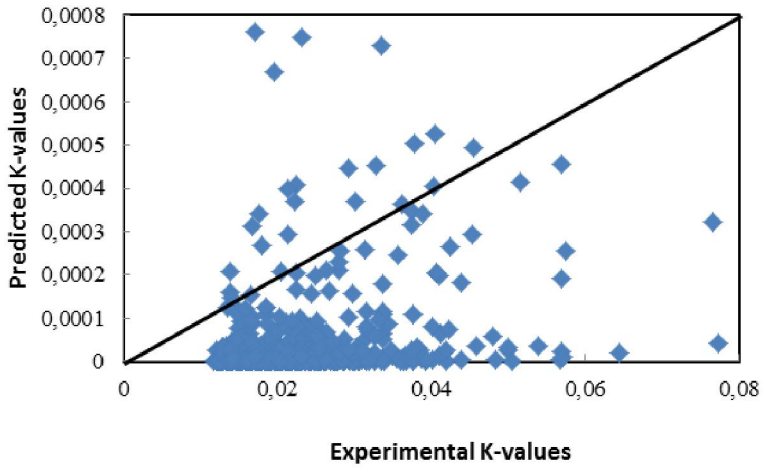

Fig. 1. Crossplot of experimental and predicted K-values (Wilson correlation)

The cross plots of estimated against the actual values using the three empirical correlations are shown in Figures (1)-(2). They indicate poor of performance in terms of correlation coefficient.

In general, Wiston-Torp and Wilson correlations underpredict experimental K-values. Standing's correlation [1] tends to overpredict experimental K-values at pressures below 65 psia.

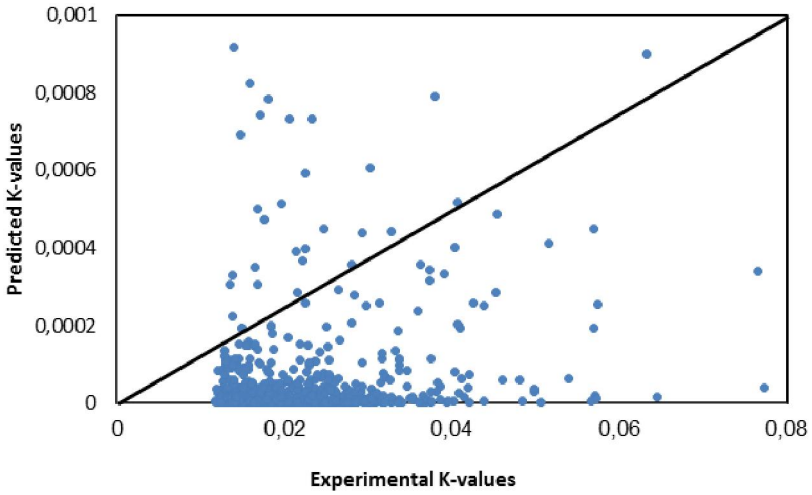

Fig. 2. Crossplot of experimental and Predicted K-values (Whiston-Torp)

Table 5 lists statistical comparison of predicted K-values by using the proposed neuro-fuzzy model with the experimental values. It is indicated that developed model gives best results compared with empirical correlations.

Fig. 3 shows scatter plot of calculated compared to laboratory measurement of K-factors. It is indicated the accuracy of the results presented in this figure far exceeds those of any correlations. Predicted and fact data of K-values for training and validation process respectively are presented in Figures (4) and (5). Figures (7) and (8) give behavior of the average percent error for training and testing data. Crossplots of predicted and experimental data for validation and training are shown in Figures (6) and (9), respectively.

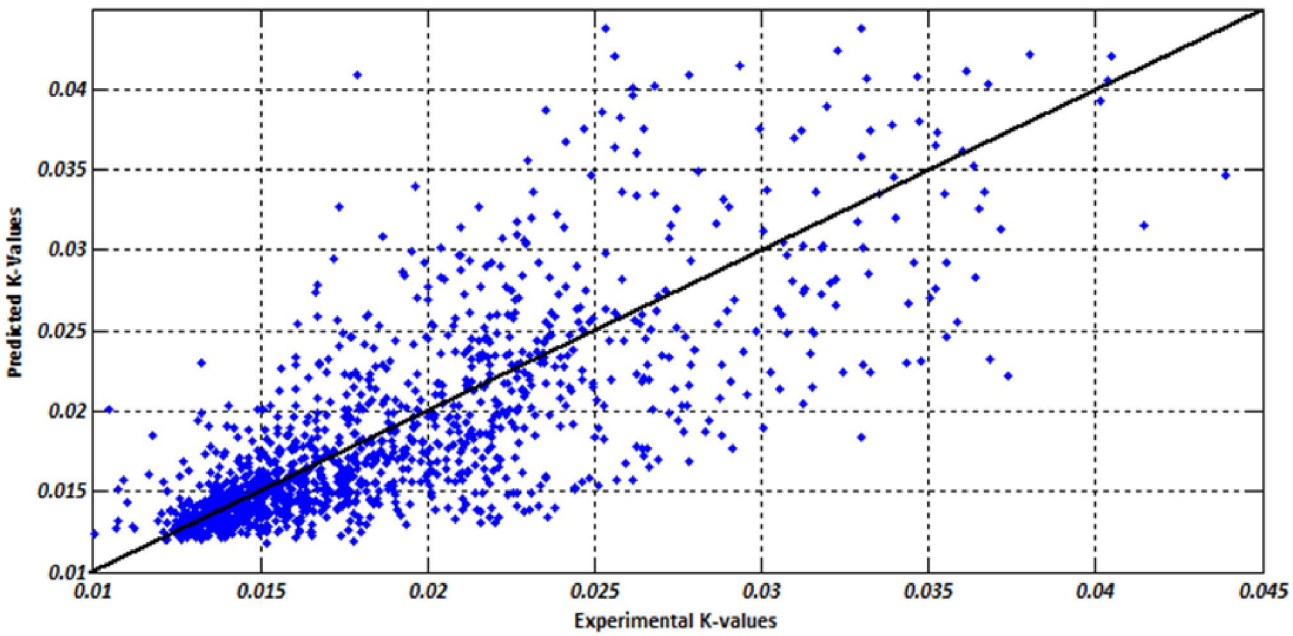

Fig. 3. Crossplot of experimental and predicted K-values of all data (This study)

Table 5. Statistical parameters for proposed neural fuzzy model

Parameter	Training	validation	All
Minimum error	0.00	0.16	0.02
Maximum error	79.49	69.50	79.13
ARE	-3.74	-1.68	-3.76
AARE	14.10	15.99	14.78
ST-deviation	14.46	13.61	14.33

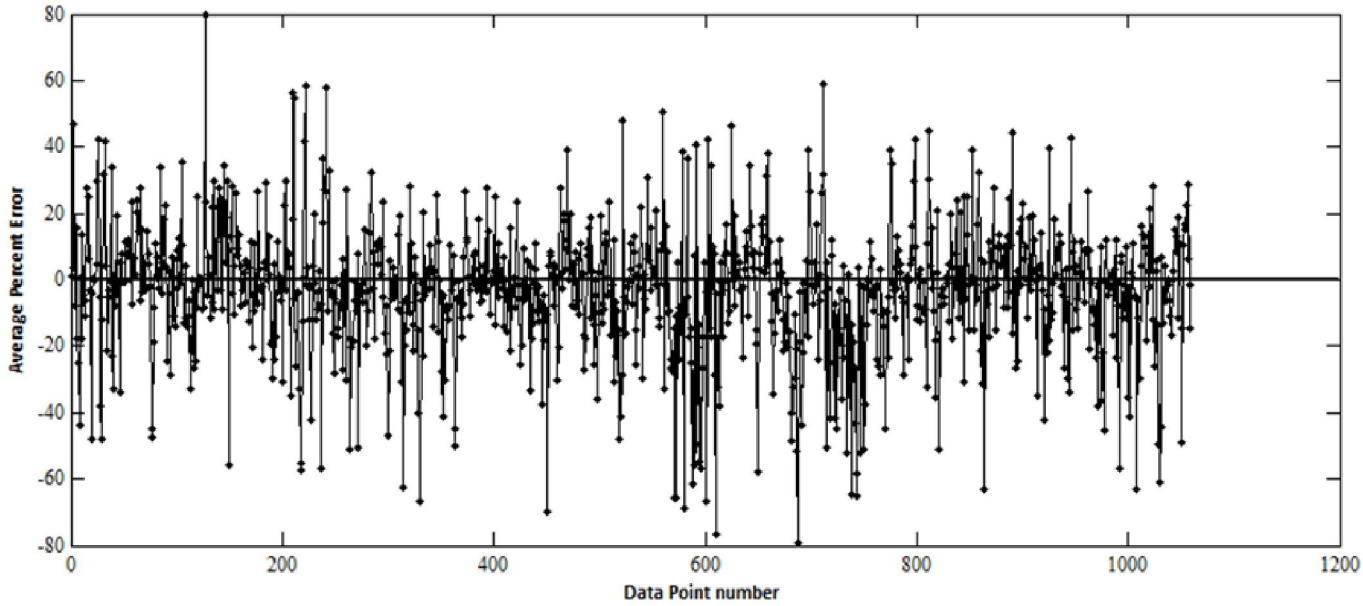

Fig. 4. Error graph for Training Set (Neuro-fuzzy model)

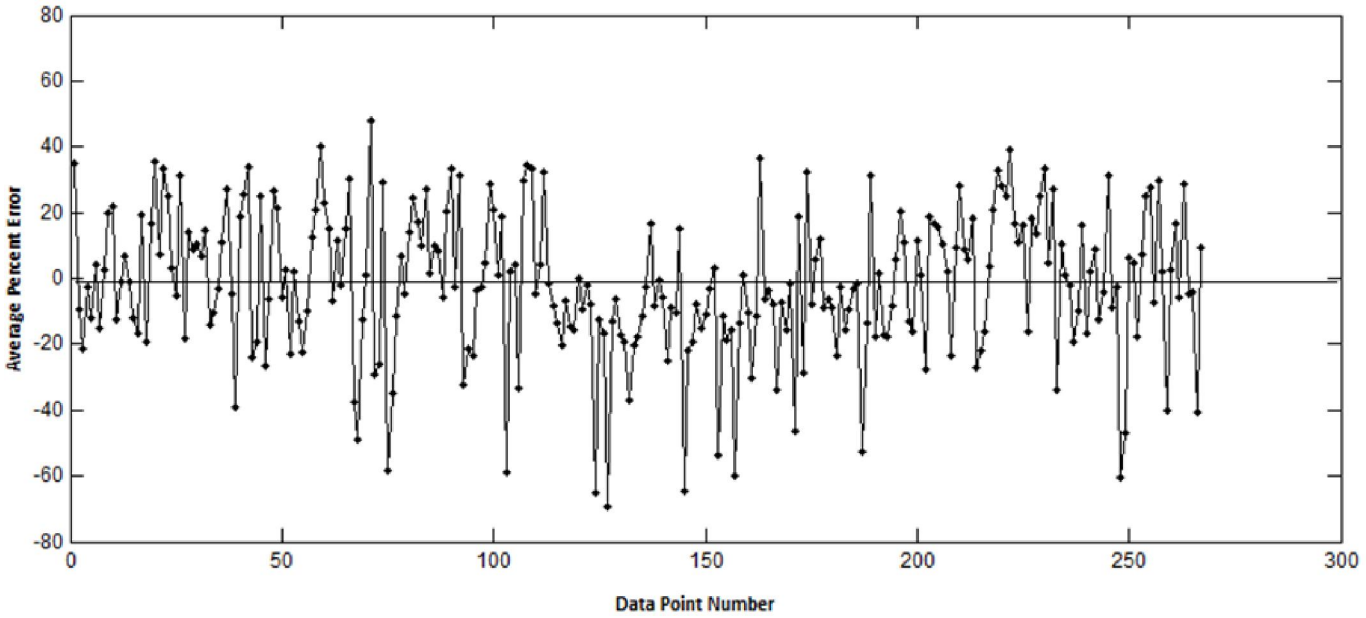

Fig. 5. Error graph for Validation Set (Neuro-fuzzy model)

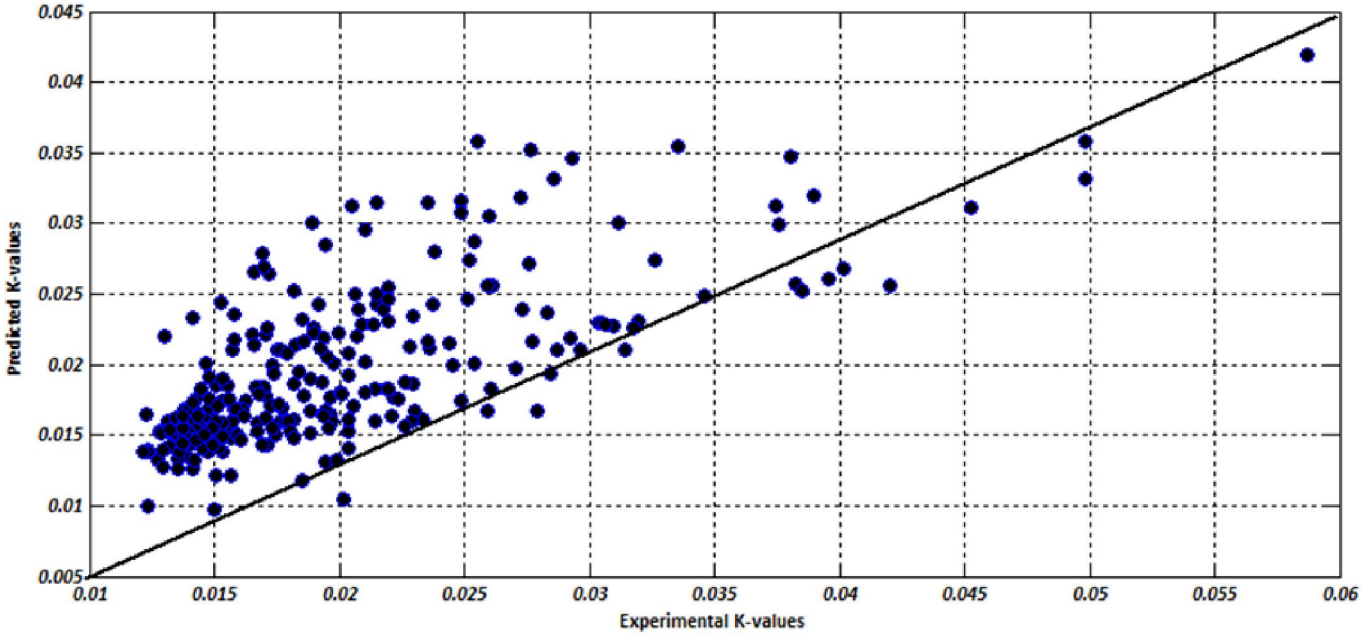

Fig. 6. Crossplot of experimental and predicted K-values for validation

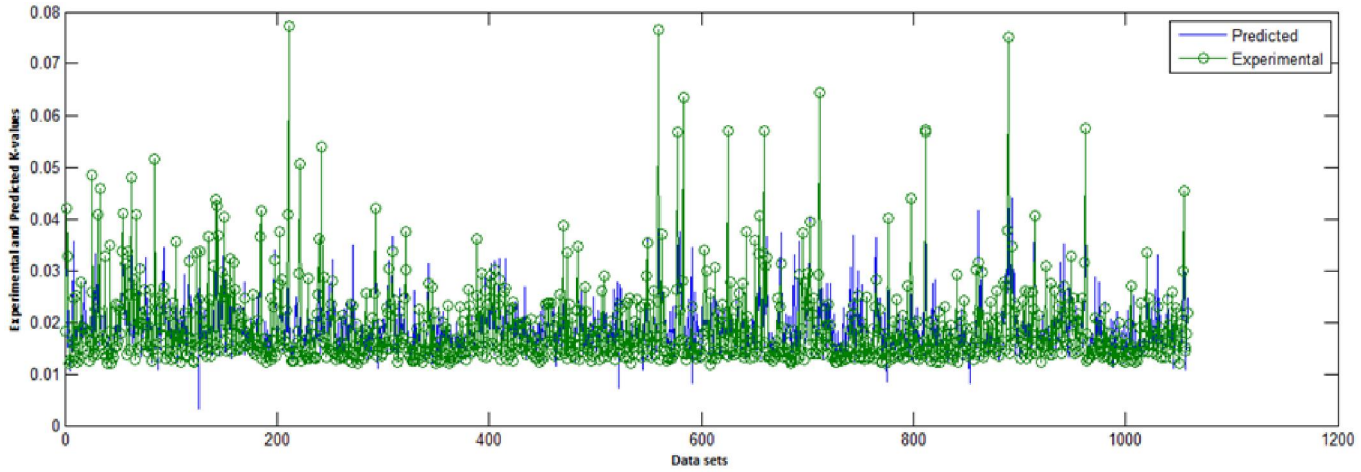

Fig. 7. Comparing Experimental and predicted k-values for Training (This study)

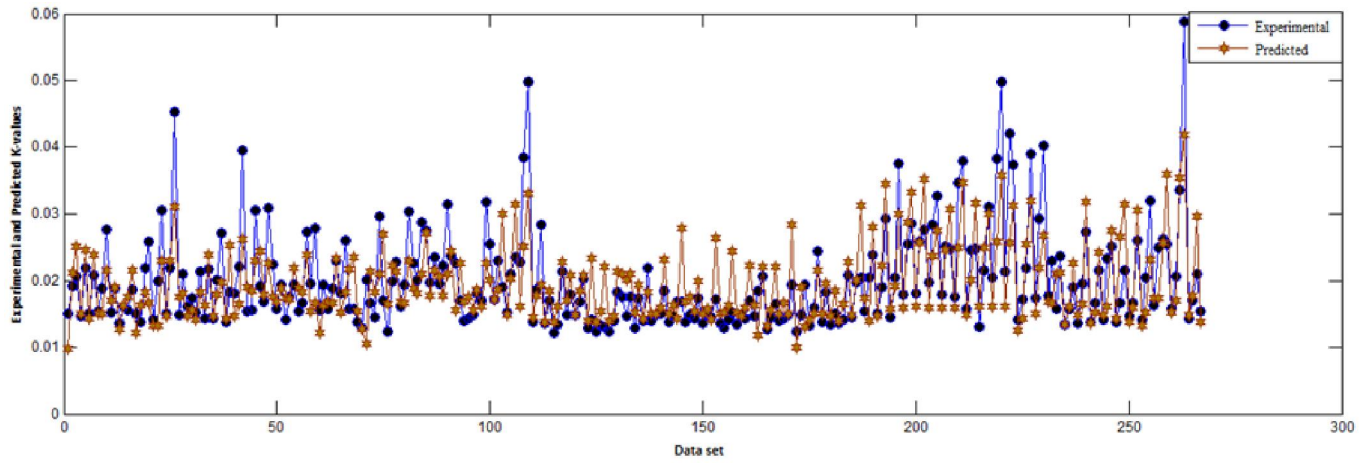

Fig. 8. Comparing Experimental and predicted k-values for validation (This study)

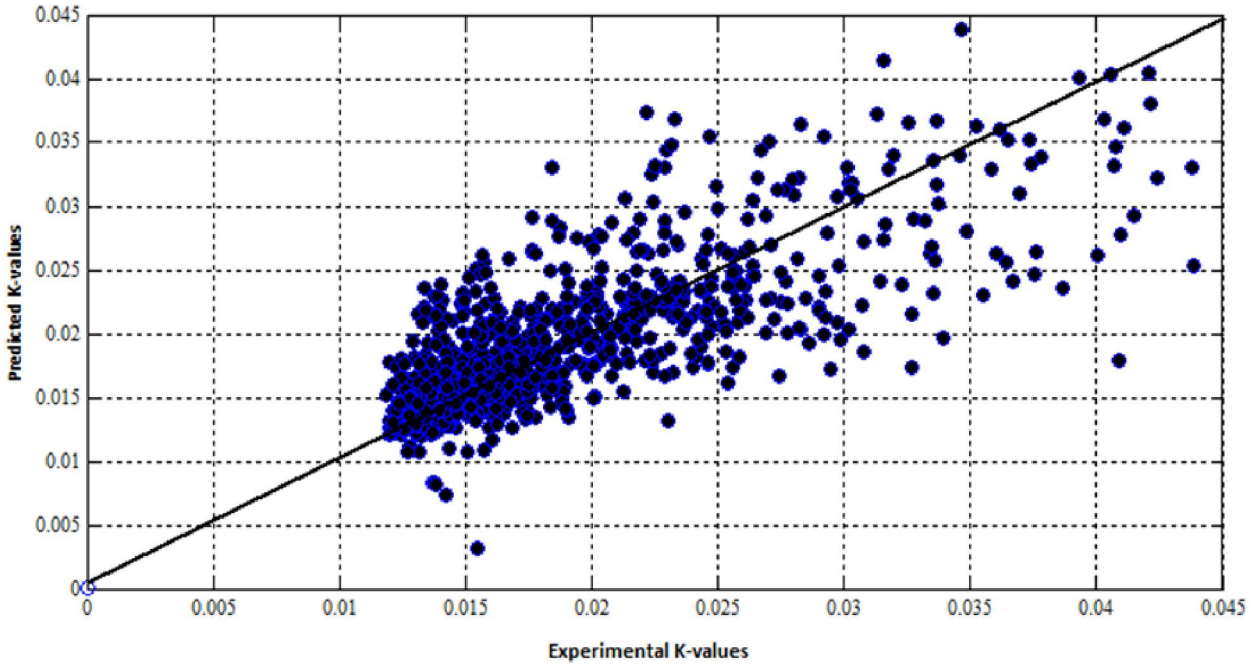

Fig. 9. Crossplot of experimental and predicted K-values for training

The Rule Viewer displays a roadmap of the whole fuzzy inference process (Fig.10).

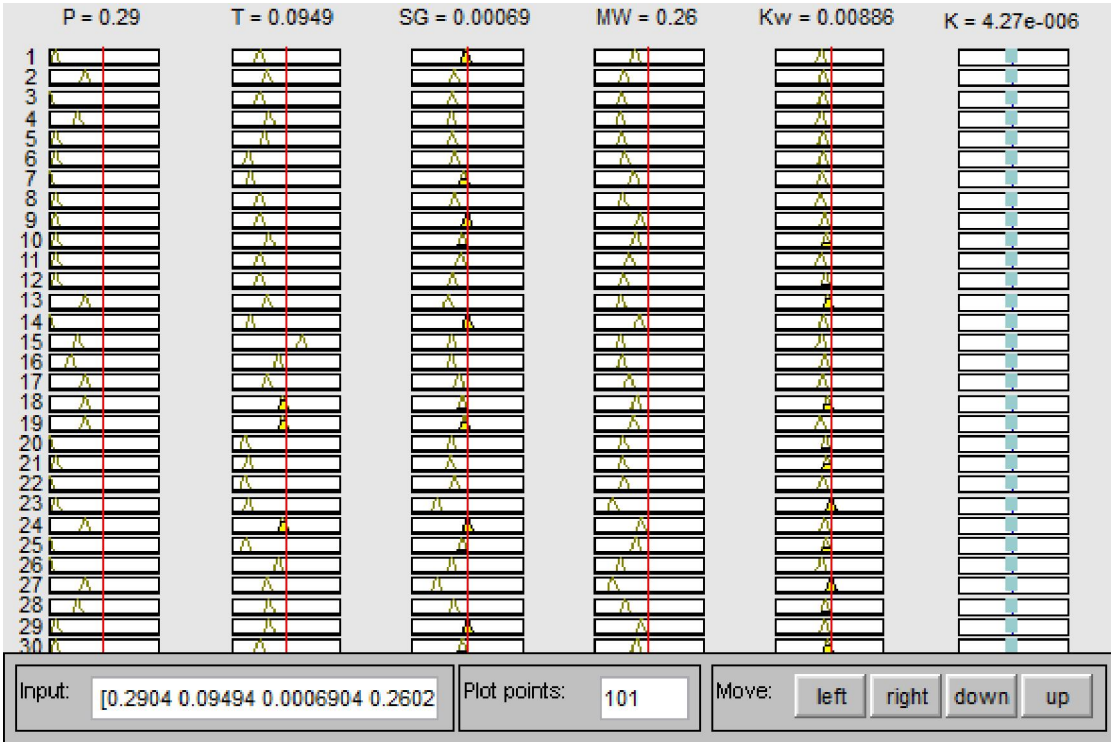

Fig. 10. Rule viewer of Neuro-fuzzy model

7 CONCLUSION

- A new hybrid neural fuzzy model was developed to predict equilibrium constant of heptanes plus fraction. Validation of the method was done by comparison the model with empirical correlation which indicate that the proposed model outperform others empirical correlations.
- The developed model can be used only within the range of used data.

NOMENCLATURE

p_c = critical pressure, psia
T_c = critical temperature, °R
ω= acentric factor
T_b = normal boiling point, °R
R= correlation coefficient
Kw= Watson characterization factor
PNA =(Paraffins- naphthenes- aromatics)

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Energy, environmental and agronomic valorizations of the rural biomethanisation of the bovine biomass

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ABSTRACT: This work consists in studying various possible valorizations of the rural biomethanisation applied to the bovine dejections. The follow-up of the adopted digester related to: the estimate of the qualitative productivity (% CH_4, % CO_2, % H_2S and % H_2; LCV and HCV) before and after conditioning. For the analysis of the gas composition and the estimation of the calorific values, we had recourse to the technique of chromatography in gaseous phase (CGP); analysis of certain environmental parameters (SM and BDO_5), in order to establish the corresponding assessments of depollution; possibilities of agronomic valorization except ground of the residues of the biométhanisation (the methacompost as full or partial substitute for peat and / or compost and juice process plants gardeners as fertilizer).
The significant preliminary results rising from this work are the following: the conditioning of rural biogas product made it possible to improve the energy performances; the process of rural biomethanisation allowed an insufficient reduction of the polluting load as for SM as for BDO_5; the use of the methacompost as a partial substrate of culture gives encouraging results for the growth in height of the pepper seedlings; the juice of process diluted at a rate of 75% showed an interesting power fertilizing.
Ultimately, the current trend towards the agrobiologic practices encourages the agronomic use of these digestats, because of the importante depollution generated.

KEYWORDS: Rural digester, bovine dejections, assessment of depollution, quality of biogas, methacompost, juice of process.

1 INTRODUCTION

Face to the very fluctuating economic situation of the energy prices and to appreciably reduce local pollution and the greenhouse effect. References [1, 2] shows that the prospection and the development of the new energy sources were undertaken for a long time [3, 4].

Many measures taken by the public authorities to protect the environment and the natural resources. Among the adopted solutions, the recourse to the use of renewable energies, which arouse an interest growing in particular those resulting from the biomass [5,6] and particularly, biogas coming from the biomethanisation of the agricultural effluents [7,8, 9].

The valorization of organic waste and mainly the animal manure for the production of biogas could be regarded as an ecological and economic solutions to these problems. The biomethanisation constitutes, today, a source of diversification for agriculture.

The biomethanisation having thus like principal vocation the production of biogas, showed lately other interests [1, 10]. It constitutes, today, one of sources of diversification for agriculture [2].

In the absence of oxygen (O_2), bacteria degrade partially the organic matter (OM) [11, 12], which leads to the formation on the one hand, of a biogas mainly made up of the methane and developed in energy [13, 14, 15], and on the other hand, residues called digestates [16, 17, 18, 19]. These secondary by-products can be used in a solid state (Methacompost) like

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integral part of the substrates of culture or be spread [20, 1, 11, 21, 22, 2], as they can be used directly in the liquid state (Juice of Process) like fertilizer of the arable lands, even, except ground [4, 23].

The present study proposes to look further into the analysis of certain determining parameters in the appraisal of energy performance of the rural biogas produced on the qualitative level (gas composition and calorific value), environmental level (polluting load in SM and BDO_5 of the dejections before and after fermentation) and agronomic except ground (use of the methacompost like substrate of growth and the juice of process like fertilizer in market-gardening seedbed) of the bovine biomass digested in a rural digester of farm.

2 MATERIALS AND METHODS

2.1 EXPERIMENTAL SITE

It is the experimentation of the biomethanisation of the bovine dungs on the level of the digester installed in the farm attached to the Agricultural Professional Training Center in Bovine Breeding (A.P.T.C.B.B.) in Sidi Thabet, Tunisia. This rural digester of farm was built around the years 2000. It is a buried pilot digester (Figure 1) with manual uninterrupted feed and having a capacity about 6 m^3.

Fig. 1. The rural pilot digester

2.2 EXPERIMENTAL MATERIAL

It is the biomethanisation of the fresh dungs produced by the cows available (like substrate) and of the black bovine dungs extracted from the adopted septic tank (like inoculum). The characteristics of these two dungs are illustrated in table 1 hereafter.

Table 1. Physical and chemical characteristics of the bovine inputs put at the test

Nature of the bovine dungs	% DM	pH
Fresh dungs (substrate)	31.5	6.5
Black bovine dungs (inoculum)	9.4	7.2

2.3 TESTS OF EVALUATION IMPLEMENTED

The qualitative analyzes of produced biogas were carried out in the test laboratory of the Tunisian Company of Industries of Refining (T.C.I.R.), located in Bizerte, whereas the environmental analyzes were carried out at the laboratory “Biogas” of the APTCBB.

2.3.1 EVALUATION OF THE QUALITATIVE ENERGY PERFORMANCE OF THE DIGESTER

The analysis of the qualitative productivity of biogas understands a determination of the composition of biogas produces and its calorific value (CV) with its lower and higher limits (LCV and HCV).

For the analysis of the gas composition, we had recourse to the technique of chromatography in gaseous phase (CGP). This technique is suitable for the compounds gas or likely to be vaporized by heating without decomposition. The components determined by this method (Figure 2) are the following: % CH_4, % CO_2, % H_2S and % H_2.

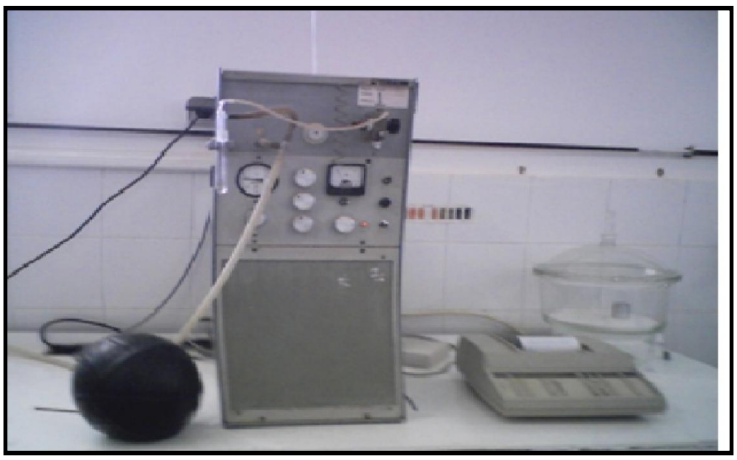

Fig. 2. The chromatography for the estimation of the composition of gas

Moreover, we were also interested in the natural energy (Figure 3), by considering the values lower and higher of the calorific value (LCV and HCV), expressed in kWh/m³, kcal/m³ or kcal/kg and which are linked by expression 1 following:

$$\text{HCV} = \text{LCV} + \text{heat of vaporization} \quad (1)$$

Fig. 3. The chromatography for the estimation of the calorific values

2.3.2 EVALUATION OF THE ENVIRONMENTAL PERFORMANCE OF THE DIGESTER

The environmental parameters in which we were interested are relating to the polluting load (SM and BDO_5) of the digested matter coming from various mixtures.

For SM, they correspond to the whole of mineral and/or organic particles present in a natural or polluted water [24]. Their determination makes it possible to consider the bacterial biomass in the digester [25]. The analysis is based on the principle of quantifying all the matters being able to be decantable after elimination of the major part of water by filtration and vaporation in the drying oven with 105 °C.

Concerning the BDO_5, this parameter constitutes a good indicator of the biodegradable OM content in water during processes of purification. The principle of the measurement of the BDO_5 rests on the quantification of O_2 consumed after a sample incubation during five days.

2.3.3 EVALUATION OF THE AGRONOMIC PERFORMANCE OF THE SOLID AND LIQUID DIGESTATES

For the case of the bovine methacompost (BMC), the evaluation in a direct way, by appreciating its maturity and its physical properties (total porosities, of ventilation and of retention) and indirect evaluation, by the follow-up of morphological parameterized of the seedlings (germination, growth in height,…) is necessary, in order to develop a suitable substrate allowing an optimum conditions for growth of the seedlings.

For the bovine juice of process (BJP), its evaluation is limited to an indirect characterization carried out, following a follow-up of the vegetative behavior (growth in height) of the pepper seedlings with respect to integral and partial watering with this product.

Concerning the evaluation of the maturity of the BMC, it is a question of carrying out a biotest of germination on lettuce seeds [26]. The aim of the biotest is to evaluate the maturity of the BMC [27], to envisage the possible existence of some phytotoxic elements [28, 29], while putting in consideration the photosensitivity of the lettuce seeds used like Plant-test[30].

The followed method consists in putting, under favorable conditions of germination, the seeds of lettuce [26]. For that, we used small pots out of transparent plastic, impermeable and hermetically closed. The BMC underwent a light humidification. We put in each pot 20 seeds of lettuce and one took as witness sand with three repetitions for the BMC. Let us announce that maturity can be evaluated, according to the percentage of germination, even, according to germinative energy. The determination of the rate and the germinative energy of the lettuce seedlings was carried out starting from regular countings of the germinated seedlings.

The determination of the porosity of the studied substrates of growth, it is based on the control and the comprehension of the microscopic structures. On a microscopic scale, the substrate is in the form of a microsystem with three phases; a solid phase composed by organic particles containing water, a liquid phase composed by absorbed water and a gas phase composed by the vacuum called lacunar space containing of gases and steam [31].

It is thus comprehensible that the porosity of the substrates is defined as being the sum of the gas phase and the liquid phase [31].The total porosity (Pt) is determined by the relationship between the volume poured with the saturation of the substrate and total volume.

The porosity of ventilation (Pv) is determined by the relationship between dried volume through the holes of drainage under the effect of the forces of gravity and total volume. The porosity of retention (Pr) is determined by difference between total porosity and porosity in ventilation. The total porosity of the substrates is generally higher than that of the ground (soil), which is about 40 to 50% of total volume [32].

The Tunisian conditions require the following proportions of porosity: $Pt \geq 50\%$, $Pa \geq 20\%$ and $Pr \geq 30\%$. These rules to be applied were inspired by the Canadian standards [33], by supporting the retention on ventilation, because of the dry climate of Tunisia.

The evaluation of porosities was carried out, using a standard test of porosity, on pure substrates: peat and compost like substrates of reference and BMC. It should be noted that each test of porosity was carried out with three repetitions.

About the evaluation of the agronomic value of the BMC and its operating requirement like substrate of culture in a pure state or in mixture, it appeared using a bearing test on the sowing of seeds of pepper. The BMC used during this test was taken after a residence time of 15 days in the rural digester, then dried for a period of four days.

Three types of substrates were tested which are a pure peat (pilot), a pure BMC and a mixture made up of 60% peat and 40% BMC. The follow-up related to the behavior of the pepper seedlings installed in alveolate plates, from growth point of view in height, while taking the heights cumulated with regular intervals (four days).

Concerning the evaluation of the fertilizing capacity of the BJP, it is appreciated by using it to sprinkle pepper seedlings already prepared in advance (sown in alveolate plates on the same support of reference which is the compost), while selecting 24 seedlings having homogeneous heights which were useful like support of the experimentation. Then, we began the watering of the seedlings selected with the solutions prepared, at a rate of a watering every 48 hours during 20 days, while taking the levellings cumulated with regular intervals (some of four days). The solutions used are: water (pilot), juice of concentrated process, then respectively diluted, at a rate of 25% or of 75%.

3 RESULTS AND DISCUSSION

3.1 QUALITATIVE CHARACTERIZATION OF PRODUCED BIOGAS

3.1.1 GAS COMPOSITION

The biogas produced by the rural digester underwent a conditioning (filtration and reduction of moisture). In this respect, the follow-up was carried out before and after conditioning to appreciate its importance qualitatively. The evaluation of the performance of the conditioning implemented is interpreted starting from the results of analyzes of the composition of the biogas produced reported in table 2.

Table 2. Results of the analyzes of the gas composition

	% CH_4	% CO_2
Before treatment	58.1	40.9
After treatment	66.1	32.7

According to the results obtained of the composition of the biogas produced, the percentage of methane (CH_4) before conditioning is close to the reality of the treated bovine biomass (58%). This percentage increased by 8% after conditioning thus recording an output of purification of 13.8%, which shows the importance of the treatment of biogas, since it ensures more reduction in polluting elements (CO_2…) while increasing the concentration in CH_4.

3.1.2 CALORIFIC VALUE

Concerning the values obtained for the calorific value of produced biogas, they give a full satisfaction on the energy performances of the rural biomethanisation (Table 3). They are understood in the whole in the fork given by [34]. According to this author, the calorific value of biogas is proportional to its content of CH_4 and it varies between 5000 and 8500 kcal/m³.

This post-processing makes it possible to have an output of purification which is about 4.8%. This output is weak because especially of the ineffective process of conditioning implemented. Ultimately, it is advisable to more improve the output of purification of biogas to reach the theoretical maximum equal to 8500 kcal/Nm^3 [34].

Table 3. Results of the calorific values

	LCV (kcal /Nm^3)	HCV (kcal /Nm^3)
Before treatment	4973	5532
After treatment	5210	5932

3.2 ESTABLISHMENT OF THE ASSESSMENTS OF DEPOLLUTION

The analyzes as of the SM and of the BDO_5 were carried out on the two mixtures initially and later introduced. The results are given in table 4.

Table 4. Follow-up of principal environmental parameters

Parameters	Mixture initially introduced	Mixture introduced later
SM before fermentation (mg/l)	13.9	20.5
SM after fermentation (mg/l)	12.3	12.2
Assessment of depollution of SM (%)	11.5	40.4
BDO_5 :beginning of fermentation (mg O_2/l)	406.7	573.5
BDO_5 : end of fermentation (mg O_2/l)	323.7	354.2
Assessment of depollution of BDO_5 (%)	20.4	38.1

The assessment of depollution as of the SM as that of the BDO_5 increases according to the concentration of DM introduced into the digester (from the first to the second mixture). The assessments of depollution obtained are regarded as non satisfactory as well while being based on SM as on the BDO_5 and deserve to be improved more especially for the case of the mixture initially introduced (substrate without inoculum).

3.3 RESULTS OF THE AGRONOMIC EVALUATION OF THE DIGESTATES

3.3.1 APPRECIATION OF THE MATURITY OF THE METHACOMPOST

The experimental results of germination of the bio-test on the BMC are mentioned in table 5.

The values obtained of the biogermination of the lettuce seeds on the BMC tested give a full satisfaction, since the rate of germination is even higher than that obtained on sand, which proves its good maturity. So the BMC produces by the rural digester, considered as wall, could thus be used like substrate as culture in seedbed except ground (breeding-ground).

Table 5. Results of the bio-test of germination

Substrate	Rate of germination (%)
Sand (proof)	82
Methacompost	95

3.3.2 APPRECIATION OF THE POROSITY OF THE SUBSTRATES OF GROWTH TESTED

Figure 4 gives an idea about the physical characteristics, in terms of porosity of the pure substrates employed during the standard test implemented.

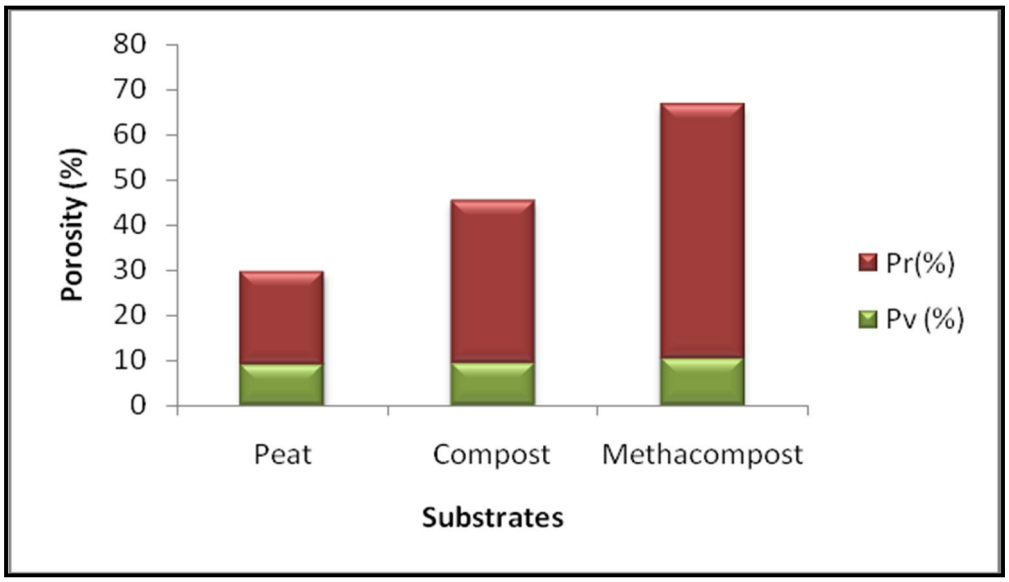

Fig. 4. Results raised of porosity of various pure substrates tested

To guarantee a good production of the seedlings, we must make sure especially of the physical characters of the substrate of growth used which must be satisfied, because they play a big role in the water supply of the plant and the operation of the roots: ventilation and temperature. The physical properties relate primarily to the porosity of the substrate and the evaluation of the water contents and of air available for the roots [31].

Concerning the results obtained, we can note that the witnesses are far from being acceptable from point of view total, ventilation and retention porosities. Only the compost shows an acceptable porosity of retention. Such results are in contradiction with the literature, which regards the peat as the ideal substrate for the breeding of the seedlings, especially

from point of view Pv. Such a situation could be due particularly to the handling errors and/or to the drying during the carrying out of the standard test of porosity.

Concerning the BMC, it meets the standards of total and of retention porosities, however, its Pv is unacceptable. In front of such situation, this substrate can be considered as retaining substrate and could be partially built-in with a substrate aerator (compost). The optimal ratio of mixture remains to be determined.

Water can act directly by its reactions of degradation and its reactions of hydrolysis. These last relatively reduce granulometric dimensions of the BMC. The retention capacity can increase and the porosity of ventilation can decrease when the granulometric components of the BMC are fine. The BMC resulting from the biomethanisation of the bovine dungs can be only a partial substitute of the peat and/or the compost.

3.3.3 OPERATING REQUIREMENT AGRONOMIC OF THE METHACOMPOST LIKE SUBSTRATE OF CULTURE

The results of the follow-up of the growth in height of the pepper seedlings cultivated on BMC in a pure state or mixed with the peat are configured on figure 5.

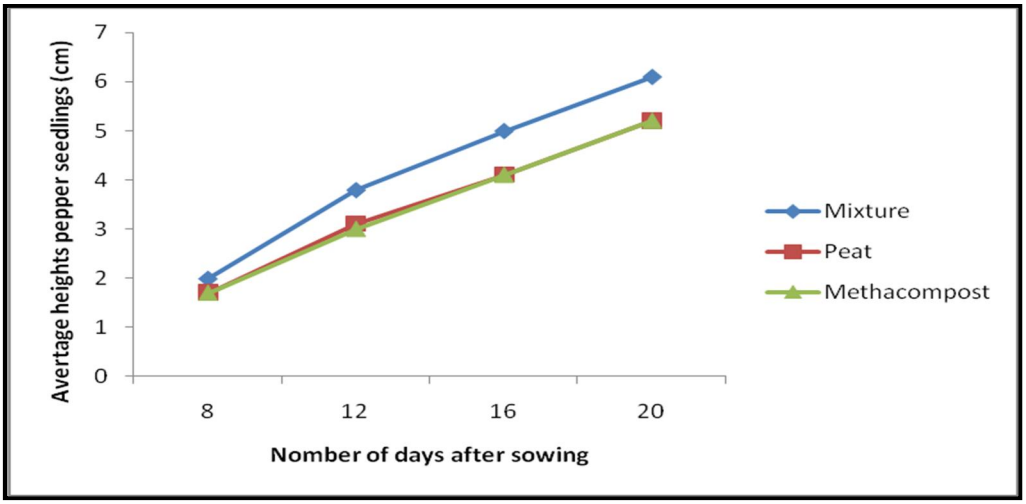

Fig. 5. Growth in height of the pepper seedlings installed on various substrates

By comparison between the various substrates of culture (pure or in mixture), the growth in height of the seedlings of pepper is almost identical for the seedlings installed on peat and BMC at the pure state. But, the seedlings installed on BMC presented hails stems, sensitive and some were burned and end up fading. The peat incorporated with BMC at a rate of 60% gives a faster growth and higher heights of seedlings without presenting any vegetative anomalies. These preliminary results are extremely interesting (being given the possibility of incorporation of the BMC at a rate of 40% with the peat) and deserve other investigations before being applied.

3.3.4 OPERATING REQUIREMENT AGRONOMIC OF THE JUICE OF PROCESS LIKE FERTILIZER

The results of the follow-up of the growth in height of the pepper seedlings sprinkled with the BJP, in a concentrated state or diluted with water in various proportions are reported on figure 6.

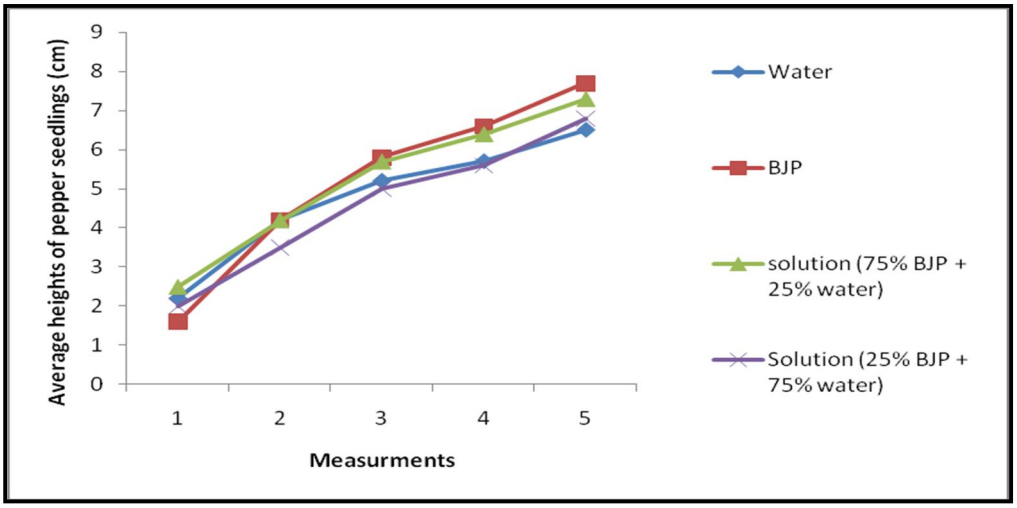

Fig. 6. Test of growth of the pepper seedlings sprinkled with various fertigations

The juice of process used in a concentrated state allowed a considerable growth in height reaching 8cm in 20 days, but it is necessary to evoke that several seedlings finished by fading suddenly. The same observations were raised for the solution made up of 75% BJP and 25% Water, as well from growth point of view of the seedlings as sudden fading. On the other hand, a solution made up of 25% BJP and 75% Water, allows a good growth without presence of anomalies of fading. Such results deserve to be confirmed by testing in parallel the report of dilution 1/2, to study the possibility of fertigation of the seedlings with this last report.

4 CONCLUSION

The animal manure is particularly interesting to use, when they are produced in significant amounts and regular and especially when they are treated biologically by biomethanisation before use.

In the light of the results obtained at the time of this study referring to energy, environmental and agronomic valorization of the bovine biomass treated in a rural digester, we could learn the verifications hereafter.

- The qualitative characterization of rural biogas shows an unquestionable interest of post-processing by conditioning and an acceptable quality on the plans composition and calorific value. It makes it possible, indeed, to more improve its potentialities energy (% CH_4 and PC).

- The follow-ups as of SM and of the BDO_5 showed that the biomethanisation allows a reduction of the polluting load which takes more importance with the increase of the concentration in DM of the matter to be fermented, proving thus that the biomethanisation is a very beneficial process in terms of energy valorization and recycling of OM for the safeguarding of the environment. This reduction is regarded as reduced and requires an improvement, considering the assessments of depollution obtained are weak with relatively acceptable.

- The bovine methacompost tested cannot be regarded as a good substrate of growth because of its insufficient porosity of ventilation, which justifies its mixture, according to adequate proportions, with the peat which has a porosity of ventilation normally more raised, for a correction of the physical balance of the substrates of growth.

- The tests carried out showed that the use of the peat in mixture with methacompost at a rate of 40% like substrate of culture, proves very encouraging and powerful with respect to the growth in height of the seedlings of pepper. The recourse to the bovine methacompost like partial substitute of the peat or the compost could constitute an interesting alternative to limit the imports, and consequently, the hemorrhage of the currencies.

- The juices of process showed an interesting fertilizing powers, in particular, that diluted to water at the rate of 75%. However, the results obtained are only preliminary and they deserve to be considered with prudence, because of certain vegetative anomalies raised in the case of the concentrated juices (from 75 to 100%).

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Voice identification Using a Composite Haar Wavelets and Proper Orthogonal Decomposition

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ABSTRACT: In present day business and consumer environment, a robust voice identification system is needed to reduce false positives, and true negatives. In this work, a modified voice identification system is described using over sampled Haar wavelets followed by proper orthogonal decomposition. The audio signal is decomposed using over sampled Haar wavelets. This converts the audio signal into various non-correlating frequency bands. This allows us to calculate the linear predictive cepstral coefficient to capture the characteristics of individual speakers. Adaptive threshold was applied to reduce noise interference. This is followed by multi-layered vector quantization technique to eliminate the interference between multi-band coefficients. Finally, proper orthogonal decomposition is used to evaluate unique characteristics for capturing more details of phoneme characters. The proposed algorithm was used on KING and MAT-400 databases. These databases were chosen as previous extraction results were available for them. In the present study, the KING database were trained with three sentences, and tested with two. On the other hand, the MAT-400 database were trained with two seconds of random voice signal, and tested with other two seconds. Results were compared with vector quantization and Gaussian mixture models. The present model gave consistently better performance on speech collected through mouthpieces, but gave comparatively poor performance on audio collected on telephones. The better performance is obtained at the cost of higher computational time.

KEYWORDS: Voice identification, Haar wavelet, Proper Orthogonal Decomposition, Signal Processing, modeling.

1 INTRODUCTION

Generally, speaker recognition can be divided into two parts: speaker verification and speaker identification. Speaker verification refers to whether the speech samples belong to some specific speaker or not. However, in speaker identification, the goal is to determine which one of a group of known voices best matches the input voice samples. Certainly, how to extract and model the speaker-dependent characteristics of the speech signal is the key point. It seriously affects the performance of the system.

In past literatures for recognition models, vector quantization (VQ)[1]-[2], neural network (NN), dynamic time warping (DTW), hidden Markov model (HMM)[6], and Gaussian mixture model (GMM) were used in speaker recognition task. Some researchers combine VQ [3] and learning vector quantization (LVQ) [4] to form the group vector quantization (GVQ) that its performance is better than LVQ but it needs to be retrained after entering new samples. Also NN in speaker recognition task was used [5]. Although NN technique is robust and has high performance, it needs to be retrained after entering new samples. DTW technique [5] is not suitable for text-independent speaker recognition. GMM [7]-[10] were widely used in speaker recognition and had satisfactory performance.

In this work, an effective and robust extraction method of speech features called LPCC with multiband support based on wavelet analysis has been implemented. In order to effectively utilize all these multi-band speech features, a modified vector quantization method called eigen-codebook vector quantization (ECVQ) as the identifier. In these text-independent

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evaluations, the experimental results showed that this method has satisfactory computation cost and performance especially on the noisy environments.

2 MATHEMATICAL MODEL

2.1 COMPOSITE HAAR WAVELETS

The Haar wavelet transform has an established name as a simple and powerful technique for the multi-resolution decomposition of time series. Unfortunately, the standard Haar wavelet transform has several limitations. The lack of translational shift invariance is very limiting when matching is to be performed over various intervals of the input data. The composite Haar wavelet used in this work is especially useful for real-time signal analysis for our purpose.

In order to provide shift invariance, the Haar decomposition is over sampled. As for voice identification, over sampling operation will only be performed on the position axis [11]. The sampling grid for the scale axis will remain dyadic in scale. Oversampling on the position axis can be done to the highest resolution required, or any required intermediate, lower resolution. The highest available resolution that is that of the sampling rate of the input is being used. This means that we let the position translation index run over the positions *i* of the time series ψ_i. Therefore, the oversampled system will be as following [12]:

$$\psi_{m_0,n_0}(x) = 2^{-m_0}\psi(2^{-m_0}x - n_0), \qquad \left\{ \begin{array}{c} m_0 = 1,2,....,L \\ n_0 = BE,...2^L - 1 - BE \\ BE = 2^{m-1} - 1, \end{array} \right\}$$

Where, BE denotes empty boundary coefficients and is introduced here in order to ensure alignment of the indices across scales. The bands that are empty are half the width of the wavelet. They are 'empty' because position of the wavelet can be aligned with the time series at either end. An oversampled grid obtained according to the above prescription is shown in figure 1.

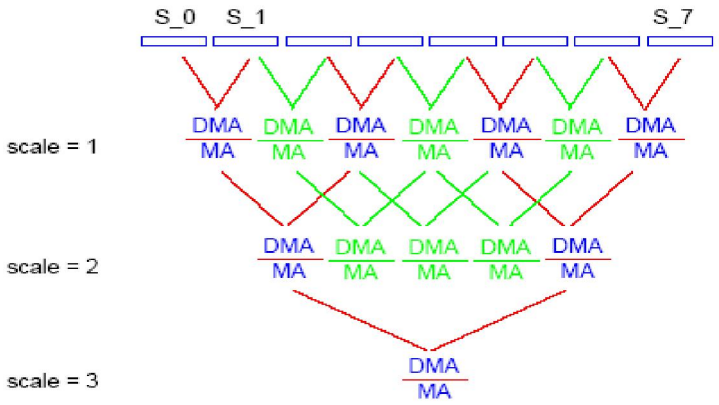

Fig. 1. Composite Haar decomposition. Highlighted (in red) is the dyadic pyramid [11]

MA=DMA is localized decomposition coefficients on the grid points. Of course it is possible to select the dyadic grid from the oversampled representation for any arbitrary starting location. One such possible (centered) selection has been highlighted in figure 1.

2.2 PRINCIPAL COMPONENT ANALYSIS

Assuming zero empirical mean (the empirical mean of the distribution has been subtracted away from the data set), the principal component w_1 of a dataset *x* can be defined as [13]:

$$w_1 = \arg\max_{\|w\|=1} E\left\{ \left(w^T x \right)^2 \right\}$$

There are two algorithms currently used to calculate PCA of a dataset that are: covariance method and the correlation method [13]. For this work covariance method is implemented.

3 SYSTEM DESCRIPTION

The target of implemented prototype system (figure 2) is to create voice signature of a user and then to isolate the target user from a group of speakers. The two distinct parts of this system one is voice signature creation and other one is speaker detection.

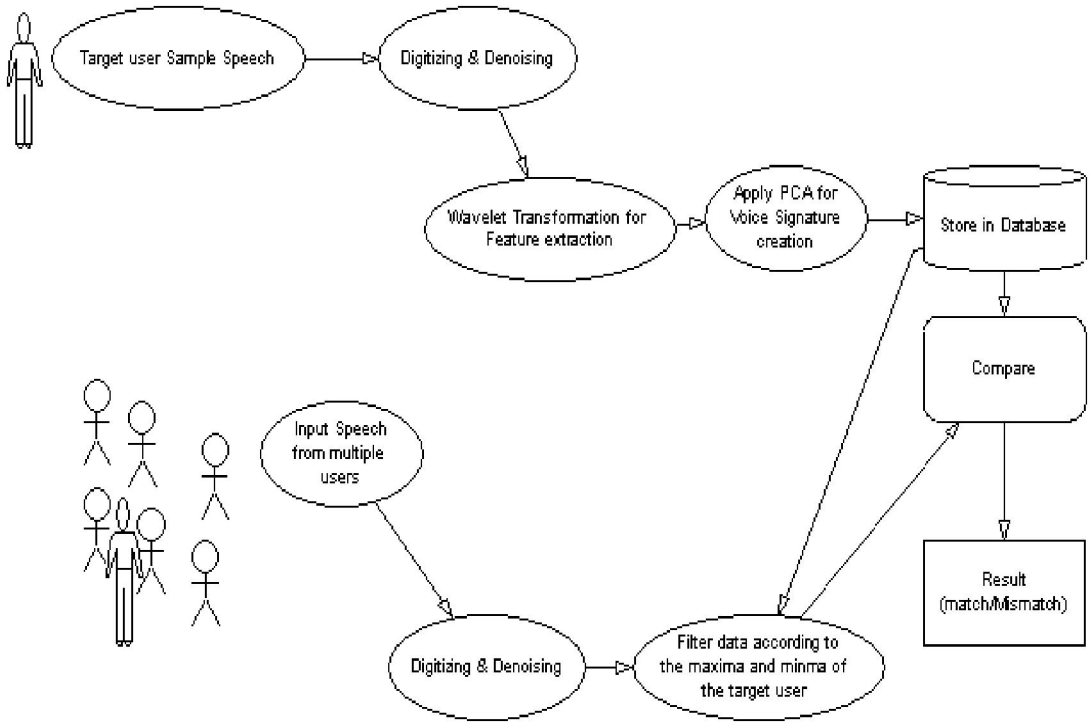

Fig. 2. Prototype System

3.1 FEATURE EXTRACTION METHOD

The wavelet transform is applied to decompose the input signal into various non-correlating frequency bands. Thus the linear predictive cepstral coefficients (LPCC) within all approximation channels are calculated to capture the characteristic of individual speaker. The main reason of using LPCC parameters is its good representation on the envelope of speech spectrum of vowel and its simplicity [9].

As the LPCC parameters are bothered by noise interference, an adaptive threshold technique is applied in each approximation channel before the next decomposition process. The most significant coefficients at each scale, with amplitude above some thresholds, are defined as follows:

$$\theta_j = \sigma_j - R_j$$

Where σ_j is the standard deviation of the wavelet coefficients within approximation channel at scale *j*, and *R* is an adjusting multiplicative factor used to restrict the threshold at a certain extent. The recursive decomposition process lets the system easily acquire the multi-band features of the speech signal. In the final stage, a combination of these LPCC values is implemented by the following equation:

$$LPCC = \underset{j=1}{\overset{L}{Append}}(LPCC_j)$$

Where *L* is the levels of decomposition process and $LPCC_j$ is the set of cepstral coefficients of the wavelet coefficients at scale *j.*

3.2 PCA FOR VOICE SIGNATURE CREATION

The PCA method [14]-[16] uses the statistical distribution of input samples to find the best projection bases. The advantages of PCA method are that the principal eigenvectors are orthogonal, and represent the directions where the signals have maximum energy. This property will speed up the convergence of model training and improve the recognition performance. While all training samples have been processed by PCA method, the evaluated mean vector $\overline{X}$ and eigenvectors $\phi_1, \phi_2, \ldots \phi_m$ may effectively describe the characteristic of samples belonging to specific word. If there is a new sample x_{new} for classification, it will be adjusted by the mean vector and project to the *m* orthonormal eigenvectors as follows:

$$p_i = (x_{new} - \bar{x})^T . \vec{\phi}_i \quad i=1,2,.....m$$

Where p_i is the projection of x_{new} on the *i*th projection base $\vec{\phi}$, and *m* is the number of the projection bases. Finally, the distance between ε and x_{new} the specific word is evaluated as follows:

$$\varepsilon = x_{new} - \bar{x} - \sum_{i=1}^{m} p_i \vec{\phi}_i$$

Where ε is a distance vector. The norm represents distance value between and the word. The new sample is belonging to the code word that is most closing to x_{new}. This training procedure known eigen-codebook vector quantization (ECVQ) [17] is described as follows:

Step 1: set up the number of the projection bases m, number of code words C_{no} maximum training times N.

Step 2: use VQ training method to calculate the centroids of all code words and classify all training samples.

Step 3: use PCA method to evaluate the mean vector $\bar{x}$ and eigenvectors $\phi_1, \phi_2, ... \phi_m$ for each code word. Figure 14 shows PCA output.

Step 4: use eigen distance formula to evaluate the distance vector ε and classify the training samples by ||ε|| .

Step 5: If the training times are less N and samples classification is not convergent, go to step 3.

Step 6: store the mean vector $\bar{x}$ and eigenvectors $\phi_1, \phi_2, \ldots \phi_m$ for each code word.

Because the LPCC is extracted from the wavelet coefficients of multi-band speech signals, in order to eliminate interference between the multi-band coefficients, the individual codebook for each band is evaluated. The total distance *total* ε between *new x* and the specific model is sum of ε in each band.

4 RESULT & DISCUSSION

The algorithm described here is applied on KING [17] and MAT-400 [18] database. KING is a database of 51 male speakers collected through microphones and telephone networks. Ten sections were recorded at different time for every speaker. MAT-400 is a Mandarin speech database of 400 speakers collected through telephone networks in Taiwan. Speakers include 216 males and 184 females. The speech signal is recorded at 8 kHz and 16 bits per sample. Furthermore, 16 orders of LPCC for each decomposition process were used. While computing LPCC, the mean normalization is used to compensate the channel effect.

In this experiment, the performance of ECVQ model is compared to conventional VQ and GMM model with Gaussian white noise corruption. In KING database, three arbitrary sentence utterances for each speaker are used as the training patterns and two seconds of speech waveform cut from the other two sentence utterances are used as the testing patterns. In MAT- 400 database, two balance sentences used as the training patterns and two seconds of other 8 balance sentences us as the testing patterns. In proposed ECVQ model, the decomposition level is 4, *j R* =0, each layer has 64 code words that are represented by a mean vector and a projection base. In VQ and GMM model, 20 orders of MFCC were used. In VQ, 100 code words were used. In GMM, 50 code words were used. The results in Table 1 show how the performance of the other models begins to degrade as the SNR of testing environment departs from that of the training environment. However, the performance of proposed ECVQ model is better than other models, and maintains its robustness at lower SNR.

Table 1. Identification of rates of the VQ, GMM, and MLECVQ for different SNR

Method	KING					MAT 400
	Clean (%)	20db (%)	15db (%)	Tel 30.8db	Tel 18.2db	Tel (%)
VQ	83.62	67.73	53.45	71.87	61.5	95.62
GMM	92.61	85.88	73.28	75.38	58.14	98.18
ECVQ	96.47	89.05	69.66	70.32	69.38	99.04

In other experiment with two sentence utterances of 20 speakers, the performance and computational cost of ECVQ is compared to conventional VQ and GMM model. The results are depicted in Table 2. In Table 2, *Y/ X* represents the results of 1 second and 2 second testing utterances. Although the computational time of VQ is much less than other methods, its performance also was lowest. When the number of code works was less than 64, the performance and computational time of the proposed ECVQ is better than GMM+VQ model.

Table 2. Identification rates and computations time

Code words	VQ		GMM		ECVQ	
	Recog. Rate (%)	Time (Sec)	Recog. Rate (%)	Time (Sec)	Recog. Rate (%)	Time (Sec)
16	57.26/74.12	0.15/0.25	80/90.92	1.61/3.19	84.14/92.1	1.2/2.45
32	68.78/80.84	0.25/0.5	83.83/93.28	3.05/5.95	86.81/94.79	2.65/4.85
64	69.45/84.03	0.45/0.95	84.67/93.45	7.38/11.35	88.48/96.47	8.3/16.6

5 CONCLUSION

An improved model of voice identification method using composite Haar wavelet is proposed in this work with addition of Principal Component Analysis method for detecting the pattern of speech characteristics of human voice. This model requires very little training with increased accuracy and language independence. This model may be improved further for artificial voice regeneration of a particular human voice.

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Impact of tax structure system on GDP and progressivity: The case of Vietnam

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ABSTRACT: To find out impacts of tax structure system in Vietnam on GDP and progressivity, models employed are Fixed-Effects and Two-Stage Least Squares, together with the regression model of tax progressivity. Data's source is from Vietnam General Statistics Office. It is cross-sectional time series over the period 1997-2010 for different 61 provinces in Vietnam. Findings present that Vietnam's tax policies are progressive, their integration policy impacts on the economic growth positively. In addition, the result is proved there is a significant relationship between the state budget and GDP. As a result, the budgetary expenses must be paid attention strictly. Because coefficients of value-added tax and corporate income tax are positive and significant, an increase in value-added tax or/and corporate income tax causes an increase in GDP. However, this view for a long-term is a negative impact on the economic growth, because the country can lose competitive advantages to attract foreign development investment, if keeping high tax rates. Note that several inadequacies in policies need reforms in both policies and tax structure system, in which corporate income tax must be focused, because of mobilization of financial outside the state is unstable. Currently, tax policies in Vietnam combine so many goals in each form of encouragement while the policy objectives are conflict, which makes difficulties to carry out. Existing lack of harmony among the taxes in the tax policy can cause a main reason of a decrease in the revenue target of the state and in regulating macro economy.

KEYWORDS: Tax, Fixed-effects, GDP, State budget, Investment.

1 INTRODUCTION

To push up growth and economic development up, improving policies of tax plays is a key point of each country. Tax has a mutual impact on socioeconomics and people's income, also is a main revenue of a country. Tax evasion is considered to be of serious concern to those dealing with taxation issues of a country because of several reasons, the major as it results in the loss of revenue. However it can create both positive performance and negative performance. Reference [1] finds negative impacts of taxes on openness and total tax revenue to the economic growth in twelve countries of OECD. He also argues that the tax rate of capital is reduced, it will cause the capital inflow to a country, because tax policy can be used to affect the amount of entrepreneurial activity more broadly. One of main reasons makes taxes negatively influencing company's business, because a tax plays as a kind of cost. An increase in company's cost, due to tax, make a decrease in revenue of company. As a result, it can dispirit company's mind accessing the market and causes economic growth down of a country [2], [3].

In addition, many research find a valid impact of tax on the growth rate [4], [5], [6], [7]. Those authors conclude that a decrease in tax rate causes an increase in the economic growth for a long-term. Like [4], [5] also confirm a long-term economic growth is existed if a low tax rate is taken into account. So, up 1% tax makes the decreasing from 2-3% GDP. In contrast, reference [6] argue the increasing of tax imposed on capital can recover the economy of country. Based on

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arguments of authors just pointed out, this article is going to explore the relationship between collected taxes and economic growth based on econometric models.

2 CHANGE PRESSURES IN TAX POLICY OF VIETNAM

Duration 1986-1995

Changes in tax in Vietnam mainly experienced from 1990 to 1995 to ensure state budget sufficiently. Those were prioritized in tax reforms, such as import tax imposed since 1988, return tax imposed since October 1990 (included eleven different tax rates from 0.5% to 40%) with many other taxes like excise taxes and income taxes. Shortly, changes in tax structure over this period have affected the growth of GDP and the state budget.

Duration 1996-2005

Many tax policies are changed in this period. Indeed, the 11th National Assembly approved two laws related to value-added tax (VAT) and corporate income tax (CIT) on January 1, 1999. However, VAT is popular for developed countries in over sixty years ago. Two countries had introduced VAT since 1966, by 1985, 35 countries had done so, and in 2004, 134 countries collected tax revenue with VAT [8].

Besides, tax reforms in Vietnam during 1996-2005 impressed a necessary point must be done in the early period of Vietnam's market economy associated with socialism orientation, due to the embargo lifted by the USA in 2000. Therefore, Vietnam promotes industrialization, modernization, and opens door toward the world integration. As a result, VAT is initially imposed on goods. Although its level is 10%, it levies 5% on goods of software computer, mechanical products, etc, with purposes to stimulate industrialization. To attract foreign investors, the government imposed the same level of tax rate for domestic and imported goods, which contribute into playing a fair game between local and foreign investors. Besides, income tax rates are also paid attention to changing.

Duration 2006-2010

The government set out three goals: (i) reducing tax rates; (ii) expanding taxes imposed on areas; (iii) stimulating production and investment to stabilize the government's budget. Therefore, CIT is adjusted in accordance with the international integration. Besides, Vietnam takes a commitment involved transparency for investors, because it can cause willingness of investors. VAT is also taken into account of adjustment. In addition, deduction in expenditure addition is also taken into account of adjustment, expenses considered are advertising and promotion cost, science research, technology innovation, training fees and expenditures for female labor. In addition, tariff taxes are changed, so on.

Although many policies of taxes are adjusted, effects of global economic crisis make a reduction in the government's budget. It, of course, negatively influence the economic growth. Therefore, GDP growth declined from 8% in 2008 to 5.3% in 2012 [27], reaching the bottom from last 10 years[1].

3 REVIEW OF THEORY

Many studies found the tax structure is related to economic growth in a country. To demonstrate an existing relationship between taxes and economic growth, statistical models are considered. Therefore, use ordinary leas square (OLS) model, in which GDP is the dependent variable, the independent variables include the national growth rate, the growth rate of overall productivity, foreign direct investment, collected tax, corporate income tax, goods and services tax, import tax, and so on [9]. The result showed that the dependent and independent variables have a linear relationship. Find the economic recovery of middle income countries through collected corporate tax [10].

Some authors argue that increased taxation can cause the fall in economic growth. Accordingly, Reference [1] and [11] found the negative impact of tax revenue's components such as corporate income tax and marginal tax rate on the economic growth. However, reference [12] and [13] conclude that there is positive correlation between taxes and economic growth, in which tax ratios, components of tax structure such as personal income, corporate income tax, sales tax and other will improve the economics growth in a country, which is argued by [8].

[1] *Vietnam General Statistics Office*

Use cross-country data during 1970-1997, with application of fixed effect regression, they found an increase in corporate tax rates lead to lower future growth rates within countries [14].

Under the policy of liberalization trade, the country can attracts foreign capital, which contribute into labor generation, although the early stages of liberalization, the revenue outcomes may be minor. Normally, the motivation of this activity is to set up competitive tax rates to neighbor countries. The result is that international tax competition produces higher average capital tax rates than in the absence of competition.

Use panel data for 117 countries over 32 years and find many developing and emerging market countries still heavily dependent on trade tax revenues [10].

Uses a regression model on time series data of 175 countries from 1948 to 1999, and proves that economic growth in 104 countries after they became a member of the WTO [15]. Therefore, the results indicate that there is a strong impact on the economic growth of a country, when that country sets up open policies of international business and free trading.

In recent years, countries around the world, included Vietnam, strengthen free trade policies, because changes in economic climate can cause a reduction in the economic growth. Therefore, reference [16] shows that GDP increase with a positive change in public policies, with an increase in the ratio of efficient expenditure policy.

4 METHOD AND DATA

Many papers use fix effect regressions to find out how relationship between tax and economic growth, e.g. [10], [4], [17]. With an unbalanced pool data consists of 769 annual observations for 43 countries over the period 1973-2003, reference [18] used the model U= U(Y-T, G, Lf, NT) to measure how relationship between GDP (Y), total government tax revenue (T), total government spending (G), net flow of foreign loans granted to the public sector (Lf), and total government non-tax revenue (NT). Use fixed-effect regressions based on cross-country data during 1970-1997 to measure impacts of taxes on GDP [14]. Likely, use panel data for 117 countries over 32 years, which fixed effects and two-stage least squares (2SLS) are applied [10]. Likely, reference [17] rise the model of fixed effects and 2SLS based on panel data and find that a higher provincial statutory corporate income tax rate is associated with slower economic growth. In addition, construction a regression model based on the panel data of 27 EU members countries for the period 1998-2010 to measure the relationship between corporate tax burden and economic growth [19]. Applied on arguments pointed out, fixed-effect and 2SLS in this paper are taken into account. Data used is cross-sectional time series over the period 1997-2010 for different 61 provinces in Vietnam. It is collected in each province and Vietnam General Statistics Office (GSO). As mentioned in (1), log of GDP is the dependent, remaining variables are independent. The explanatory variables are value added tax (VAT), corporate income tax (CIT), state budget (SB). These indicators in (1) are in logarithm.

According to (1), i represents the number of provinces in Vietnam, t is time period (year) and ε_{it} is error term. We also include the dummy variables, which D1 is the dummy variable presents change in VAT policy started since 2000, this means, 1 being from 2000 onwards, 0 as the time from before 2000. D2 presents a change in corporation income tax imposed since 2004, 1 being since 2004 onwards, 0 before 2004. D3 equals to 1 since Vietnam was a member of the WTO in 2007 onwards and 0 the period before 2007.

$$\ln GDP_{it} = \alpha_o + \alpha_1 \ln VAT_{it} + \alpha_2 \ln CIT_{it} + \alpha_3 \ln SB_{it} + \alpha_4 D_{1i} + \alpha_5 D_{2i} + \alpha_6 D_{3i} + \varepsilon_{it} \quad (1)$$

To find out the implication of the structure of a nation's tax system, the equation (2) was used by [20], [21], [22].

$$\tau = \tau_0 + \tau_1 y \quad (2)$$

Where τ_0 is a base level of the marginal tax rate and τ_1 determines the degree of progressivity of the tax system. If $\tau_1 = 0$, the marginal tax rate is independent of income, implying a proportional tax system. For $\tau_1 \prec 0$, the tax system is regressive, and for $\tau_1 \succ 0$, the tax system is progressive [23].

To measure tax progressivity, the regression model shown in (3) was developed [24] and found tax progressivity is bad for economic growth.

$$\ln T_t = \alpha_0 + \alpha_1 \ln GDP_t + \varepsilon_t \quad (3)$$

where Tt is the tax revenue in period t. Duration 1965-1995, Iceland and Spain are progressive for tax structure system, because their progressivity are 1.08 and 2.01 respectively [24]. Other countries with high progressivity are Denmark, New Zealand, Swedent, and Switzerland.

Based on equation (2) and equation (3), this paper also applies the model of progressivity to evaluate Vietnam's structure tax system.

5 EMPIRICAL ANALYSIS AND DISCUSSION

Based on cross-sectional time series over the period 1997-2010 for different 61 provinces in Vietnam, figure 1 produced means that there is an increase in GDP, VAT, TCI and TB during 1997-2010, in which the provincial buget is always highest value, this is not surprised, because it is a main revenue source gathered by many revenues, e.g. taxes. With that VAT is a main contribution to the budget, its share of 32% on average from 1997-2010, while tax on corporate income accounts for average of 14%.

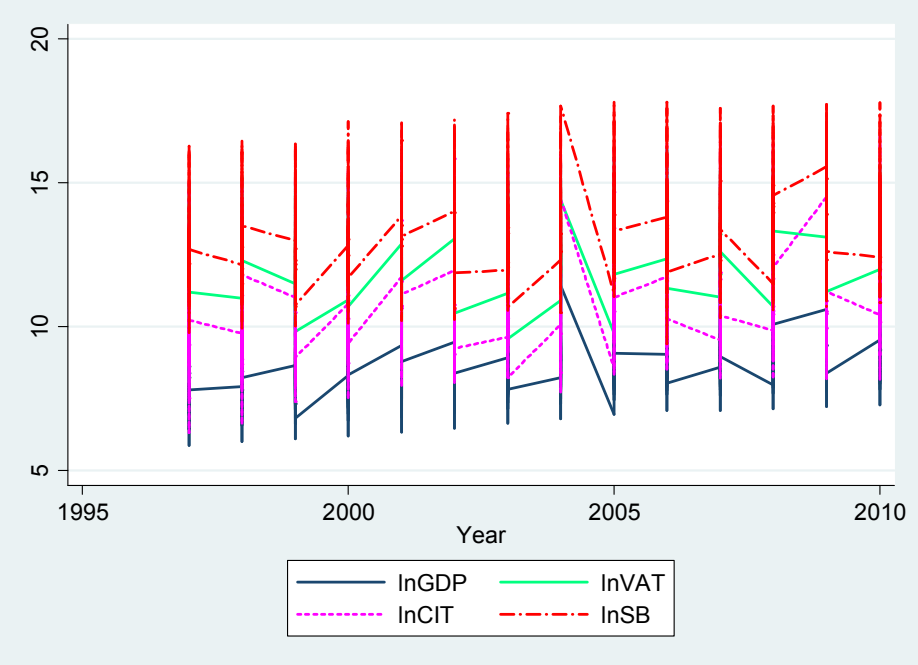

Fig. 1. Presentation of GDP, VAT, CIT, SB (in logarithm) duration 1997-2010

Source: Vietnam General Statistics Office (GSO)

As depicted in figure 2, an increase in lnVAT causes a raise in lnGDP, similarly for lnCIT and lnSB. As a result, there may be linear relationships between lnGDP as a dependent variable and independent variables, e.g. lnVAT, lnCIT, lnSB. Based on statistical evidence, all tax structures are significant and correlated with GDP [4]. However, those relationships are negative. This result is also consistent with the most previous studies of taxes such as [25], [26], [17].

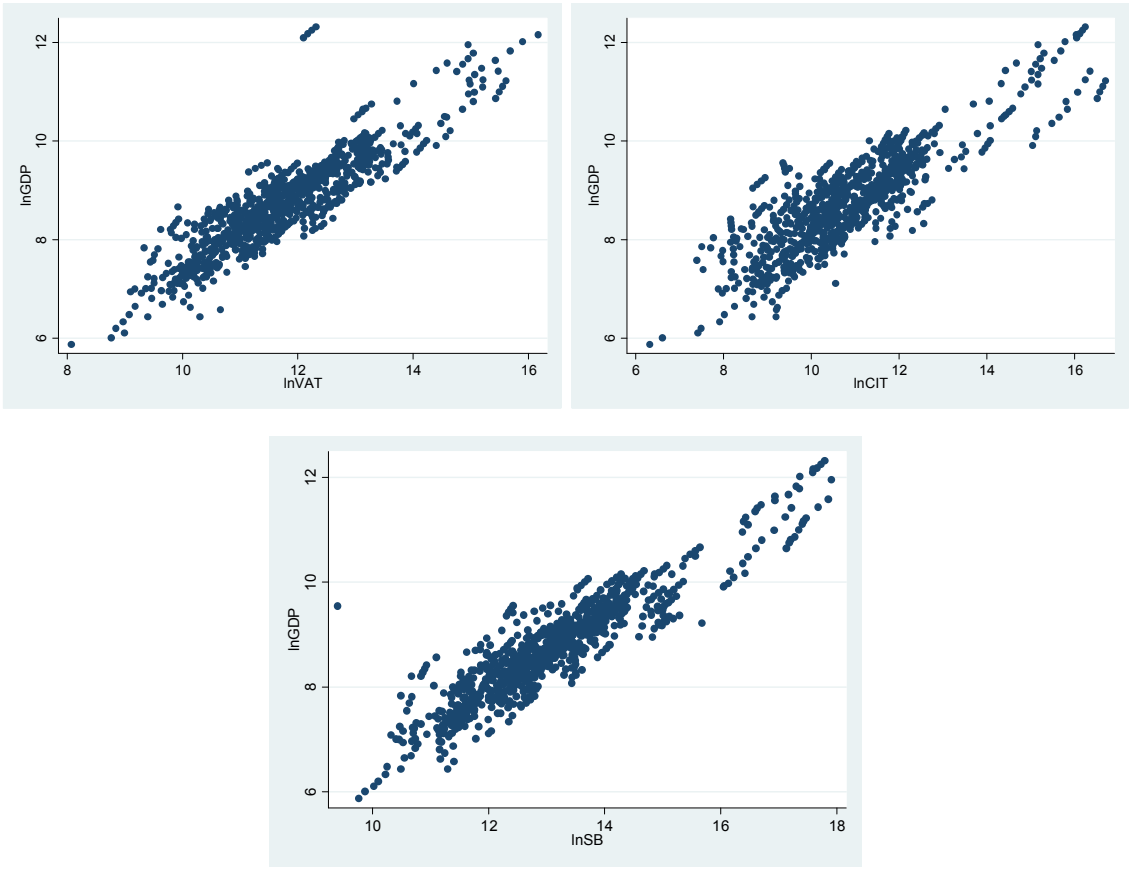

Fig. 2. Correlation between lnGDP and lnVAT, lnCIT, and lnSB

Source: GSO

To confirm the relationship between tax structure and economic growth, we can check results in table 1. Accordingly, fixed-effects and Two-Stage Least Squares (2SLS) are employed with 850 observations, and their R-squared are 0.843 and 0.867, respectively. In addition, F test of two models are significant at any level, conclusion is the model of (1) is goodness of fit. As mentioned in table, coefficients estimated in fixed-effect regression are significant at any level, while coefficients of lnCIT in 2SLS is significant at 10% and of D2 is not significant at all. As a result, findings mean that tax structures in Vietnam duration 1997-2010 have a significant and positive impact on GDP. It means that if the tax cuts 1% introduced by the provincial government, the economic growth will fall down around 0.1%. This result is opposite to Lee and Gordon (2005) [14]. Therefore, according to Lee and Gordon, a cut in the corporate tax rate by 10% points will raise the annual rate by one to two percentage points. Similarly, a 1% point cut in the corporate tax rate is related to a 0.1-0.2% point increase in the growth rate [7].

D1 presents an evidence of changes in Government policy for VAT. As resulted in regressions, the rate of VAT changed since 2000 has a positive impact on the growth of GDP. Similarly, D2 is significant in fixed-effect regression, this can conclude that changes in corporate income tax from 28% to 25% since 2004 onward is positive for the economic growth. As a result, changes in Vietnam's tax structure prove a positive influence to the economic growth. In addition, the result also confirm a positive change in Vietnam's integration policy to being a member of WTO, because there is an evidence of the significant relationship between D3 and GDP.

Similarly, D2 depicts changes in tax policy imposed on corporate income tax from 28% to 25% since 2004 onward, this decision is a positive impact on GDP. It has created good conditions for actors in the market to maintain and expand their business, not only for local investors, but also for foreign investors. D3 presents the period that Vietnam economy is verified a member of WTO in the beginning of 2007. Because the coefficient of D3 is positive and significant at any level, conclusion is Vietnam's GDP growth is existed after 2007. This can be positive changes in economic policies of Vietnam.

Table 1. Results of fixed effects and 2SLS

Variables	Fixed-effects		2SLS	
	Coefficient	P-Value	Coefficient	P-Value
lnGDP	0.100	0.000	0.208	0.000
lnCIT	0.104	0.000	0.058	0.054
lnSB	0.110	0.000	0.381	0.000
D1	0.269	0.000	0.719	0.000
D2	0.319	0.000	0.047	0.218
D3	0.159	0.000	0.097	0.009
Constant	4.5611	0.000	0.482	0.005
R-Squared	0.843		0.867	

In terms of applying equation (3) into panel data, its estimation is resulted in (4) as below. This result means the real progressivity of Vietnam is good for economic growth. In sum, because the coefficient of lnGDP is positive, the tax system of Vietnam is progressive, as proven.

$$\ln T = 1.86 + 1.18 \ln GDP \quad (4)$$

*(12.95)***[2] (71.84)****

6 CONCLUSION

With data of cross-sectional time series over the period 1997-2010 for different 61 provinces in Vietnam, fixed-effects and 2SLS are employed, together with the regression model of tax progressivity. Findings present policies of Vietnam's tax structure are progressive and its integration policy positively impacts on the economic growth consistent with [15], which the performed regression shows a positive effect of variables lnVAT, lnCIT, lnSB and dummy variables of D1, D2, D3 on the growth. Conclusion, an increase in VAT or/and CIT causes a rise in the growth of GDP, which is in line with [6]. However, this view for a long-term is negative impact on the economic growth because the country can loose competive advantages of tax policies. In addition, changes in tax burden will affect saving behavior of consumers or taxpayers.

As found by some paper, reduction of the tax burdent will have a greater effect in the economic growth of a country, also attract more FDI. Note that accessing the WTO of Vietnam since 2007 is a positive impact on GDP, but it can be a main pressure for the government pay attention to reforming tax rate.

In general, the structure of the tax system in Vietnam must have the appropriate changes to be in line with the economic development. Budget expenditures must be also paid attention considerably, because the result is proved that there is a significant relationship between the budget and GDP.

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Green Lean Six Sigma and Managerial Innovation in Malaysian Automotive Industry

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ABSTRACT: The purpose of this paper is to determine the relationship between the Green Lean Six Sigma (GLSS) and the Management Innovation (MI) to be implemented in the Malaysian Automotive Industry. This paper tries to examine how the GLSS can contribute and have a positive impact on the development of MI to achieve better performance in the automotive industry. In addition, by applying the advantages of innovation in an industry, they are able to ensure they have a competitive advantage factor. There are several elements that can be selected to support the GLSS and MI practices in the automotive industry. The relationship between structure MI and GLSS is proved by the use of Structural Equation Model (SEM) as recommended. Since this is a concept paper, most of the literature from the previous survey taken as a basic guide for this study as well as the construction of models of the relationship between the GLSS and MI is made. Next, the hypotheses can be generated based on the model of the proposed research and literature review. It has been shown that the MI which acts as an intermediary for the Malaysian automotive industry can continue to perform to make the transformation GLSS practice management system in the Malaysian automotive industry more efficiently and effectively in line with the industry to be the best among the competitors in other countries.

KEYWORDS: Green lean six sigma, managerial innovation, environmental, automotive industry, structural equation modeling.

1 INTRODUCTION

Malaysia is well known as the largest total passenger car market in ASEAN due to high purchasing power and the rapid growth of the economy. However, Malaysia has gone a step further in the automotive field to be car manufacturer after the establishment of Proton and Perodua instead of act as assemblers of motor cars only. Great opportunity can be achieved by the development of Small and Medium-Sized firms (SMEs) in the event of an increase in the ability to develop the industry. Malaysian automotive industry will face greater challenges from neighboring countries in Asia, especially Thailand when the implementation of AFTA in 2005. In this regard, Malaysia should take some steps to ensure there is a gap between the competitors.

Several research effort discussed in the literature indicate that companies who implemented the Lean Six Sigma (LSS) initiative show the significant environmental improvement by being extremely manage to improve efficiency, reducing costs, enhance customer response time, contribute to the quality, earn larger profits and upgraded public image [1]. In the proper way of implementation, among the advantages of the green system is able to build the company's image as a socially responsible organization and the environment as well as, the occurrence of a remarkable reduction of energy, generation of waste, and harmful materials. Production of green system are highly recommended by agencies such as the EPA, which strongly support of this research, especially if manufacturing LSS can act as a catalyst for the implementation the system so that this relationship can provide a lasting impression on the environment and performance organization.

Basically, the managerial innovation occurs when a goal is achieved through changes in how the organization of the work carried out, or significantly changes the shape of customs organization. According to previous studies, the purpose of innovation management is to enable the organization to use creative efforts to introduce new ideas in terms of production

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and the efficient process [1]. This step is not only dependent on the research and development (R&D), but it deals all employees from each stage who can account for creative ideas for continuous development of the company.

Purpose of this paper is to determine and develop research model of the successful implementation of LSS has adopted the concept of 'green' to further enhance competition with other manufacturers and to evaluate its impact on the managerial innovation. At the same time, to identify measures that support improved management and things that hinder the process of improvement for Malaysian automotive industry using empirical study.

2 LITERATURE REVIEWS

2.1 GREEN LEAN SIX SIGMA IN MALAYSIAN AUTOMOTIVE INDUSTRY

Today, the automotive industry contributes significantly to the Malaysia's development in terms of creating skilled employment, deepening our Research and Development (R&D) capacity, and strengthening our component manufacturing and installation capabilities. However, the Malaysia's automotive manufacturer is in the spotlight as they have to compete with more experienced manufacturers in the automotive industry. A step should be taken to make their product is more competitive advantage and profitable. In a sense while history certainly informs the presents, ideas and perspective of the present may provide alternatively explanations and perspectives for understanding the past.

Many researchers have described the advantages of applying environmental strategies. For example, by implementing an environmental strategy, it can give different effects according to industries such as manufacturing or operation, energy consumption, raw material collection, marketing, disposal and waste management [2]. Traditionally, authorities and organizations have stepped up efforts to reduce polluting activities. However, referring to [3], the economic performance of an organization can be enhanced through innovation efficiency are responding by environmental regulations. In contrast to the small and medium manufacturers, their goal to use environmental strategy is not only supported by short term motivation, but also driven by strategic considerations. Consider on that situation, most small and medium sized manufacturers need to reload the cost of doing business to carry out an environmental strategy and rules ([4], [5]).

In ensuring that this can be done, lean not only act as exclusion errors initial but studies have been done to see how lean value system can be applied in the green strategy. Implementation of lean strategy in green into a unique blend can also be sure that it can help in the industrial sector [6]. Moreover, to attract customer, other approaches such as integrated quality tools that can be used as long as it is consistent with the actual objective lean. It means, whatever the concept of lean parallel to the goal of providing customer value and does not take much time, it is suitable for use with such as six sigma and green ([6], [7]).

As well as lean and six sigma since both have the same advantages. Both approaches can improve quality, shorten the processing and reduce the chance of defects. In addition, the function of lean is to eliminate waste, while six sigma was able to reduce variation and improve a number of elements that the products are at a satisfactory level. For the impact, both approaches may increase the company's performance. It was support by [8], six sigma is a concept which have the most precise linked with a defect in the quality and the elimination of change while, lean was associated with the scavenging efficiency and speed as in line with the goal of lean which is to reduce waste in all aspects of producing a product and accelerate the speed of a process.

Lean and six sigma approaches need each other due to lean applied in the organization, especially the lack of cutting edge manufacturing in services and technical compare six sigma is more focused on skilled workers in a quantitative approach. Thus, according to [9], the integration of lean and six sigma can help organizations build infrastructure improvements as a whole. This is indicates that both approaches give a positive impact on the performance of the organization as well as to create a combination of tools to analyze and find the best troubleshooting steps for organizations that implement them.

However, there is limited evidence of green, lean and six sigma consultancies have been combined into a working framework. Most of researches only focus on how to implement either combination of lean or green or six sigma with green, which are each of those approaches may affect the performance of the organization. Therefore, the integration approaches of Green Lean Six Sigma (GLSS) require the support by the number of elements with the various advantages could affect the performance of an organization who implements the approach. Those elements are leadership focus, training and education, structured improvement procedure and focus in metrics. A summary of those elements used in this research is given in Table 1.

Table 1. The advantages of elements on GLSS practice

Elements	Advantages of elements
Leadership Focus (LF)	On an ongoing basis improvement activities, cooperation and good communication and information operations spread quickly to achieve improvements in the quality of leadership if the concept is implemented effectively [10].
Training and Education (TE)	When the training and education has been implemented, it indirectly encourages employees always perform their duties with full dedication through enough skills. In addition, self-motivation can be developed through training and education where is in the end, result of their works are satisfactorily when all functions successfully applied effectively [11].
Structured Improvement Procedure (SIP)	To increase productivity, the organization proposed to adopt a structured improvement procedure. It is part of an organization that aims to provide knowledge and learning to the employees, to find a solution for a problem with quality and is a step in the strategy for the organization to carry out improvement projects ([10], [12], [13]-[14]).
Focus in Matrix (FM)	Quality management process can be enhanced when there is an understanding of an objective, efficient daily operation activities, intelligent manage tools and commitment among the employees of an organization to adopt the metric ([13]-[14])

2.2 MANAGERIAL INNOVATION IN MALAYSIAN AUTOMOTIVE INDUSTRY

In a recent year, the technology fast cycle, diversity and globalization move dramatically in the market of environment. In order to face these challenges, organization need to survive and grow for better management and gain a competitive edge going. This is also one step taken by an organization to create value for the competition toward pursue innovation [15]. Therefore, [16] suggest a method by stated that innovation is achieved by obtaining economic benefits from the creation and discovery. In other words, innovation is the renewal of a product, process, operation management and others to bring economic and convenience benefits to the organization and customers.

To increase productivity and performance at different stages of economic, organizations should consider implementing of innovation as a key factor for the development of a global organization. Innovation can be strengthened by empirical evidence as well as providing a positive impact on the organization ([17], [18], [19]). Therefore, comprehensive innovation model should be able to expect a difference and direction of innovation in the organization as a whole. Besides, organization also need to consider simultaneously all the factors explaining innovation in the organization of various different levels in order to build a comprehensive model of innovation ([19], [20], [21]). Therefore, organizations need to be more committed to adopt and carry out a lot of research to generate innovation as it is a huge shift in organizational management [22].

Referring to previous research, to ensure that this innovation practices can have a positive impact on the organization, there are several factors needs to be studies. According to [23], the implementation of practices innovation must know the roles undertaken as the transfer of coordination and integration implementation in order to make the innovation yielded effective and efficient. In addition, the successful of an organization can be seen when there are related idea norms of rational behavior [24]. This means, it can be said the successful implementation of managerial innovation is influenced by the actions of the organization.

However, the discussion of innovation is broad and large in scope. Therefore, organizations need to know what the ultimate goal of reform or change is to be made by them. This statement is supported by ([22], [25]), it is difficult to use the term organizational innovation as a broad scope to describe all kinds of innovation in an organization. Therefore, in order to create a sophisticated organizational structure and effective way to improve the complexity of the environment, practitioner of an organization must have an effective system and a good matrix ([19], [26], [27]). Thus, although innovation is a huge thing, but it still can be implement in accordance with the proper planning or in stages.

Various types of organizational innovation can be identified such as technology and administration or between product and process innovation ([22], [28]). This statement also supported by [16]. They highlight that, most studies of innovation performance is more focused on the company's internal innovation process, such as research and development in product innovation and improvement of production processes in terms of process innovation in a social system that disseminated and formed in the community.

In conjunction with that, an organization can determine the right choice either innovation of technical or prefer managerial through adequate level of technical skills or adequate capacity to establish effective interpersonal relationships [23]. Therefore, organizations need to make some research to identify problems that need to be improved, and then they

determine the category of innovation (technology or management) would apply where it can contribute to efficiency in the management and performance improvement.

However, as other practices, innovation will also deal with some problems or weaknesses. According to [29] and [30], the process of innovation implementation quite difficult to implement given the fluctuation customer's expectations and competitive pressures are broad and rapid technological change and radical innovation resulting in the change process becomes more complex, expensive and risky. Especially in the present situation where the market volatility and globalization require organizations to deal with the challenges of competition involving technology, management and organization [23]. Therefore, a structured planning and cooperation from various parties is needed. Many things need to be considered and emphasized as market conditions, the performance of competitors, technological advancements and customer requirements are taken into consideration so that the measures taken to innovation is appropriate to organizational goals.

Based on previous studies, it is believed that the problem of disadvantage of the use or development of the innovation can be overcome when there is a good management system. Coordination between technology production and methods of execution should exist, and that is the reason organization now needs to emphasize managerial innovation. This is because, according to [31], the division innovation of the organization into managerial and technology is very important for both sides where the type is and amount of organizations resources is different to ensure successful implementation.

For technological innovation, it is significant change and is very easy to spot in an organization. For example, it involves the use of new technology in the manufacturing procedure ([31], [32]). While technological innovations change the physical environmental, the implementation managerial innovation may covered the social system of organization ([31], [33]).

Managerial innovation can be identified by monitoring on a specific action related to the organization and it is as a measure to capture the potentially critical role of human agency in the process [34]. This reinforces the study by [22] that managerial innovation functions much focus on new ways to develop innovative manufacturing processes and advanced. In addition, the process of managerial innovation implementation requires understanding the role of self assessment and design better tools so as to avoid failure in implementation.

Study by [35] concludes that the process of change is divided into three phases; the first phase is making decisions and design, implementation phase and the phase of use. The three phases include the organization of action in deciding to adopt and implement management innovation designed hence it is used in the context of the organization and eventually when made practice of managerial innovation within an organization and planning. Therefore, organizational need to really understand the scope of what is required by the organization and use of the potential of an organization's progress in order to measure the application performance of managerial innovation.

Implementation of managerial innovation can be done effectively if supported and facilitated by a number of elements involving organizations especially among workers. Based on several previous studies, there are three elements that are identified may improves change in management. List of elements and their purpose contains of knowledge management, creativity skills and social culture is given in the Table 2.

Table 2. The list of elements' purpose on managerial innovation constructs

Elements	Purpose of elements
Knowledge Management (KM)	Excellent firms may support by the small groups but those structure of team-based able to contribute to the extent knowledge as a consequence of their mutual learning by enlarge or combination of their initial knowledge for achieve better management ([36]-[37]).
Creativity Skills (CS)	Creativity can be fully utilized when a person has a holistic knowledge of being able to think of something fresh and widely. As a result, employees may develop job satisfaction and improve their level of creativity [38].
Customer Perspective (CP)	When organization is committed to ensure the customer perspective, they automatically will strive to meet the demands and needs of customers. Thus, a variety of things that will try to improve by organizations such as producing affordable products, improve product and service quality for customer satisfaction and improve process management ([39]-[40])

2.3 THE RELATIONSHIP BETWEEN GREEN LEAN SIX SIGMA AND MANAGERIAL INNOVATION

Before to measure the relationship between green lean six sigma (GLSS) and the management of innovation (MI) is identify, the purpose and function of the green, lean, six sigma and managerial innovation needs to be understood for the first stage. This is to indicate the relationship of this approach can be pointed out and implemented by the organization's structures and processes accurately and efficiently. Definition of each of the practice that will be used in brief based on previous studies is given in Table 3.

Table 3. The summary of definition on each practice implement in this research

Elements	Advantages of elements
Green	The automotive industry should adopt environmental management practices in the design prior to production of a product, raw materials, recycling programs and to eliminate harmful substances that do not produce sewage wastes, toxic substances or air emissions, and accordingly, environmental performance can also be maintained ([41]-[42]).
Lean	The way of waste disposal, the use of continuous lean have an interest in developing velocity point creation procedure which is to increase its value and customer satisfaction. Separated from the target lean practices is to ensure smooth dumping design with restoration to the level of value, the use of processing, reduced transport time and viable production requires the upgrade process sustainable ([10]-[43]).
Six Sigma	Six sixma is a tool that can drive business to upgrade the purpose of obtaining and taking good explanation defects or lapse to go and arrange consistently upgrading and ready to focus attention on the yield variation in the production process ([44], [45]-[46])
Managerial Innovation	Managerial innovation as a change in management, work organization, working environment and expertise the workforce. Therefore, it can be concluded managerial innovation is a reform effort to create a more organized and perfect work environment [50].

Roughly, based on table 3, it shows each practice which are green, lean, six sigma and managerial innovation has similar goals. In short, GLSS integration can help organizations improve the quality of products or services. Despite the production is performed, it involves a variety of processes such as resource conservation and management of operational activities by applying environmental factors as a waste of resources-saving measures. Almost organization aims to make their product or service competitive advantage among its competitors and attract more customers directly. For the impact, the organization may earn higher profit. This is where the need for managerial innovation applied because it could change the working system normally undertaken by the management. With these changes, the organization is able to achieve the targets set parallel with the advantages offered by the GLSS. However, the integration between GLSS and MI practice must be proven by a number of previous studies that effective implementation can be done in an orderly manner to avoid errors or wastage in terms of cost and time.

Improve training development among employees is the importance role as growing rapid technological change. To ensure keep pace with industry advances in technology, employees should always be involved and maintain the process in acquisition of knowledge skills and acquired through formal education skills. However, the implementation of innovation will not only contribute to the understanding of the area's ability to process through the study of technology development, but also potentially beneficial innovations in the management process approach.

According to [36], action taken by management in any sectors of organization is different because it depends on the level of importance of environmental issues. But environmental pressure received by the organization to make them be far more proactive. In addition, he said that with the implementation of an environmental strategy, it assist bring the organization into a competitive advantage through cost savings and different products than those available in the market. This was shown by the attitude and technique in the application of environmental assist industries to achieve better performance. Consider all of this, organizations should implement environmental strategies as opportunities and be able to produce a competitive product or service.

Reference [38] stated that concept applied by the organization for the processing of products and implementation services usually fluctuates according to the rate of competition and technological shifts. Based on managerial innovation, it can shift from the normal activities of an innovation to the practice of effective new structure in short span of time. Learning techniques range from the lower level to upper management. In other words, the implementation of the overall innovation

occurs and its good approach for effective innovation management. Furthermore, with the support of innovation management, lean approach succeeded in changing markets and strategic development of the automotive industry. For example, in the product life cycle, lean undergoing the process of innovation has led to increase in product sales during the maturity phase.

While [48] had studied the implementation six sigma resulted organization which aims to dismantling process and eliminate waste from the appropriate organization and management when implementing six sigma in a structured manner. This strategy successful to achieve organizational goals by implemented with strategic tools and techniques in a strictly manner. Therefore, the management of an organization must have effective techniques for implementing six sigma with appropriate approaches. It is important to analyze a work process and practices improved design changes in management. Proper technique is also able to give an advantage to the organization to manage the allocation of resources when implementing six sigma [49].

3 RESEARCH HYPOTHESIS

The important of this paper are to explore the relationship between Green Lean Six Sigma (GLSS) and Managerial Innovation (MI) in Malaysian Automotive Industry. Therefore, the research hypotheses were developed. The hypotheses will be stated based on numbering system from H_1.This style of hypotheses statement is chosen due to the nature of answering hypotheses using structural equation modeling methods. As a result of study in literature review, the following hypotheses of the study have been developed:

H_1: There is a positive and direct significant relationship between GLSS practices and managerial innovation in Malaysian automotive industry.

4 RESEARCH METHODOLOGY

In achieving the objectives of the study, sampling method is used by using structured questionnaire. The population of this study comprised in Malaysian Automotive Industry and the data was obtained from Malaysian Automotive Components Parts Association (MACPMA), Proton Vendors Association (PVA) and Kelab Vendor Perodua (KVP).

SEM techniques was utilize to perform require statistical analysis of the data from the survey. Exploratory factor analysis, reliability analysis and confirmatory factor analysis to test for construct validity, reliability, and measurements loading were performed. Having analyzed the measurement model, the structural model was then tested and confirmed. The Statistical Package for the Social Sciences (SPSS) version 17 was used to analyze the preliminary data and provide descriptive analyses about thesis sample such as means, standard deviations, and frequencies. Structural Equation Modelling (SEM using AMOS 6.0) will use to test the measurement model.

5 A PROPOSED RESEARCH MODEL

Based on the literature review, it is hard to found empirical studies were investigating the relationship between GLSS and MI. Thus, this paper aims at analyzing of the relationship between GLSS and MI for Malaysian automotive industries. This model is called proposed research model as presented in Figure 1.

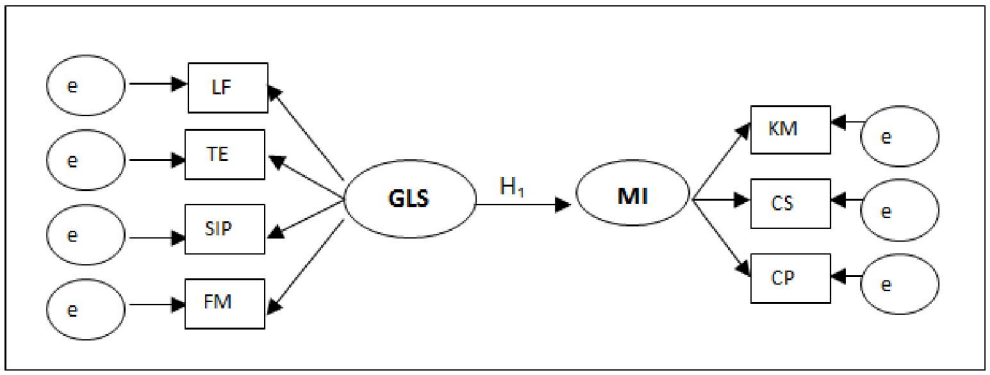

Fig. 1. Proposed Research Model for Green Lean Six Sigma and Managerial Innovation in Malaysian Automotive Industry

**Note: GLSS=Green Lean Six Sigma, LF=Leadership Focus, TE=Training and Education, SIP=Structured Improvement Procedure, FM=Focus in Metrics, MI=Managerial Innovation, KM=Knowledge Management, CS=Creativity Skills, CP=Customer Perspective*

6 CONCLUSION

This study aims to examine the relationship between Green Lean Six Sigma (GLSS) and Managerial Innovation (MI) to be implementing in the Malaysian automotive industry. Therefore, the hypothesis is created with strong evidence based on literature review. Various studies have shown that managerial innovation is one approach that can support of GLSS concept to be implementing by the Malaysian automotive industry. Based on previous research, organization should follow the process and procedures the application of managerial innovation, for achieve better organization performance. In addition, the efficiency and quality of the products also able to attract more customers in line with the advantages offered by the GLSS. In future agenda, the next step of this study is to design a questionnaire and investigate the relationship between GLSS practices and MI in Malaysian automotive industry.

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Modélisation de la Cinétique de Séchage de la Carotte (Daucus carota)

[Modeling of Drying Kinetics of Fresh Carrot (Daucus carota)]

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ABSTRACT: This work concerned the study of the influence of the drying parameters on the water loss of the fresh carrot coming from the area of Adamawa. This study was undertaken in a drier designed and produced in a tropical environment. Drying was carried out at various temperatures 45; 50 and 55°C and at various speeds of the air circulation (0.5;1 and 1.5 m/s), with relative humidity of the variable air between 60 and 70%. The water content initial of the carrot samples were 90.8%, and we followed during drying, the loss of weight of the samples. It arises from the results that the temperature and the air velocity drying have a significant influence over the time of drying. The couple (55°C; 1m/s) is that which makes it possible to obtain the results most interesting for fresh carrot. This couple led to a time of 200 minutes drying. The modeling of the experimental data shows that the exponential model represents perfectly the behavior of this product; some is the cases of figure considered. This work would allow a better valorization of the local resources, the reduction of the losses post harvests, the reduction of the consumption of energy.

KEYWORDS: Modeling, parameters of drying, loss out of water, drying kinetics, fresh carrot.

RESUME: Ce travail a porté sur l'étude de l'influence des paramètres de séchage sur la perte en eau de la carotte fraiche provenant de la région de l'Adamaoua. Cette étude a été menée dans un séchoir conçu et réalisé dans un environnement tropical. Le séchage a été réalisé à différentes températures 45 ; 50 et 55°C et à différentes vitesses de circulation de l'air (0,5 ; 1 et 1,5 m/s), avec des humidités relatives de l'air variant entre 60 et 70%. La teneur en eau initiale des échantillons de carotte étaient 90,8%, et nous avons suivi au cours du séchage la perte de poids des échantillons. Il ressort des résultats que la température et la vitesse de l'air séchant ont une influence significative sur le temps de séchage. Le couple (55°C ; 1m/s) est celui qui permet d'obtenir les résultats les plus intéressants pour la carotte. Ce couple conduit à un temps de séchage de 200 minutes. La modélisation des données expérimentales, montrent que le modèle exponentiel représente parfaitement le comportement de ce produit, quelque soit les cas de figure envisagés. Ce travail permettrait une meilleure valorisation des ressources locales, la réduction des pertes post récoltes, la réduction de la consommation d'énergie.

MOTS-CLEFS: Modélisation, paramètres de séchage, perte en eau, cinétique de séchage, carotte fraîche.

1 INTRODUCTION

Adopté par l'homme comme moyen de conservation de produits agricoles depuis des décennies, le séchage est mis en œuvre de plusieurs manières différentes, pour des résultats divers. Ayant pour but de stabiliser un produit en le déshydratant, de façon à abaisser sa teneur en eau en dessous d'une valeur permettant sa conservation à température ambiante, il provoque malheureusement des modifications d'aspect, de goût, de texture et de qualité nutritionnelle du produit final. Le séchage utilise principalement les phénomènes de transfert de chaleur comme moyen d'élimination d'eau contenue dans le produit. Plusieurs travaux portant sur l'étude du comportement de la carotte pendant le séchage et

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d'autres légumes en général, montrent que plus la température est élevée et la couche mince, plus l'opération est rapide [1]. Mais très peu de chercheurs font varier la vitesse de l'air lors des essais. De plus ils vont au delà de la température maximale de séchage admissible par les carottes. Dans ce travail, nous aborderons le cas spécifique du séchage en couche mince pour mieux appréhender le comportement d'une couche mince aux alentours de la température maximale admissible par les légumes [2], ceci pour un écoulement d'air variant en vitesse et température.

2 MATERIEL ET METHODES

2.1 MATERIEL

2.1.1 MATERIEL VEGETAL

La carotte (*Daucus carota*) est une plante bisannuelle de la famille des opiacées (anciennement ombellifères), largement cultivée pour sa racine pivotante charnue, comestible, de couleur orangée, consommée comme légume. Le terme «carotte» désigne aussi ce légume. C'est un légume riche en carotène. L'apport énergétique de la carotte crue est de 31 kilocalories par 100 g (130 kJ par 100 g). Elle contient environ 92 % d'eau, 1 % de protéines, 0,20 % de lipides et jusqu'à 4,50 % de sucre. Les carottes sont riches en Béta carotène (pro- vitamine A). Avec 25 g on couvre plus de la moitié du besoin quotidien de vitamine A (204% pour 100g). La teneur moyenne en vitamine C est de 7 mg par 100 g. Elle contient aussi de la vitamine B1 et B2. Les minéraux apportés sont principalement du calcaire, calcium, magnésium, potassium et fer. La teneur en fibres est importante. Celles-ci sont composées en majorité de pectine et de cellulose [3].

2.1.2 MATERIEL EXPERIMENTAL

C'est un séchoir électrique à convection forcée avec recyclage contrôlé d'air. Ses dimensions extérieures sont : H = 2,10 m ; L = 0,50 m et l = 0,50 m. La partie intérieure, appelée chambre de séchage, a une capacité 0,25 m^3 et est revêtue de tôle en aluminium. La laine de verre placée entre le contre-plaqué et la tôle constitue l'isolant thermique entre l'extérieur et la chambre de séchage ; Ce qui permet de réduire le coefficient d'échange à une valeur inférieure à 0,40 $W/m^2°C$ [4]. L'extérieur du séchoir est recouvert d'une tôle d'aluminium enduite d'une couche de peinture. Ce séchoir permet d'avoir un écoulement d'air ascendant et donc un séchage traversant. La température de l'air asséchant peut varier entre 24 et 90°C et sa régulation est assurée par un thermostat du type AKO-14123. La plage d'utilisation de ce thermostat est de –30 à 99°C avec une précision de ± 1°C.

Les différents paramètres pris en compte pendant l'opération de séchage sont la température, l'humidité de l'air, la masse du produit et la vitesse de l'air asséchant.

2.2 METHODES

2.2.1 LES ESSAIS

Vingt et cinq essais ont été réalisés en faisant varier les propriétés de l'air d'un essai à l'autre. Ainsi trois valeurs possibles pour la température : 45 ; 50 et 55°C, se sont imposées, de même que trois valeurs possibles pour la vitesse de l'air : 0,50 ; 1 et 1,50 m/s. Pour chaque essai, la perte de poids a été enregistrée. Sept essais ont consisté à vérifier l'homogénéité de la température dans le séchoir vide pour différentes valeurs de la consigne.

2.2.2 PROTOCOLE EXPERIMENTAL

La figure 1 ci-dessous présente le protocole expérimental utilisé lors des essais en laboratoire.

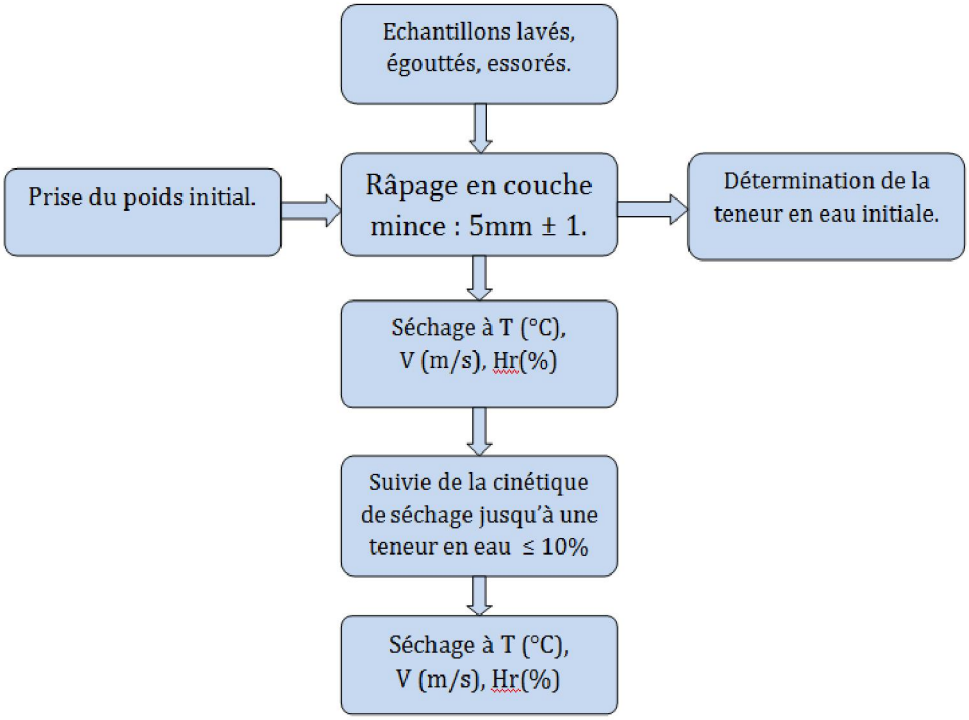

Fig. 1. Protocole expérimental

Ce protocole est le même pour chaque triplet température, vitesse, humidité relative de l'air.

Les opérations de séchage donnent lieu à deux types de transfert : le transfert de masse et le transfert de chaleur. Considérant le transfert unidirectionnel de vapeur d'un élément de volume vers de l'air à travers une surface d'échange plane, on peut faire les hypothèses suivantes :

- Le transfert de vapeur est unidirectionnel ;
- La surface d'échange est plane ;
- La teneur en eau initiale est la même en tout point de l'élément ;
- L'élément de volume est assimilable à un corps mince.

3 RESULTATS ET DISCUSSION

3.1 INFLUENCE DE LA VITESSE DE L'AIR SUR L'EVOLUTION DE LA TENEUR EN EAU

Les figures 2, 3 et 4 présentent l'influence de la vitesse de l'air séchant sur l'évolution de la teneur en eau des échantillons en fonction du temps respectivement pour les températures 45 ; 50 et 55°C.

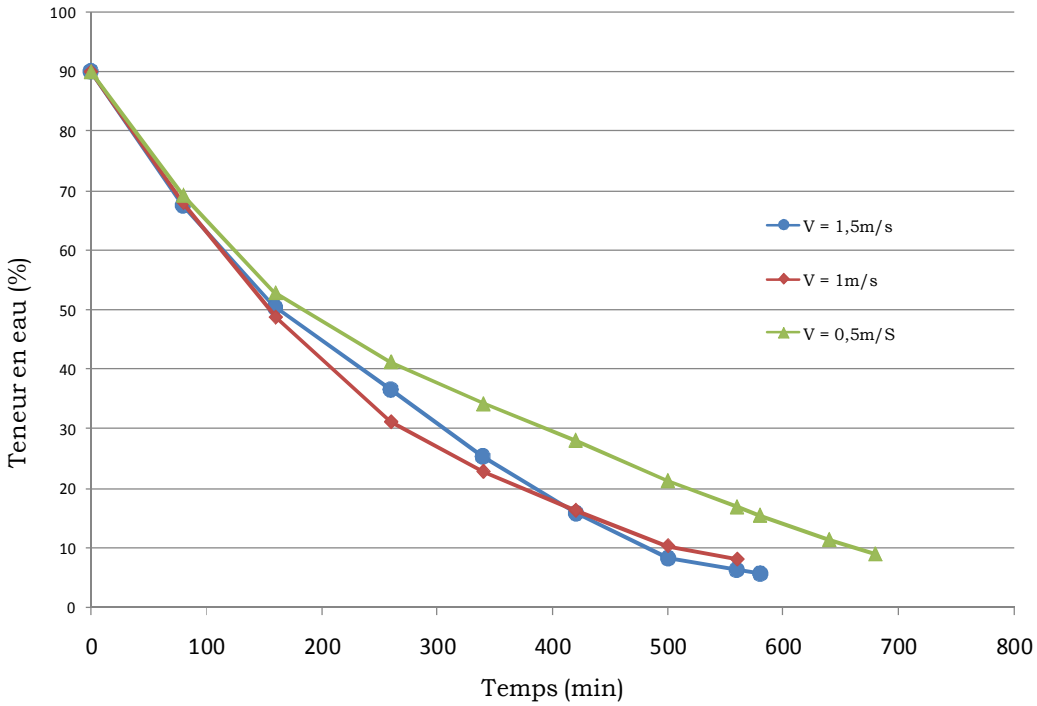

Fig. 2. Influence de la vitesse de l'air sur l'évolution de la teneur en eau à T= 45°C

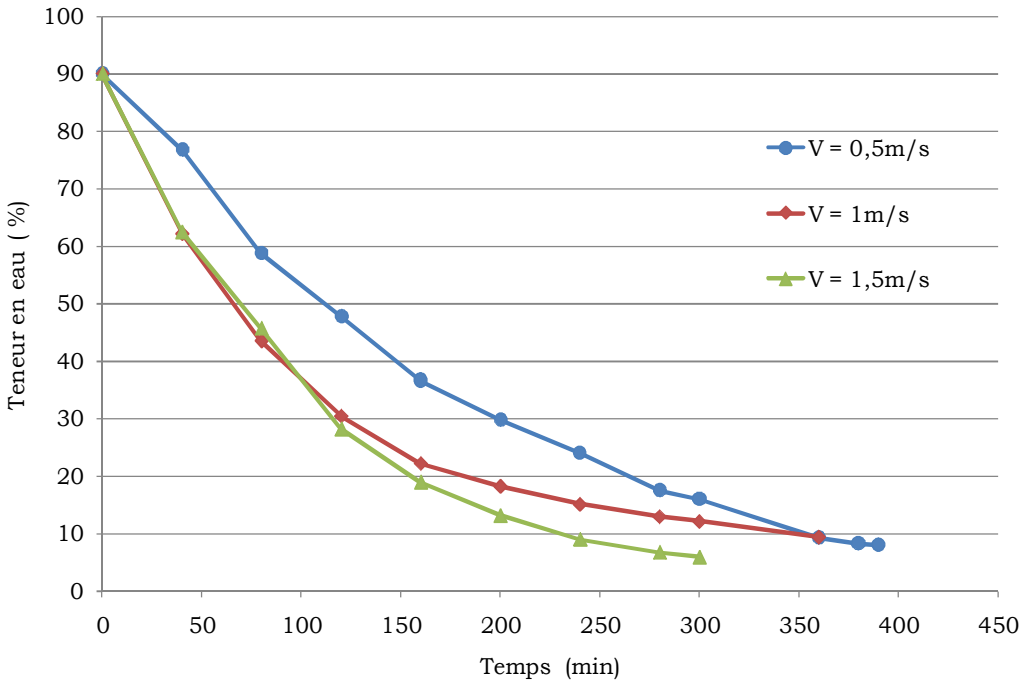

Fig. 3. Influence de la vitesse de l'air sur l'évolution de la teneur en eau à T= 50°C

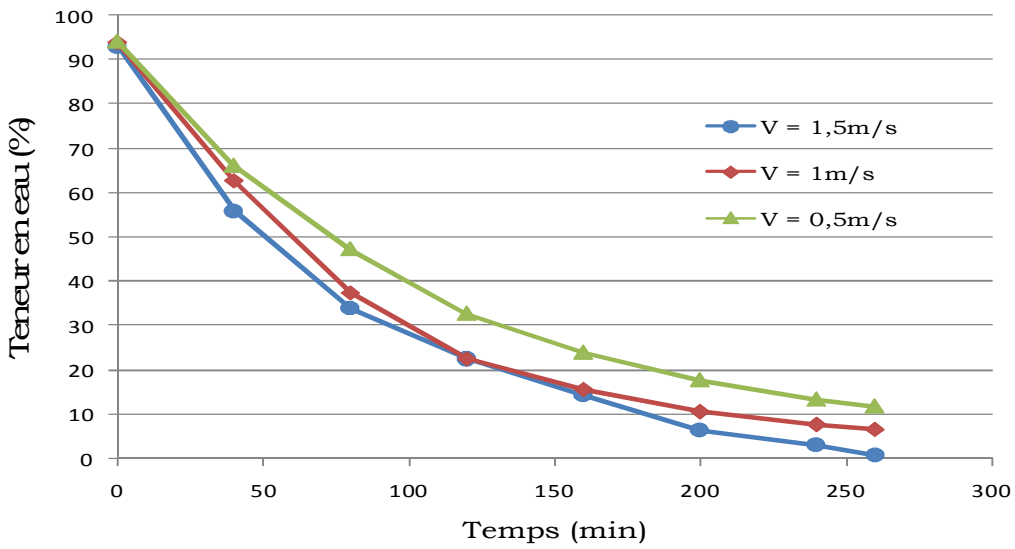

Fig. 4. Influence de la vitesse de l'air sur l'évolution de la teneur en eau à T=55°C

L'on voit que pour des vitesses de l'air de 0,5 ; 1 et 1,5 m/s, les temps de séchage respectif, sont de 650, 500 et 490 minutes (fig. 2), de 350, 345 et 220 minutes (fig. 3) et de 270, 200 et 170 minutes (fig. 4). Considérant la teneur résiduelle en eau de 10 % [2], l'augmentation de la vitesse de l'air séchant n'a d'influence significative que pour le passage de 0,5 à 1 m/s où l'on gagne 150 minutes soit 30% du temps de séchage (fig. 2), de 1 à 1,5 m/s où l'on gagne 125 minutes soit 36% du temps de séchage (fig. 3) et 30 minutes, soit 15 % du temps de séchage (fig. 4).

Le temps de séchage des échantillons diminue avec l'élévation de température. Augmenter la température de 45 à 50°C permet de réduire ce temps de 300, 165 et 270 minutes en valeurs absolues et 46 % ; 33 % et 55 % en valeurs relatives pour des consignes de vitesse de 0,5 ; 1 et 1,5m/s respectivement. Augmenter la température de 50 à 55°C permet de réduire ce temps de 80, 145 et 50 minutes en valeurs absolues et 42 % ; 42 % et 23 % en valeurs relatives pour des consignes de vitesse de 0,5 ; 1 et 1,5m/s respectivement. Au terme de cette première partie, des résultats portant sur l'influence des paramètres sur l'évolution de la teneur en eau des échantillons, il ressort que le couple 55°C - 1m/s est le plus intéressant car il conduit à une texture acceptable pour la teneur en eau finale recommandée. Il induit aussi un temps de séchage de 260 minutes. Travailler avec une température et/ou une vitesse plus faible conduit à un temps de séchage plus long et onéreux. Choisir une température et/ou une vitesse plus élevée conduit au phénomène de croutage. Le tableau 1 suivant récapitule ces résultats.

Tableau 1. Récapitulatif des résultats

Température (°C)	Vitesse (m/s)	Temps de séchage (min)	Observation
45	0,5	650	
	1	500	
	1,5	490	
50	0,5	350	
	1	345	
	1,5	220	
55	0,5	270	
	1	200	
	1,5	170	Croûtage

En dehors du triplet (55°C, 1m/s, 170 min) qui confère un produit de qualité non acceptable, on remarque que le temps le plus court, et pour lequel la qualité du produit est acceptable est 200 minutes. C'est le temps optimal pour ces essais.

3.2 EXPRESSION DES MODELES DE SECHAGE

3.2.1 TEMPS DE SECHAGE

Dans la littérature, plusieurs modèles sont utilisés pour approcher les données expérimentales [5]. Les modèles ci-dessous expriment le profil de temps de séchage, obtenu durant les essais. Ces modèles sont valables pour le séchage dans les plages limites des variables fixées et, applicables à cet équipement uniquement, sous réserve des essais concluant sur d'autres équipements.

Tableau 2. Matrice de calcul des effets

N° de l'essai	Moyenne	Température (°C)	Vitesse (m/s)	Interaction Température-Vitesse	Temps de séchage (mn)
1	+ 1	– 1	– 1	+ 1	Y_1 = 650
2	+ 1	+ 1	– 1	– 1	Y_2 = 270
3	+ 1	– 1	+ 1	– 1	Y_3 = 490
4	+ 1	+ 1	+ 1	+ 1	Y_4 = 170
Effets et Interaction	395	-700	-260	60	
Niveau -	45 °C	0,5 m/s			
Niveau +	55 °C	1,5 m/s			

A partir des données issues de ce tableau, nous exprimons le temps de séchage ainsi qu'il suit :

$$Y = 395 - 700T - 260V + 60T*V \quad (1)$$

Dans ce modèle

- Y est le temps de séchage (teneur en eau finale de 10%) ;
- T est la température comprise entre 45 et 55°C ;
- V est la vitesse de l'air comprise entre 0,5 et 1,5 m/s.

3.2.2 TENEUR EN EAU

Parmi les modèles existant dans la littérature, le modèle exponentiel de [6], a été retenu pour rendre compte de l'évolution de la teneur en eau du produit pendant le séchage.

$$\Phi = \mathrm{A}\exp(-\mathrm{Kt}) \quad (2)$$

- Φ : la teneur en eau du produit ;
- A: coefficient d'adéquation du modèle ;
- K (min^{-1}): facteur de décroissance "decay factor" de l'exponentiel.

Nous obtenons les valeurs et expressions suivantes des coefficients à l'aide du logiciel STAT GRAPHIC

Tableau 3. Coefficients du modèle mathématique

	A	K	R^2
Couple (55°C ; 1m/s)	0,9	0,0109	0,5

Le modèle de perte en eau est donc :

$$\Phi = 0,9*\exp(0,0109\ t) \quad (3)$$

Comme on peut le constater, le modèle ainsi obtenu rend compte du comportement du produit avec un carré de corrélation ($R^2 \leq 0,5$) assez intéressant.

Ceci veut dire que les courbes de perte en eau exprimées ci-dessus (courbes théoriques) décrivent au mieux et dans le temps le comportement du produit lors du séchage. On observe une différence maximale absolue au carré de 0,5 entre les valeurs que donnent les modèles et les valeurs réelles (obtenues lors des essais).

4 CONCLUSION

Au vue des travaux menés, il ressort que les paramètres non adéquats conduisent bien évidemment à un séchage, mais aussi à un temps de séchage plus long et donc à une consommation excessive de l'énergie électrique. Or, avec les paramètres adéquats, on diminue considérablement la consommation d'énergie. Lorsque toutes les conditions sus citées sont atteintes, il en découle naturellement l'idée de modélisation des cinétiques tant de la perte en eau, que du temps de séchage. Ceci, dans le but d'une éventuelle interpolation et/ou extrapolation.

NOMENCLATURE

Symbole	Désignation	Unité
t	Temps	min
V	Vitesse	m/s
T	Température	°C
H	Hauteur	m
L	Longueur	m
l	Largeur	m

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Importance of the *Meskat* system and its landscape insertion through the olive groves of Sousse Region (Tunisian Sahel)

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ABSTRACT: The present work aims to study the importance of the hydrological *Meskat* system and its landscape insertion through the olive groves of Sousse region. The inventory of the anti-erosion works reveals that the management of watersheds by the *Meskat* system was performed on approximately 44 000 ha, so, 40.5% of the supported area of the region by the erosion control structures (108 500 ha). This is an architectural and hydraulic heritage with a good quality rural landscape. This work aims to minimize the soil losses, to capture the surface runoff, to increase the soil fertility and to improve the crop yields.

The current landscape of *Meskats* is an old as well as a current farmer's work. There is a richness conceded by the ancestors to their descendants. But this heritage is, in some cases, badly preserved. It should be noted that if, in the past, olive-tree left to the reconquest of the lowest parts of the hills to take advantage of the runoff, in the present, the urban population is looking for a natural landscape, is leaving to the reconquest of the hills (impluviums) to enjoy a world of pleasant views over the surrounding agricultural landscape, which risk the peril. However, the *Meskat* system remains the essential component of the territory organization, of the olive oil production and of the suburban and rural landscapes in Tunisian Sahel.

KEYWORDS: *Meskat* system, olive groves, rain mode, landscape insertion, Tunisian Sahel.

1 INTRODUCTION

Since the independence, several techniques of water and soil conservation have been adopted in Tunisia to meet a rational and sustainable use of natural resources. Thus, the erosion control work was inherited from the expertise of the different succeeded civilizations in the country [1]. Moreover, Tunisia is very rich with traditional anti-erosion structures characterized a geographical dispersion and a big decentralization. Furthermore, these erosion control works are influenced by many climatic, pedological and topographic factors. The Meskat symbolizes the ancestral system of the Sahel, characterized by an annual rainfall ranging from 200 to 350 mm [2].

Meskat system is widespread in the region of Sousse. This region is characterized by low slopes relief, by hilly areas in the South and mountainous areas constituting the typical hillsides in the North of the region. Based on these characteristics and on the pedoclimatic conditions, this area is known by a culture diversification and landscapes that have sustained the development of tourism. The soil occupation is dominated by the presence of the olive groves characterized by their economic wealth and landscape beauty. The olive-trees, planted in rain mode, use the agriculture conservation based on the collection of the surface runoff [3]. Hilly areas behave like impluviums for olive groves situated at a lower level. However, the arid climate and the water scarcity accentuate the fragility of the natural environment. Indeed, the Meskat system

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participates efficiently to guarantee a satisfactory production of olive groves. This work presents the mains characteristics of the Meskat and reveals its distribution and its integration into the landscape through the olive groves in Sousse region.

2 CHARACTERIZATION AND MESKAT SYSTEM DISTRIBUTION

2.1 SPECIFICATION

The hydrological Meskat system is considered as an ancient technique in Tunisia, which had a large extension from the Roman era. It is a soil and water conservation work adopted in semi-arid regions, mainly the Sahel of Tunisia. The Meskat represents a catchment structure of rainwater for fruit trees and mainly for olive groves.

2.2 COMPONENTS AND OPERATING PRINCIPLE

The components of the *Meskat* system from the upstream to the downstream, are: (i) the catchment area or «*Meskat*» or «*H'mada*» which represents the hilly area that, often encrusted, not cultivated and characterized by the dominance of the limestone layer, the development of spontaneous plants (Artemisia, Rosemary, Halfa, etc.) and the existence of old structures such as «*Fesguias*» or «*Majels*» to conserve the surface runoff, (ii) the furrow which are designed to conduct water from upstream to downstream, (iii) the dispatchers which are the embankments built in parallel between the catchment area and the plantations, (iv) the «*mankâas*» or compartments that symbolize the downstream part of the *Meskat'* system (they are planted with olive trees and other crops), (v) the «*tabias»* which are mounds of soil and low-rise bordering the *mankâas,* and (vi) the «*manfes»* or the «*majref*», are located at the extremity of the *tabia*, and allowed the water flow between the compartments (Fig. 1 and Fig. 2).

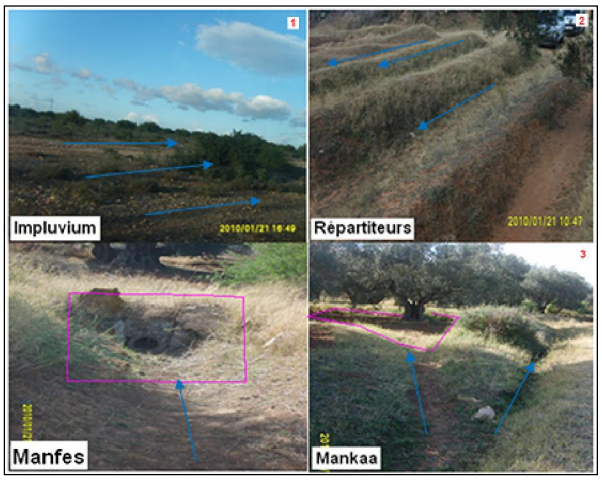

Fig. 1. Some illustrations of the components of the Meskat system

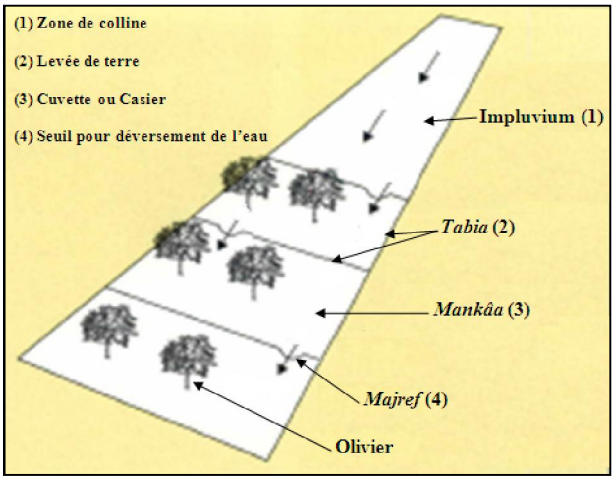

Fig. 2. Constitution and operating of the Meskat system

The operating principle of the Meskat system (Figure 2) consists on the exploitation of the hills area to capture rainwater which will be transported and subsequently directed through channels to be distributed by dispatchers, to mankâas. These later are planted with olive trees in the valleys. The water passes from locker to another through the «majref» [3].

2.3 IMPACT OF THE MESKAT SYSTEM

The Meskat system plays, first, an important role to struggle against erosion by water and soil retention. In addition, Meskats are excellent structures to correct the stabilization and soil balance slope [4]. Moreover, this system allows the improvement of soil fertility ([5], [6]) and the increase of agricultural production. The role of the Meskat did not stopped at this stage, since it can also recharge the ground water and decrease the stream flow.

2.4 LOCATION AND OCCUPATION OF MESKAT SYSTEM IN SOUSSE REGION

The area occupied by the Meskat system is about 44 000 ha, so 40.5% of the area supported by the anti-erosion structures (about 108 500 ha). M'Saken region represents the most managed area (61%), followed by 30% of the area of Kalâa Kébira (Table 1).

Table 1. Distribution of Meskat system in Sousse region [7]

Zone	Area (ha)	%
Bou Ficha	0	0.0
Kalâa Kébira	13 246	30.3
Kalâa Sghira	1 133	2.6
Enfidha	0	0.0
Sidi Bou Ali	1 512	3.5
Kondar	0	0.0
Sidi El Hani	0	0.0
M'Saken	26 520	60.6
Akouda	1 181	2.7
Hammam Sousse	101	0.2
Hergla	0	0.0
Sousse Riadh	68	0.1
Total	43 761	100.0

3 LANDSCAPE INTEGRATION OF *MESKAT* SYSTEM THROUGH THE OLIVE GROVES OF SOUSSE

3.1 HARMONIOUS LANDSCAPE VIEW

Water, soil and topography are elements that enroll the landscape by determining the spaces organization and agricultural activities. Regardless their scale, open agricultural areas participated in urban and architectural heritage setting. The developed areas by a *Meskat* system reveal the particularity of a mosaic ecosystems (Fig. 3), where coexist a harmonious panorama of natural cultivated and uncultivated and semi-natural areas (roads, ditches, channels, etc.). Areas of the extreme west of Sousse region are characterized by the presence of field and feed crops in hillsides and olive groves in *mankâas*. In addition, farmers in these areas are installing annual crops between lines. The coastal zone, with lower slope (3%) and sandy soils, will split into two almost juxtaposed areas following the coastline, one in the east of the spreading with nodules and in which wells familial irrigated areas were created and the other in the east in contact with the sea, favorable for vegetable crops (for example the region of Chott Meriem). This particular landscape composition has a strong impact on plant biodiversity. The habitat is so fragmented and influenced by human activities related to agriculture, which largely pleased eco-tourists.

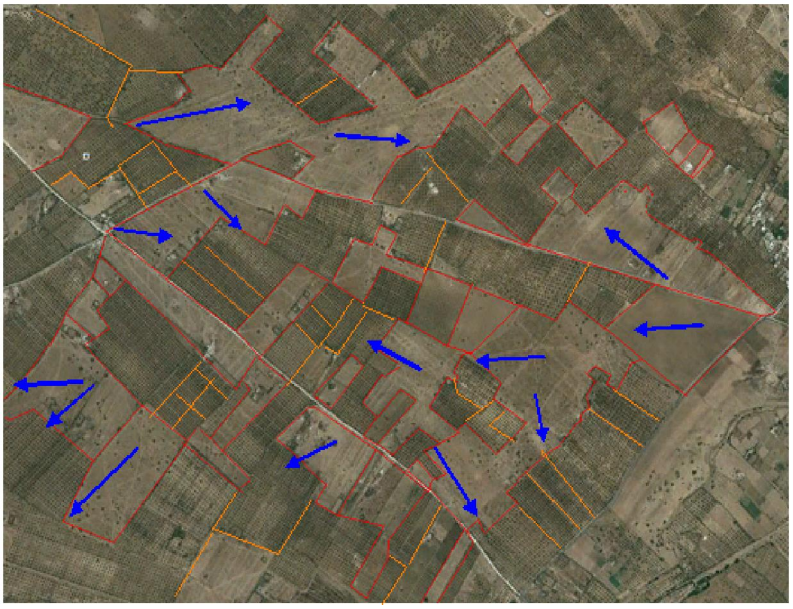

Fig. 3. Over view of Meskats and their landscape integration

3.2 CONSTRAINTS OF THE AREAS PLANNED BY THE *MESKAT* SYSTEM

The population explosion and urbanization are the major constraints imposed to *Meskat* system [8]. Indeed, according to studies of the Center of Research in Agricultural Engineering (CRAE, Tunisia) and the Institute of Agricultural Engineering in Lausanne (Switzerland), accomplished in 1975 and 1982, the use of mechanical tools for tillage instead of animals makes the access to plots difficult (basins) and force farmers to destroy some *tabias* located between the basins. In addition, maintenance operations which are a prerequisite for the success of the work are increasingly weakened by the increasing number of owners by inheritance.

The movement of rural decline in the downstream parts of watersheds, resulting in land abandonment and therefore the lack of maintenance as well as of tillage, was the cause of soil compaction, *tabias* clogging, these separating basins, and the appearance of erosion manifestations. This phenomenon is the result of the importance of surface runoff during special hydrological events (floods). The consequence of this situation is a general decrease of productivity of olive groves managed by *meskats* systems and a renunciation for maintenance of these systems, which led to a resumption of streams runoff which have never flooded before [2]. This situation is now more pronounced.

4 CONCLUSION

The *Meskat* system is a specific example of the traditional water and soil conservation work that collects rainwater for olive cultivation in semi-arid regions (Tunisian Sahel). Therefore, it succeeds in improving soil fertility, in increasing production and in developing the tree carpenter. Topography and land use diffuse a typical landscape in a mosaic form, thus justifying the landscape harmonious integration of *meskats* through olive groves and offering a good quality rural landscape.

The proper operation of *Meskat* system is guaranteed by maintenance and preservation of this ancestral system. Nevertheless, abandonment and overexploitation had neutralized gradually the importance of the system. In addition, periurban *meskats* are threatened by urbanization. This phenomenon intensified the degradation of land managed by the *Meskat* system, and therefore, the decline of olive groves and hills occupation by the buildings so that residents enjoy a variety of existing landscapes. Ultimately, the rational use of *meskats* is of a great importance for a sustainable development, taking into account water issues as part of life in sustainable landscapes.

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Effect of temperature and residence time of calcination phosphate on the chemical reactivity: Application to the case of Bouchane phosphate (Morocco)

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El Jadida, Morocco

ABSTRACT: The calcination of phosphate consumes the fossil energy and generates greenhouse gas emissions. This later owed not only on the consumption of these energies, but also in the decomposition of carbonates and in the combustion of the organic matter. The energy consumption and the emission of gases require an optimization of the calcination depending on the residence time and temperature of calcination. These walking parameters influence the chemical reactivity and the solubility of finished product. To assist in that, we have studied the evolution of the main components of the control in the calcination (C_{org}, CO_2, P_2O_5, CaO), the specific surface area and density of the ore according to the time and temperature. This treatment was performed in the laboratory in a fixed bed. The different analytical techniques that were applied are: sieve analysis, quantitative study by ICP, the mineralogical characterization by X-ray and differential thermal analysis coupled with thermogravimetric analysis. The obtained results show that mechanisms relative to the heat treatment of the phosphate are multiple and are strongly influenced by the nature of the matrix and the parameters of the treatment. The obtained product answers well the trade profiles and the requirements for use under the conditions of a temperature approximately of 800°C and a period of 30 minutes. In these conditions, we note a decrease of 89.29% organic carbon and carbon dioxide of 72.72% with the increase in weight of Bone Phosphate Lime to 12.63%. However, the chemical reactivity and the solubility are affected.

KEYWORDS: Physical properties, Phosphate, Impurities, Optimization, Calcination, Energy.

1 INTRODUCTION

1.1 THE EFFECT OF CARBONATE SUBSTITUTION ON THE PHYSICOCHEMICAL PROPERTIES OF PHOSPHATES

The sedimentary phosphates are granular materials and are more commercialized than 90%, they present themselves with physico-chemical properties and crystallographic varied due to geological conditions and alterations after-deposit. They are mainly composed of the group of apatite in liaison n with other accessory minerals and impurities [1] - [5]. These sediments are represented mainly by the poles fluorapatite-hydroxylated [$Ca_{10}(PO_4)_6(OH, F)_2$] and / or carbonated fluorapatite (francolites) [$Ca_{10}(PO_4)_{6-x}(CO_3, F)_x(OH, F)_2$] where x is generally about "1" [1]. They admit a large number of substitutions (impurities) at contents sometimes high that can modify strongly their physic-chemical properties. They allow the incorporation of a large number of elements in the crystal structure. The replacement of certain groupings by others in the apatitic network is accompanied generally with a variation of the crystallographic parameters according to the volume of the substituted groupings [1], [5], [6]. At the atomic scale, either by creating gaps and / or for reasons of steric hindrance, ionic substitutions changing the parameters of the mesh the apatite structure. A larger scale, the substitutions generate, in general, the variations in crystallinity, of thermal stability and solubility [4]. Particularly, the Francolites having one significant substitution of carbonates are very reactive. They are metastable with respect to fluorapatite and can be systematically altered by the combined effects of leaching, the metamorphism and the time. The francolites is different from fluorapatites by their chemical compositions [3]. Being porous, they offer a larger surface area and therefore a high solubility and high

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chemical reactivity [2], [3]. We note that, the CO_2 content in francolites with excess fluoride varies by geological ages. Indeed, old layers the francolites usually contain a limited amount of carbonate substitution while younger layers may have compositions that include the model francolite.

The chemical reactivity is a principal parameter during the attack phosphate or in its direct use. In neutral ammonium citrate, the solubility of francolites having a maximum of substitution CO_3^{2-} (For CaO/P_2O_5 = 1.67 the solubility is about 7 % the P_2O_5). This value declines with decrease of the carbonate substitution up to approximately 1 à 2 % du P_2O_5. For the francolites having very low carbonate substitution (CaO/P_2O_5 = 1.33), this property is the same as in magmatic apatite. We note that, the Moroccan phosphates have a value that varies between 4.5 à 7 %. It appears that, the chemical reactivity of francolites increases with decreasing crystallographic parameter "a" and the growth degree of substitution carbonate. It is reported here that, carbonates bound only with apatite which determine the solubility of francolites. Contrariwise, the free carbonates affect the dissolution of phosphate rock because they are more soluble than the latter. The presence of carbonates in significant quantities may cancel the solubility of phosphate [6]. Thereby, other impurities also affect the reactivity [3]. Consequently, the rate of impurities determine the issues and laws of development of rock phosphates.

1.2 THE IMPURITIES OF PHOSPHATES AND THESE EFFECTS

The deposits of high-quality of natural phosphates are depleted day by day in the world. While the present sources are derived from sources grade containing various impurities. These impurities are sometimes well separated (exogangue) or intimately mixed with ore (endogangue), the levels of these impurities vary widely amongst the sources of phosphate rock in the same deposit and according to conditions of sedimentation [7]. They include, in various combinations and concentrations, the organic matter, the quartz, clay minerals, carbonates, radioactive elements and metal oxides.... Indeed, the organic material is a constituent characteristic of sedimentary phosphates, it presents in association with minerals (clay or carbonate) [8]. The carbonates are mainly represented by calcite, the dolomite, the iron and ankerite, therefore they introduce calcium (Ca), Iron (Fe) and Strontium (Sr) as main impurities in the crystal structure [8]. Moreover, the quartz can occur as detrital grains or as microcrystalline varieties. The other silicates may include feldspars and micas (biotite and muscovite). The content of silica will depend mainly on the proportion of quartz and detrital minerals or neoformed clays (muscovite, illite, kaolinite, montmorillonite ...) during the diagenesis. The quartz may represent a significant proportion of the phosphate matrix. Among other, zeolites, including clinoptilolite and heulandite are occasionally found [2], [3], [8], [9].

The natural phosphates also contain dangerous elements including heavy metals, such as cadmium (Cd), chromium (Cr), mercury (Hg) and lead (Pb). And the radioactive elements such as uranium (U), which comes in different forms oxides, more or less in radioactive equilibrium with its descendants, the uranium values so highly dependent on the intensity of reducing conditions. It is noted that, the organic matter may be responsible for high contents of uranium, arsenic (As) and barium (Ba), and much less lead (Pb), cadmium (Cd) and zinc (Zn) [10].

All impurities, as well as major trace, manifest adverse effects during the various stages of processing of phosphates in its derivatives as well as on the direct use [11]; [12]. In the industrial sector, the organic matter poses serious problems. It is very strong, on the slow kinetics of the crystallization of dihydrate crystals. It also affects the shape of the hemihydrate crystals that have a direct role on the filterability and permeability of phosphoric acid during its separation from the phosphogypsum [11] - [13]. Indeed, the organic matter results in the formation of foams disadvantage cooling the reaction of the attack phosphate with sulfuric acid (exothermic reaction). Thus, the temperature and viscosity of the slurry increases, which leads to the formation of hemi-hydrate phosphogypsum.

In addition, the presence of organic compounds constitutes a disturbing element [11] - [14]:

- They reduce sulfates to sulfides and subsequently results in severe corrosion of reactors [15], [16].
- They also contaminate the finished product giving black color with phosphoric acid varies from bright green to dark green [15].
- They significantly impede the recovery of heavy metals, during extraction interacting with organic solvents to form stable emulsions and / or the drosses in organo-aqueous interface.
- They have a negative effect on the storage business phosphoric acid [11].

The clays occupy an important place among the minerals associated with phosphates. Their impact on the treatment and recovery of phosphate ores are also present, they affect the filterability and product quality acid [15]. Thus, they generate dirt along the transformation process.

In addition, the components MgO, Al_2O_3, Fe_2O_3 and F affect the chemical quality of the product phosphoric acid and

change its physical characteristics, in particular its viscosity and density. They are also generating trouble when the concentration of the acid (sludge formation), its storage and its shipping (post-precipitation). Thus, fluorine is considered a depressant the reactivity. While calcium and free carbonates reduce the solubility of phosphate [12].

For heavy metals, such as cadmium (Cd), which is probably the most sought after because of its potentially high toxicity to human health. It can be contained in foods that come from phosphate fertilizer containing a quantity of cadmium than the norm. In addition, there are chromium (Cr), mercury (Hg) and lead (Pb). These metals can change shape and thereby become more or less mobile [17], [18]. They have no positive biological activity. Moreover, their life is infinite. Two factors increasing the severity of metal pollutants. On one hand, they are not biodegradable, and secondly, they accumulate in the environment and in particular in sediments by partnering with organic and inorganic materials by the interplay of adsorption phenomena, the complexation and the chemical combinations [19], [20]. Thus we find in phosphates radioactive elements, which are considered as toxic to humans and animals [10], [11].

Therefore, impurities have no economic interest and are, on the contrary, a lower value for the commercial product. The enrichment of phosphate therefore appears as a significant step, to essentially get rid of at least a large part of these drawbacks.

1.3 THE CALCINATION OF PHOSPHATES

The sediment phosphates may suffer, depending on the impurities, to mechanical and / or thermal operations enrichment, such as: crushing, screening, washing, screening, drying, calcination, magnetic separation, flotation and dry beneficiation. These operations have been studied by many authors that are cited by A. Bendada [11]. The contents of impurities and BPL (BPL: Bone Phosphate Lime) are correlated with each other. That is why depending on the content of BPL four categories are distinguished of phosphates: extra low content (ELC), low content (LC), average content (AC) and high content (HC). The phosphates HC and AC have the levels of BPL = 68% and are considered marketable products, in the case of conventional methods such as washing and drying are used to eliminate, respectively, the moisture and the fine clay fractions. Other separation methods can also use, for example the crushing and screening, to remove the large hard siliceous materials. By against, for phosphates LC and ELC previous few mechanical operations followed by calcination are often used. The aim of the latter is the stabilization of heavy metals, dehydration of humidity adsorption and structural water, the roasting of organic matter, decomposition of carbonates and other volatile compounds in gaseous form or in the form of fine. The calcination is also on the physical properties (composition, grain size, density, porosity, specific surface area, hardness, heat capacity, thermal conductivity ….) [16], [21], [22]. This is often associated with extinction to remove the magnesium, it is used in areas with a low energy cost and limited water resources [2]. The behavior of the ore to the conditions of calcination a direct impact on the course of treatment processes, it conditions the operation of the process and stability. We note that studies of the thermal stability of carbonated apatite converge to the same decomposition scheme of the product with temperature: (i) dehydrating material (humidity and all or part of the water content), (ii) burns of the organic material and (iii) decomposition of the carbonates species [23]. The residence time, the temperature and the physico-chemical properties of the phosphates are the main parameters of the calcination [2], [3]. They have a direct impact on the course of industrial processes and consequently, on overall yield. In addition, the method of calcination is an interesting factor to take into account. In this context, a comparative study of the calcination of phosphate in rotary furnace for 30 minutes, and in flash furnace (Flash) for 4 seconds, was carried out by Blazy. It follows that dynamic flash furnace calcination at 1000 °C gives more interesting than the rotary furnace calcination at 950 °C results, both in terms of the quality of the phosphate washed calcined than at the manufacture of the phosphoric acid [14]. Therefore, the rapidity of temperature rise inside the particles generates water vapor and volatile gas can escape by diffusion. Although most of the chemical and physical transformations affect the thermokinetic phenomena, the residence time in the furnace leads to transformations that cannot be partially closed; changes are kinetically blocked and roasted ore incompletely if the exposure time is very short. In addition, a long service causes of energy waste with the presence of bonding and aggregate formation.

In addition, those aspects of chemical reactions that occur during calcination, have been the studied extensively both theoretically and experimentally [2], [3]. View of the complexity of phosphates, the calcination involves several chemical reactions whose kinetics depends on the operating parameters. We note here that the distribution of heavy metals in the calcined phosphate and volatile gases depends on their vapor pressures. The calcination leads, in general, the emission of organic pollutants. The concentration and the extent of this depend on the initial amount of the behavior and origin of these pollutants in the middle. The most common compounds found are: SO_x, NO_x, N_2O, CO, CO_2 and F. the most metals are concentrated in the more solid than in gases. The vaporization is very low below 700 °C and beyond, even though it is significant, due to their very low concentrations in gases [24] - [26]. So, unlike the organic part, heavy metal phosphates are

only partially destroyed during calcination. The greater part remains in the solid residue and more volatile, in very small quantities, evaporates depending on their property and their speciation [26].

1.4 THE STATES OF MATTER (GROSS, DRY, CALCINED)

The proportion of a certain chemical element material varies depending on the heat treatment. These changes are specific to each material. They are caused from moisture after drying and from the loss to fire the product after calcination.

The mass percentage (P_i) a chemical composition on a dry matter basis wherein the moisture content is zero, taking into account the absence of the volatile during drying, will be obtained with the following formula:

$$P_d = P_c \times \frac{100}{100 - RH} \quad (1)$$

With

P_d : Mass percentage of component "i" in dry matter;

P_c : Mass percentage of component "i" the crude;

RH : Rate of humidity (%).

With losses to fire, is distinguishes between the degradable material with the other non-degradable. In both cases, it will be possible to calculate a simple rule of three, from the characteristics of the dry matter, the percentage by mass of the chemical compositions in the calcined product. This weight ratio is obtained with the following formula:

$$P_{CUD} = \frac{P_d}{100 - pf} \times 100 \quad (2a)$$

$$P_{CD} = P_d \times \frac{fl}{100} \quad (2b)$$

With

P_{CUD} : Mass percentage of component "i" undegradable in the calcined material;

P_{CD} : Mass percentage of component "i" degradable in the calcined material;

fl : Fire losses by %.

From the formulas (1) and (2) one can linking the mass percentage of a component "i" calcined with the crude by the following formulas:

$$P_{CUD} = P_d \times \frac{10^4}{(100 - fl)(100 - RH)} \quad (3a)$$

$$P_{CD} = P_d \times \frac{fl}{100 - RH} \quad (3b)$$

The rate of advancement (X) the chemical constituents of a calcined product is obtained with the following formulas :

$$X_{CUD}(\%) = \frac{P_{CUD} - P_c}{P_c} \times 100 \quad (4a)$$

$$X_{CD}(\%) = \frac{P_{CD} - P_c}{P_c} \times 100 \quad (4b)$$

With

X_{CD} : Rate of advancement of a constituent "i" degradable in the calcined material;

X_{CND} : Rate of advancement of a constituent "i" undegradable in the calcined material.

Using the formulas (3) and (4), the rate of advancement of chemical constituents rate can be expressed by the following formulas:

$$X_{CUD}(\%)=[\frac{10^4}{(100-fl)(100-RH)}-1]\times 100 \quad (5a)$$

$$X_{CD}(\%)=(\frac{fl}{100-RH}-1)\times 100 \quad (5b)$$

In the case of calcination the phosphate, the quantity of volatile chemicals elements decreases, they do not disappear completely, with the additional presence of an amount of adsorption water in the calcined phosphate due to the hygroscopic equilibrium. For against, the amount of minerals remains almost constant even if the relative amount expressed as a percentage mass increases dramatically. For this, it must be taken into account the rate dehydration, the adsorbed moisture and the rate conversion of volatiles.

2 CHARACTERIZATION OF THE BOUCHANE PHOSPHATE

2.1 THE PRINCIPAL PHOSPHATE DEPOSITS IN MOROCCO AND GEOLOGICAL DATA

The deposits of phosphates in Morocco are located in a number of basins in four different geographical areas. It differs from North to South [30] (Figure 1). The Moroccan phosphate sedimentary series contain relatively large amounts of associated minerals [1]. These general properties have been described in several previous studies [2], [8], [27] - [29].

The phosphate test before valuation is an important study of the feasibility of a project. It is therefore necessary, as a first step, to characterize and determine the physicochemical properties of phosphate in the study area.

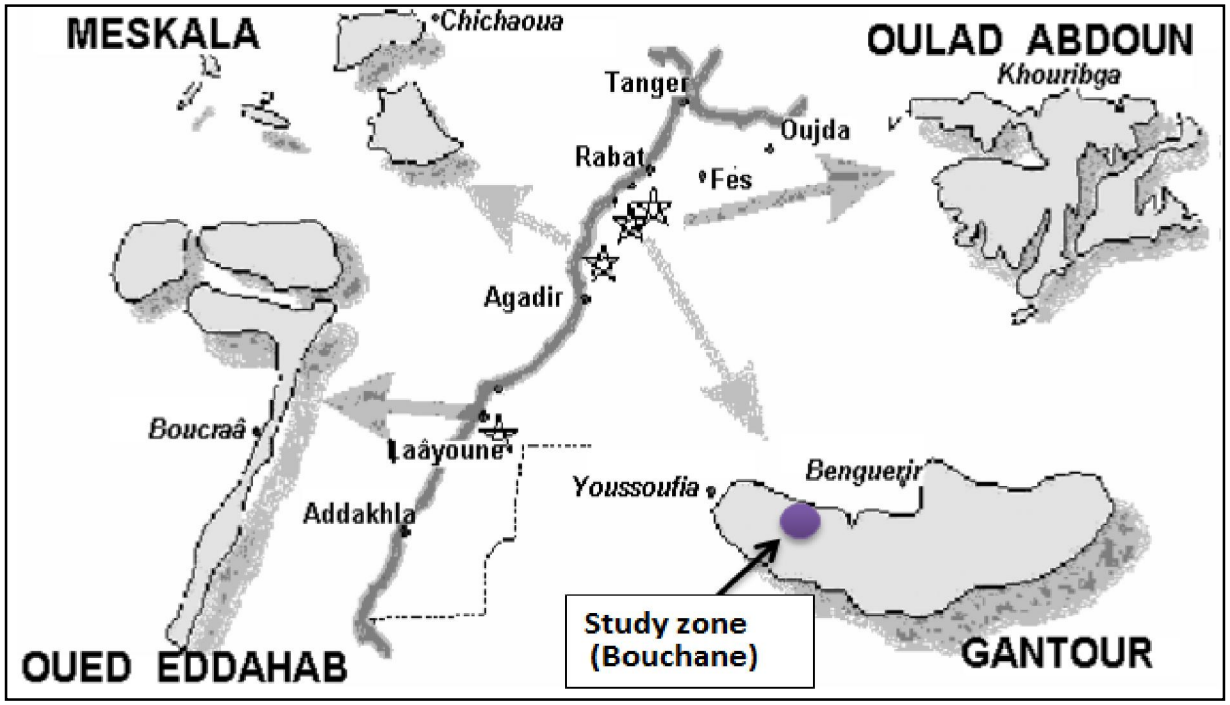

Fig. 1. Card the basins phosphates in Morocco [31].

The phosphate studied comes from the region of Bouchane, field, located 40 km to the east of the city of Youssoufia which is the western part of the deposit basin Gantour (Figure 1). This deposit has large reserves of phosphates. It is the subject of special attention because of the particle size and chemical properties interesting, as the presence of in small quantities, of the organic material and carbonates and abundance of grain phosphate particle size distribution lower and upper. In addition, the operating cost is reduced by the fact that it is carried out in open. The ore of this deposit is currently undergoing a washing enrichment, for eliminating clays, and then it will be transferred to units of heat treatment (drying or calcination).

2.2 PREPARATION OF THE SAMPLES

A series of samples of the phosphate deposit was taken. The total mass is concentrated in the range of 125 to 800µm. In the laboratory, samples were mechanical treatment and brought into contact with the open air in plastic bags before being subjected to analysis (qualitative and quantitative), measurements and thermal treatments. One of the difficulties of phosphates is their heterogeneity, so sampling is an essential step. To have a good statistical representation, a pretreatment of homogenization was carried out according to standard NF X31-101.

2.3 PHYSICAL-CHEMICAL CHARACTERIZATION THE RAW PHOSPHATE OF STUDIED AREA

2.3.1 THE QUANTITATIVE CHEMICAL ANALYSIS

The Bouchane phosphate consists mainly of carbonate fluorapatite, it also contains several other minor elements such as: Si, K, Al, S, Mg, Cd, Cr and Fe [32]. The chemical composition of the sample of phosphate rock, determined by volumetry, is shown in the table below (Table 1).

Table 1. Average chemical composition of the crude phosphate

Elements	weight Percent (%)
P_2O_5	30.39 ± 0.15
CaO	48.20 ± 0.25
CO_2	6.60 ± 0.08
C_{org}	1.40 ± 0.03
H_2O	5.60 ± 0.01
Other	7.81 ± 0.52

With C_{org} : Carbon organic

The analysis by ICP-AES, of a few controllable elements along the recovery process and its phosphate derivative shows that our sample is similar to a rather poor carbonated magnesium phosphate, in silica and metal oxides while the pyrite is not present (Table 2).

Table 2. Chemical compositions of raw phosphate Bouchane determined by ICP – AES

Chemical compositions	Raw phosphate (%)
P_2O_5	31.10
CaO	49.10
F^-	3.50
CO_2	6.50
SiO_2	1.38
H_2O	5.15
Al_2O_3	0.42
K_2O	0.07
MgO	0.65
Na_2O	0.60
SO_3	1.52
Cd	16.21 ppm

Several authors have linked the content of metallic pollutants with organic matter. They advocate the affinity between heavy metals and organic carbon [9], [24], [25], [33]. The result of analysis by ICP - AES shows that the Bouchane crude phosphate contains little of these metals. Therefore we are not interested to study the thermal behavior and stability of these metals in this paper.

2.3.2 DIMENSIONAL RANKING

The particle size distribution of our phosphate was performed by manual sieving dry with a series of screens Canvas Nylon mesh with round holes in geometric progression. The results obtained in Figure 2 showed that the majority is concentrated in the range of 125 to 800µm (close to 87%) [32]. we note that the most phosphorus-rich grain size distribution between 160 and 350 µm [34].

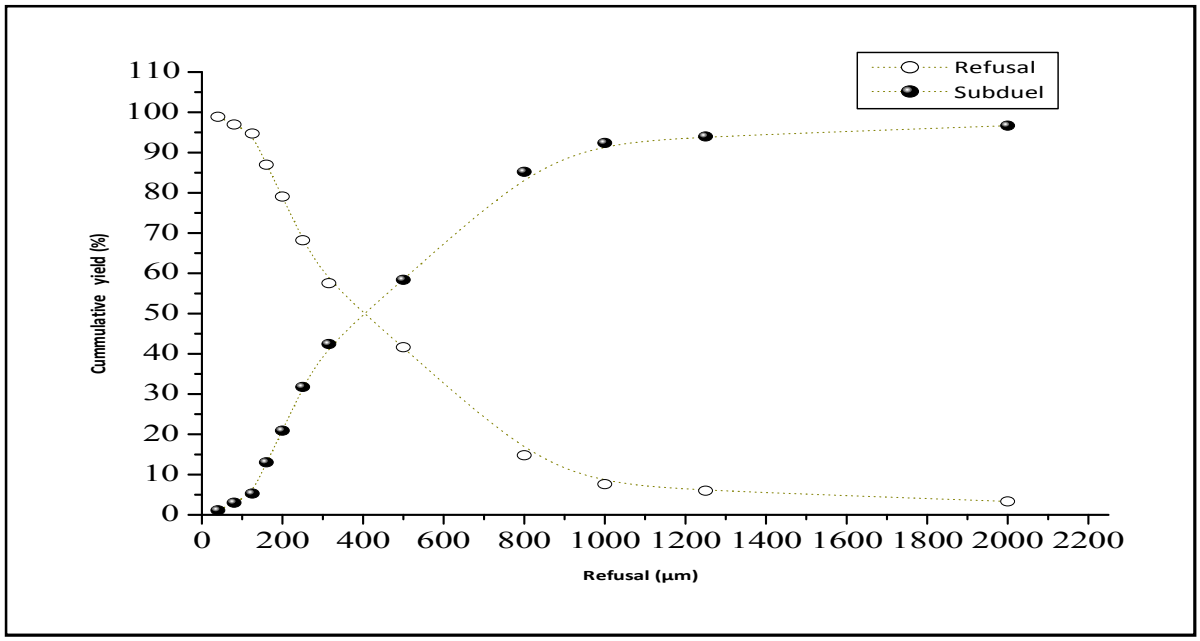

Fig. 2. Ranking dimensional sieving before classification phosphate

In the laboratory, samples of phosphate were subjected to mechanical treatment (grinding, homogenization and quartering) using a hammer mill. We performed successive operations on the refusal mesh than 500 µm and screening of fine fraction less than 40 µm. Thus, one gets the size between 40 µm and 500 µm high in phosphorus [35], [36]. This granulometric distribution is consistent with that used on an industrial scale, especially in transformation methods of phosphates in these derivatives, for a better reactivity. The classification results are shown in figure 3 [32].

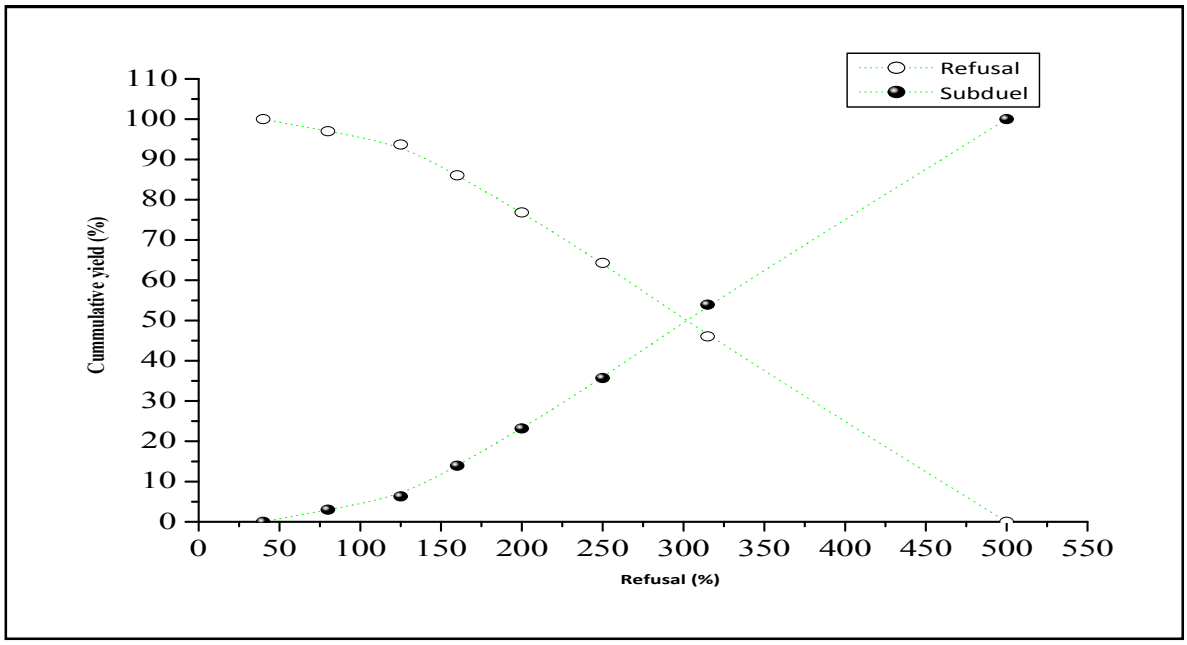

Fig. 3. Ranking dimensional sieving after classification phosphate

2.3.3 THE MINERALOGICAL ANALYSIS OF THE BOUCHANE PHOSPHATE

- ***Thermal analysis:***

The thermal measurements DTA-TGA were performed in air with a heating rate of 10 °C / minute, from room temperature to 1000 ° C on the wafer classified.

The thermal behavior was studied in order to predict the temperature and calcination conditions necessary to obtain a better phosphate. Three successive losses masses have been identified in connection with three temperature ranges respectively assigned, to humidity, water content, organic matter and to decomposition of carbonates [32] and this for a sample of particle size and chemical properties mentioned above (Tables 1 et 2 et Figure 3). The DTA-TGA curve of the studied crude phosphate is shown in figure 4.

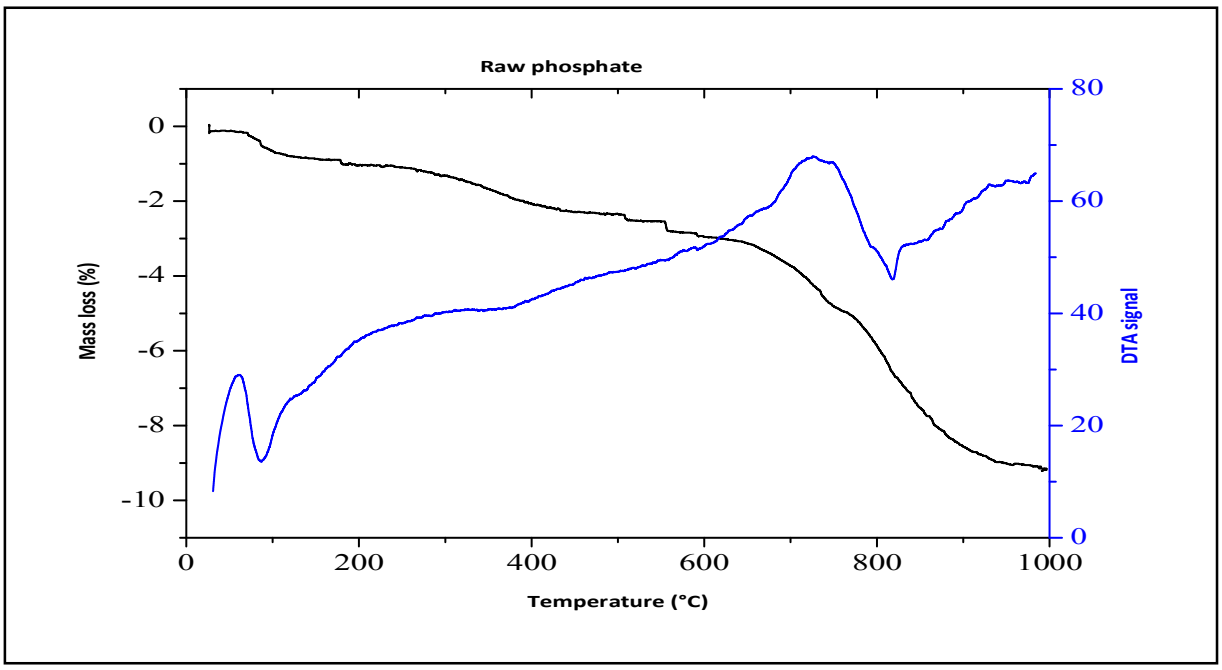

Fig. 4. DTA-TGA curve of a sample of Bouchane crude phosphate

The thermal analysis DTA - TGA shows three main mass losses:

- ✓ The dehydration represented by endothermic peak of low amplitude initially attributed to adsorption water (moisture) and observed at room temperature up to 100 °C (peak at about 80 °C). This step does not change the crystal structure of apatite. It corresponds to physisorbed water from which depends on the value of the gross surface area of the phosphate, the partial pressure of water vapor and handling conditions. The rate of humidity level of the sample used is of the order of 1%.
- ✓ The second low mass loss (2 at 3%) starts around 200 ° C and which lasts up to 550 °C. The result, certainly and simultaneously, from the superposition of an endothermic reaction (from structural water) and an exothermic reaction (combustion of organic matter). We note here that the decomposition temperature depends on the raw phosphate, the experimental conditions and the partial pressure of the volatile.
- ✓ The third mass loss starts from 550 °C. It is due to continuity in the field of low exothermicity, visible and might originate from the combustion of the residual organic material and an area of strong endothermic reflecting the decomposition of carbonates (calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$)) with release of CO_2. Thus, there is a sharp increase in the rate of mass loss between 700 and 900 °C which is due to the increase in the thermal decomposition kinetics of calcite. In addition, there is a uniform exothermicity is due to recrystallization phenomena and sintering [37]. Let us note that 1000 °C, the total mass loss is about 9.2%. This value differs between Moroccan minerals according to the level of impurities [23].

- ***Characterization by X-ray diffraction (XRD):***

The X-ray diffraction was performed using a diffractometer XPRT MPD Panalytical - Philips in copper anticathode ($\lambda_{CuK\alpha}$ = 15.405 nm) at ambient temperature (Figure 5).

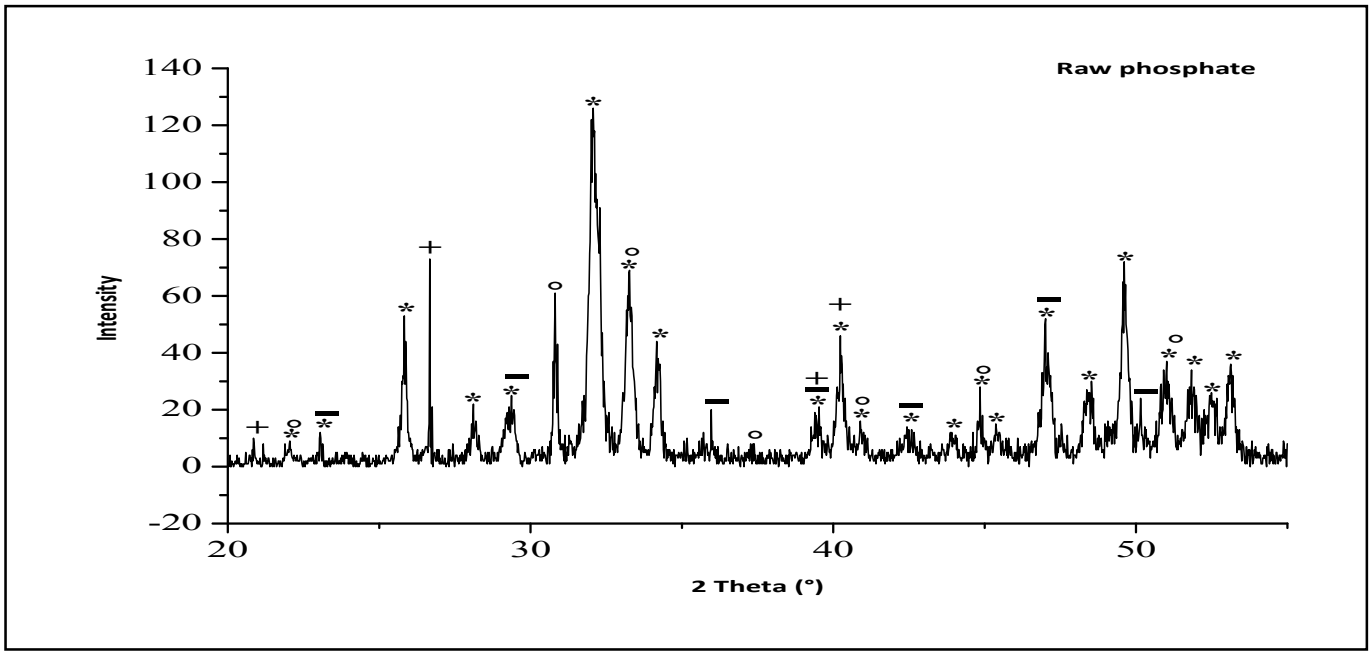

Fig. 5. RX diffractogram of a sample of the crude phosphate (*: Fluorapatite, +: Quartz, x: Calcite, °: Dolomite)

The diffractogram reveals the presence of the following phases: fluorapatite $Ca_{10}(PO_4)_6F_2$ (2θ : 32.2°; 49.8°; 25.8 ; 34.33 ; 53 ; 51.8 ; 48.4; 49.6 ; 28.2 ; 52.2°), quartz SiO_2 (2θ: 26.587 ; 50.1 ; 20.885°) and carbonates which are in the form of dolomite $CaMg(CO_3)_2$ (2θ : 30.9 ; 37.1°) and calcite $CaCO_3$ (2θ : 36.041°) (Figure 5). It appears that the recorded dolomite, calcite and quartz phases due to their nature exogangue, while the interference of these phases with fluorapatite are due to their natural endogangue. They constitute the francolite. These overlaps can be removed, to a certain percentage, during heat processing by calcination [32]. We also note a good peak resolution X-ray diffraction, which reflects indicates a certain level of crystallinity of the phosphate. Thus, the similar diffractograms RX has been identified for other Moroccan phosphate especially those deposits Khouribga [38] and Youssoufia [39], [40].

3 BEHAVIOR OF THE MAIN CONSTITUENTS OF CONTROL

The behavior of the main components of control (C_{org}, CO_2, P_2O_5 et CaO) during calcination was carried out by following the evolution of their weight percentages as a function of time and a function of the temperature. With the aim of determine the optimum conditions for the calcination without affecting the enrichment [32], [41].

3.1 EXPERIMENTAL PROCEDURES

The tests were carried out on samples of classified phosphate of particle size of between 40 and 500 μm. each one of these samples, the mass of about 200 grams, was placed in a vertical cylindrical enclosure in stainless steel, then in an adjustable electric furnace. The experimental procedure is as follows:

- ***Protocol "1" :*** Study of the calcination temperature by introducing into the furnace at 600 °C, samples. Sampling, at different temperatures (T_1 = 650 °C; T_2 = 700 °C; T_3 = 750 °C; T_4 = 800 °C; T_5 = 850 °C and T_6 = 900 °C), of a sample to submit to chemical analysis.

- ***Protocol "2" :*** The tests were performed on the same source of phosphate. We studied the residence time of calcination by proceeding in two ways:

a- First procedure (calcination in crucibles): Introduction of eight samples in crucibles in the furnace at a fixed temperature. Sampling, every five minutes, a sample for analysis of the main components of control (C_{org}, CO_2, P_2O_5 et CaO). The temperature range is 600 to 900 °C for 40 minutes.

b- Second procedure (calcination in the fixed bed): Before introducing the fixed bed, including the sample, in the electric furnace adjustable by temperature, the latter are fixed each time to a fixed value (T_1 = 600 °C; T_2 = 650 °C; T_3 = 700 °C; T_4 = 750 °C; T_5 = 800 °C; T_6 = 850 °C and T_7 = 900 °C). Sampling, a function of time, of a sample for analyzing constituents of the principal control (C_{org}, CO_2, P_2O_5 and CaO). The interval time is explored from 0 to 40 minutes.

Before all analyzes, The calcined product was cooled under the conditions of room temperature and atmospheric pressure, and submitted to extinction, by injecting air, and sieving to remove the volatile material and the adsorbed fraction with particle size bottom at 40 mm, low phosphorus [34], [36].

3.2 RESULTS AND INTERPRETATIONS

- ***Study of the calcination temperature:***

The experimental protocol "1", described above, allowed us to study the variation of the composition of C_{org}, CO_2, P_2O_5 and CaO depending on the temperature. The results of chemical analyzes are shown in figures 6a, b, c and d.

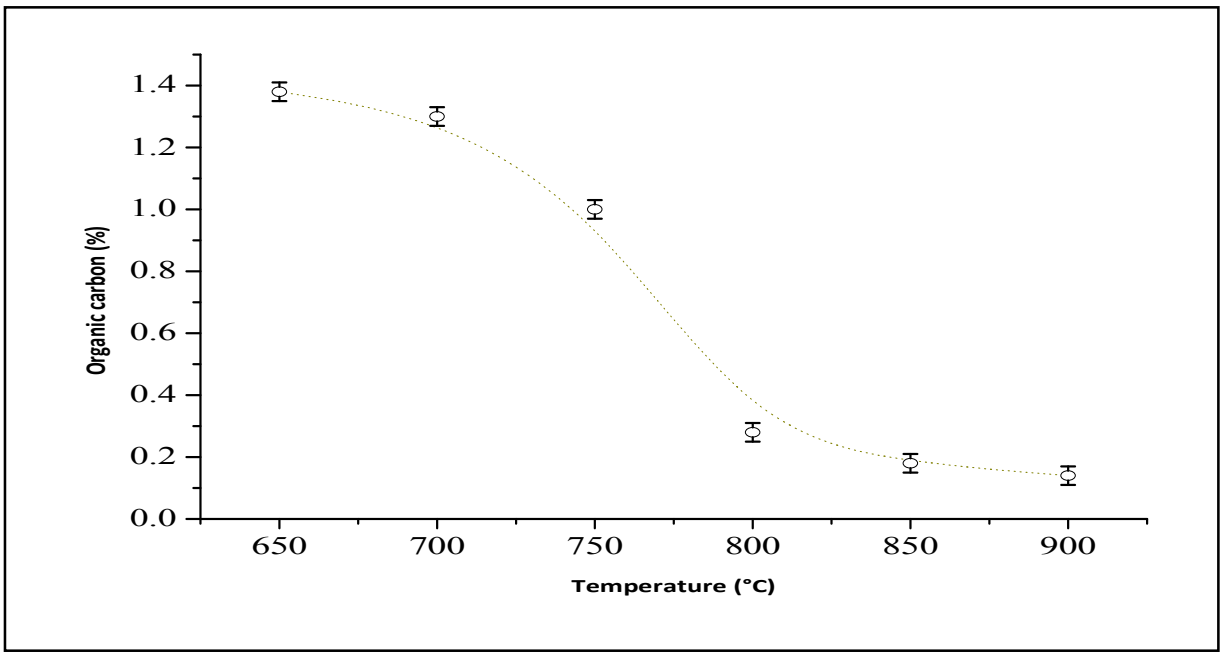

Fig. 6a. Variation of the C_{org} as a function of temperature

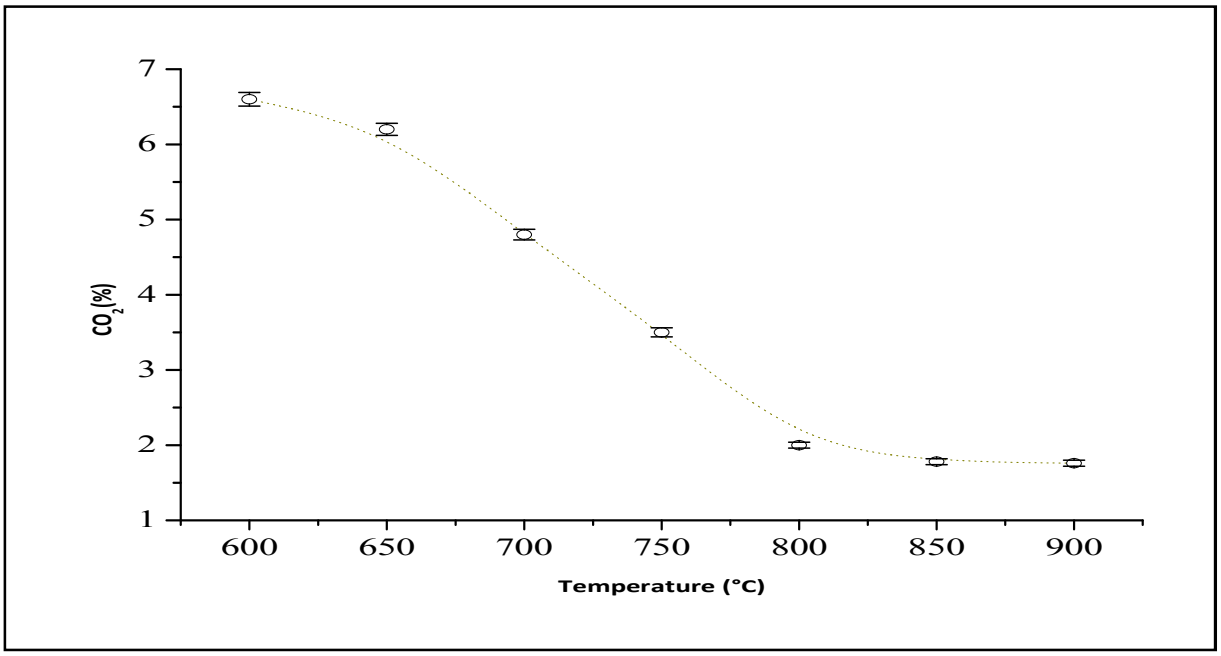

Fig. 6b. Variation of the CO_2 as a function of temperature

As shown in Figure 6a, the organic carbon content varies slightly from its initial concentration (1.4%) at temperatures between 600 and 700°C. From 700°C, the roasting of organic matter increases and appears to be complete to 800°C. Beyond 800 °C the mass percentage of C_{org} remains, significantly, substantially constant and with a value minimum about 0.15%.

In addition, the carbon dioxide begins to clear starting from 600 °C to reach a minimum value of the order of 2% at 800 °C (Figure 6b). This value remains relatively the same beyond this temperature.

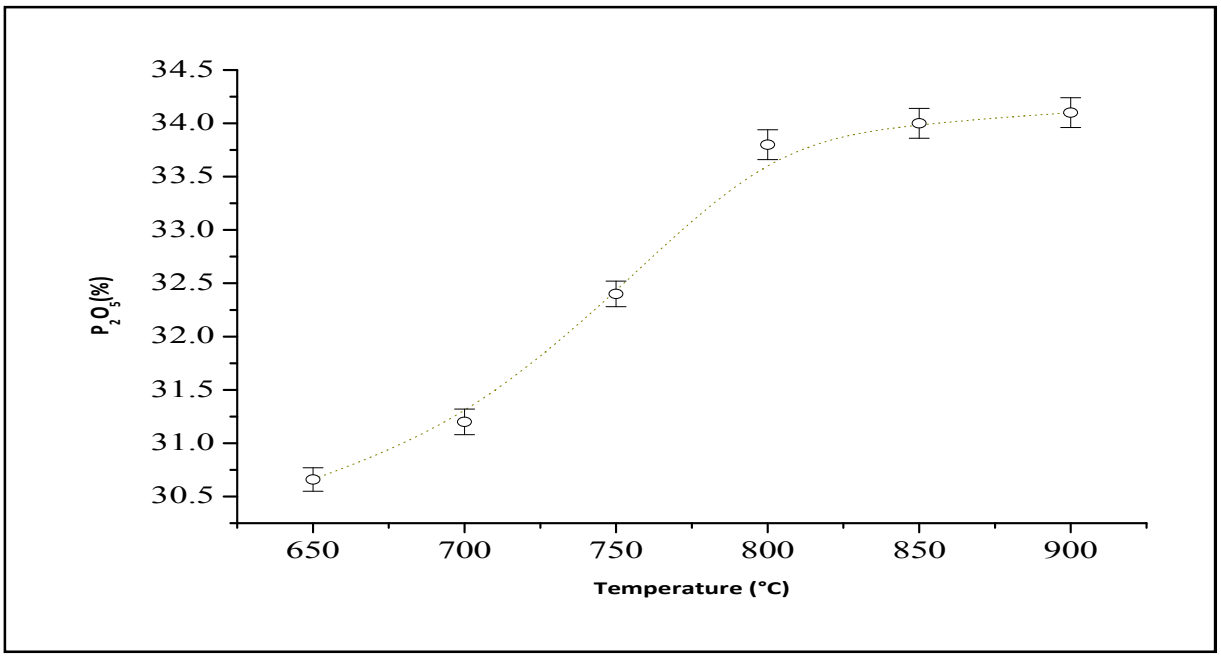

Fig. 6c. Variation of the P_2O_5 as a function of temperature

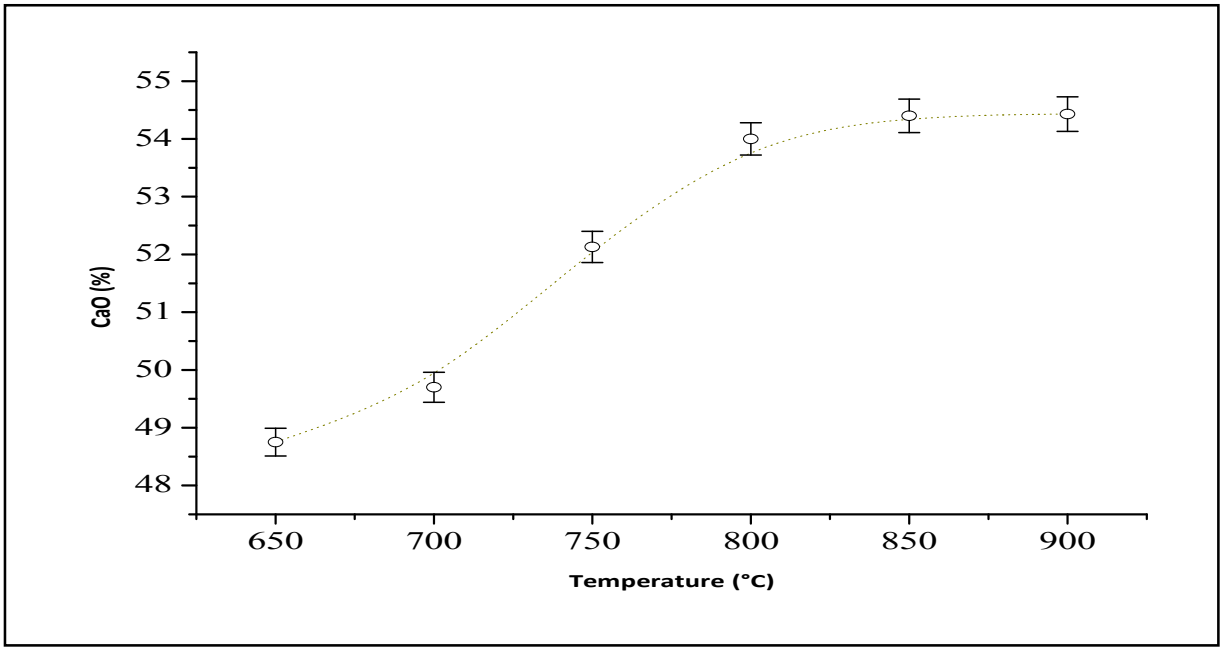

Fig. 6d. Variation of the CaO as a function of temperature

Consequently, the respective weight percentages P_2O_5 and CaO vary in the same way with temperature (Figures 6c and 6d). They believe between 600 and 800 °C. Beyond 800 °C, these values are almost invariant.

It is therefore concluded that from 800 °C, the values of the main components of control become almost invariable.

- ***Study of residence time:***

The study of the residence time is of paramount importance in any energy optimization for the calcination. On an industrial scale, the residence time depends on the reaction medium, equipment characteristics and operating parameters of the process.

In our case of thermal treatment of calcination, we tried in protocol 2 to study the variation of the principal constituents of control (C_{org}, CO_2, P_2O_5 and CaO) as a function of time at different temperatures between 600 and 900 °C [32], [41]. The figures 7a, b, c and d include the results of tests.

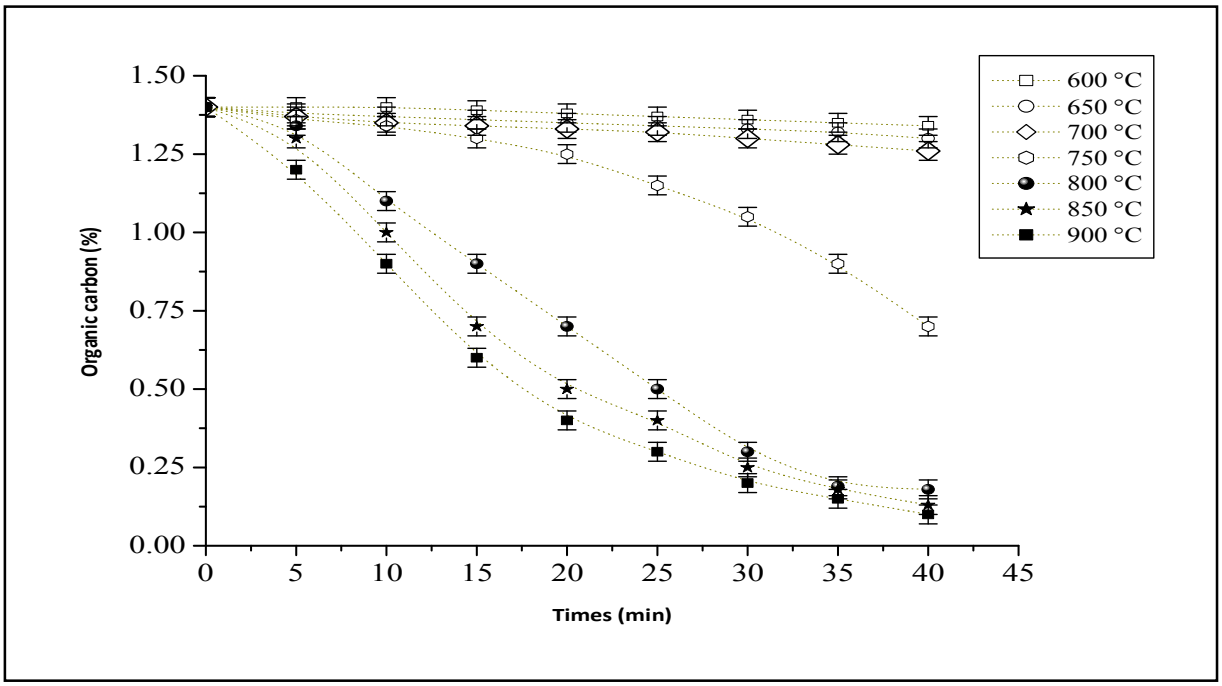

Fig. 7a. Variation of the C_{org} as a function of time at different temperatures

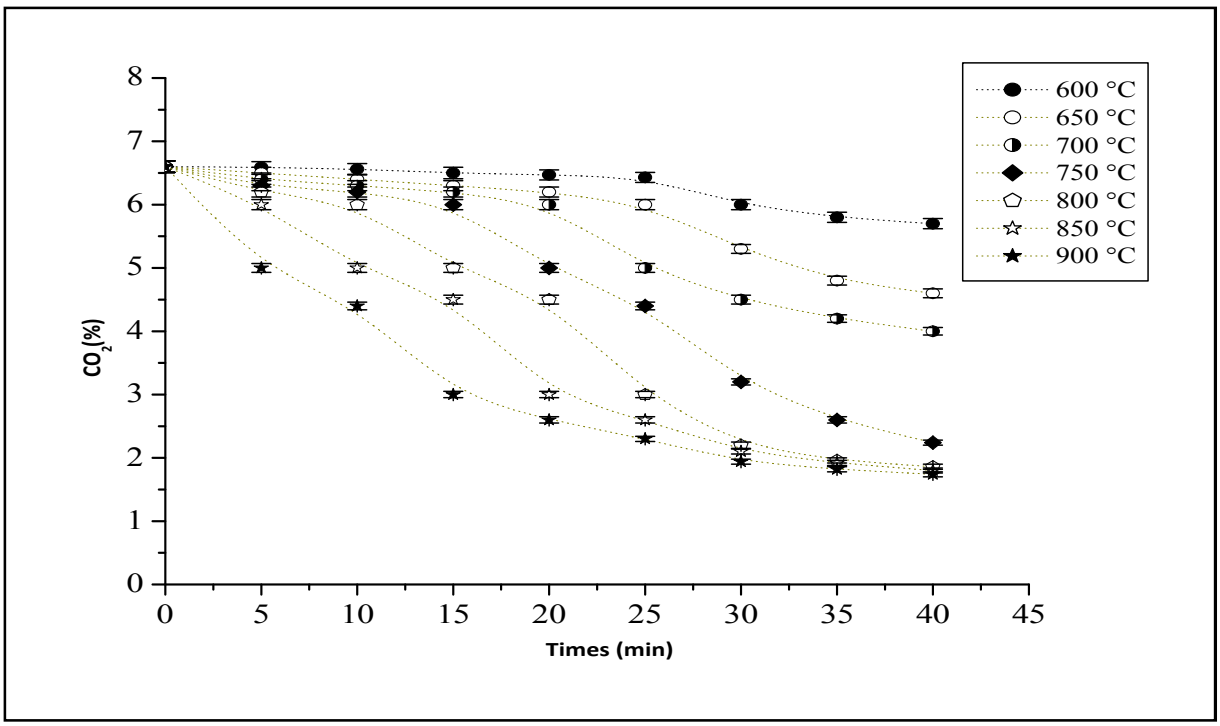

Fig. 7b. Variation of the CO_2 as a function of time at different temperatures

As we have seen previously, to a temperature of between 600 and 700°C the organic carbon content varies slightly depending on the time. This is from 700 °C as the burning of organic matter becomes measurable and accelerating with the raising the temperature. The content of organic carbon reaches a quasi-stationary 30-minute limit after roasting for higher temperatures at 800 °C, is about 0.15% (Figure 7a).

The figure 7b shows that the release of carbon dioxide is initiated from 600 °C with a remarkable speed up to 800 °C. Beyond 800 °C and from a holding time 30 min, the curves of variation are very close to 2%.

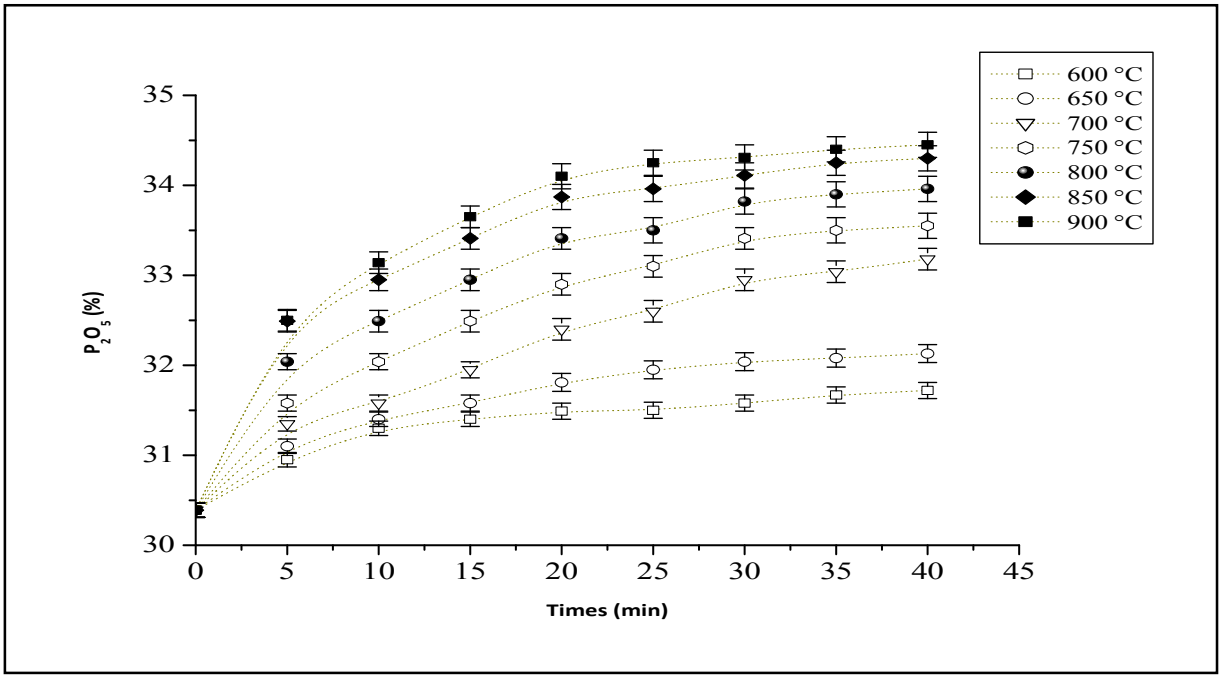

Fig. 7c. Variation of the P_2O_5 as a function of time at different temperatures

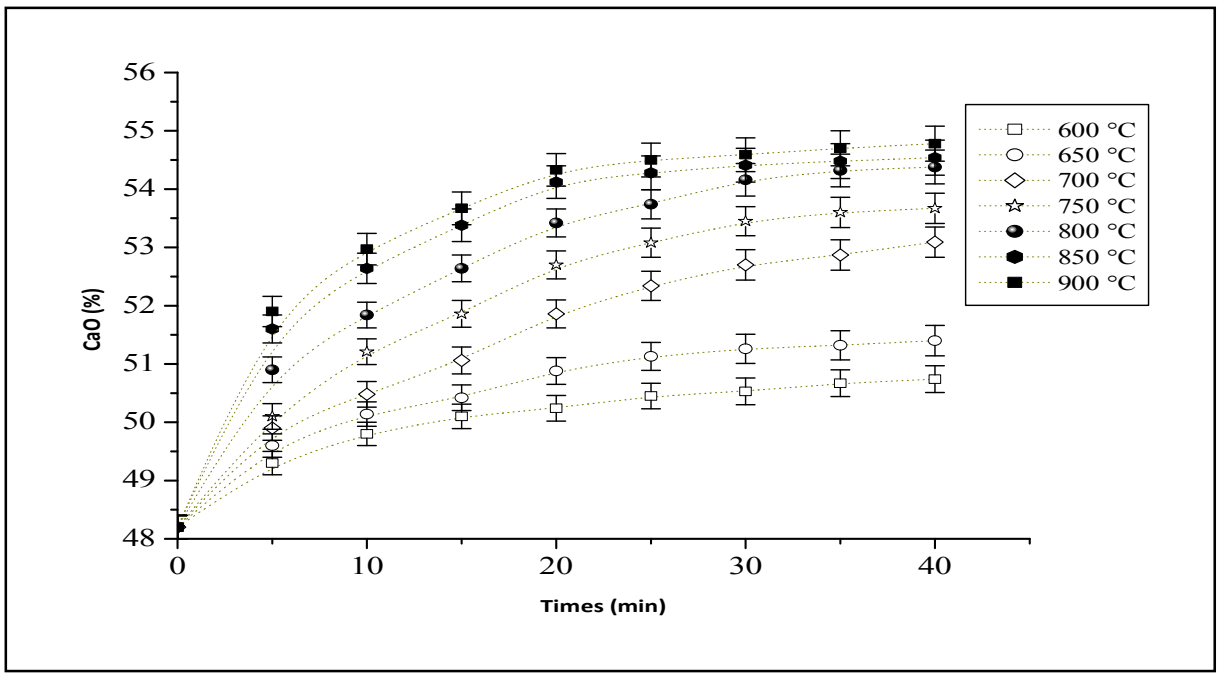

Fig. 7d. Variation of the CaO as a function of time at different temperatures

The percentages by weight of phosphorus pentoxide and lime vary in the same manner as a function of temperature and time (Figures 7c and 7d). They believe between 600 and 800 °C, after the roasting of organic matter and the decomposition of carbonates. Beyond 800 °C, these values are almost invariant and with 33.82 and 54.16% respectively.

3.3 THE RATE OF HEATING OF THE FURNACE

The electric furnace including a sample of approximately than 200 grams is maintained, in the intervals of temperature and time studied, to a variation in the rate of heating where the temperature rise is not linear (Figure 8).

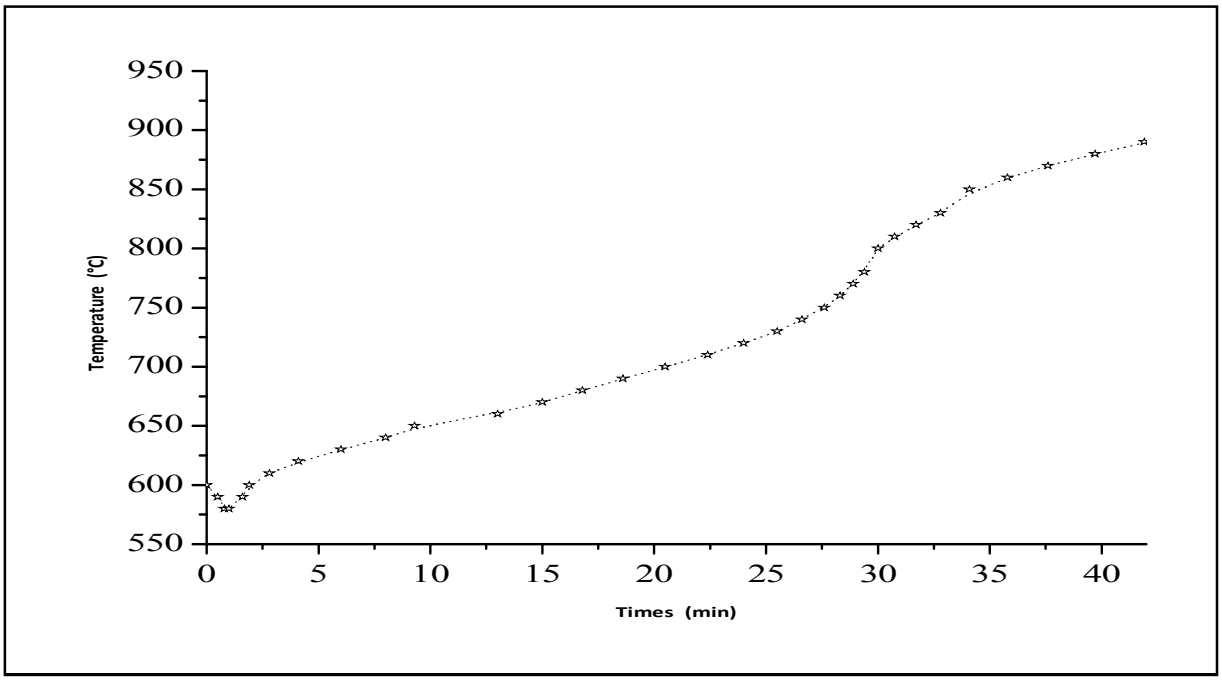

Fig. 8. Heating speed of the furnace

The speed of the heating of the furnace consists of three parts: (i) the first is the heating of the fixed bed and the sample. It requires a time of about 2.5 minutes. (ii) The linear velocity becomes to a temperature of 800 °C for 30 minutes. (iii) Beyond these conditions, the rate of heating increases. This tells us that the kinetics of thermal decomposition of the sample decreases as the content of organic matter and carbonates become weak. These remarks agree reasonably with results cited in the preceding paragraph.

4 BEHAVIOR OF ORGANIC MATTER AND CARBONATES OF CALCINED PHOSPHATE

We concluded that the calcination of phosphate requests a temperature of 800 °C and a residence time of 30 minutes. However, enrichment is never complete as it will be confirmed by studying the behavior of organic matter and carbonates of calcined phosphate, by differential thermal analysis coupled with the thermogravimetric analysis and the analysis of X-ray diffraction.

The ATG analysis revealed successive three losses masses, as in the case of crude phosphate, (Figure 4) in relation to the respective temperature ranges assigned, (i) the adsorption of moisture of the resulting hygroscopic equilibrium, (ii) to the dehydration of structural water and the roasting organic matter remaining after calcination and (iii) the decomposition of carbonates undissolved during calcination (Figure 9) [32]. The mass losses related to general reactions endothermic or exothermic nature that can followed by ATD. It follows that the endothermic peaks are due to the phenomena of dehydration and decomposition of carbonates. While, the exothermic peaks are due to the phenomena of roasting organic matter and recrystallization of the apatite phosphate.

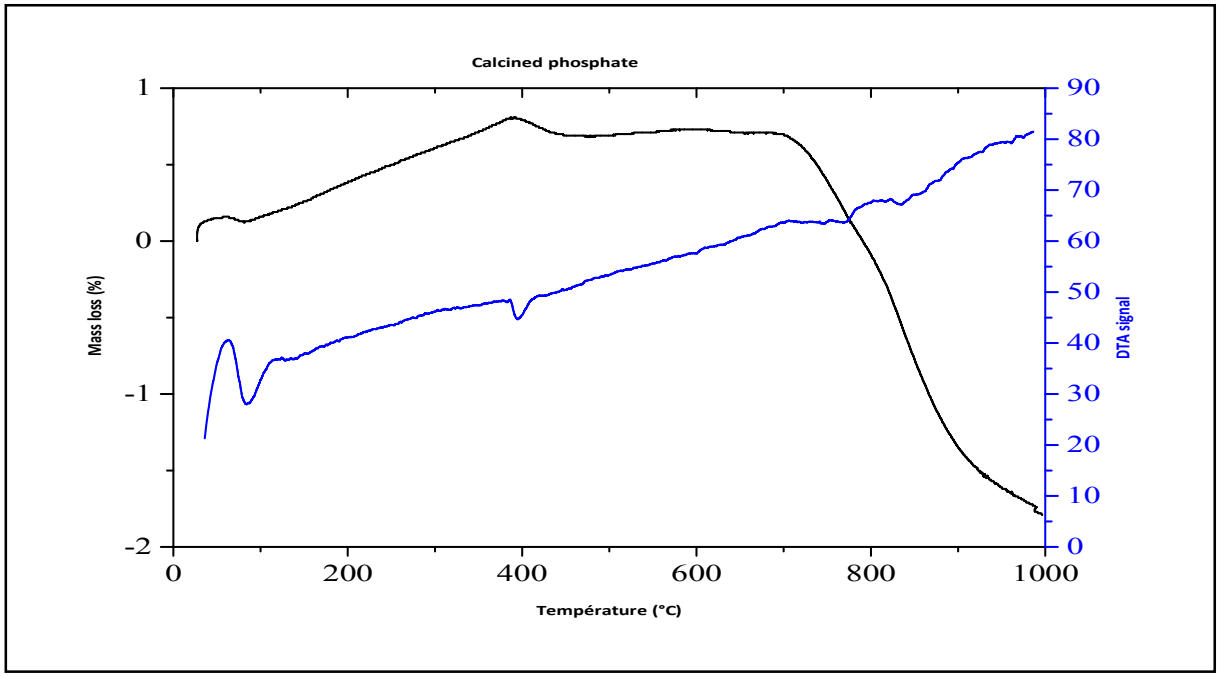

Fig 9. Curve DTA-TGA of a sample of Bouchane phosphate calcined

The peaks highlighted correspond to:

- The dehydration: This is an endothermic peak of low amplitude assigned from humidity related of adsorption phenomenon. It is observed from room temperature to 100 °C with a peak around 80 °C.
- The second mass loss: it is an endothermic peak starting around 400 °C due to the departure of the remaining amount of structural water. The exothermic reaction associated with the combustion of the organic material becomes low in the calcined phosphate is fully offset by the endothermicity.
- The third mass loss: It trigger from 750 °C. It is due to the decomposition of carbonates (calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$)) remaining in the calcined phosphate with the release of CO_2.

The results of thermal analysis of the behavior of organic compounds and carbonates can be concluded that the almost total decomposition is effective only from 700°C. Is noted that the mass loss, the phosphate calcined under the conditions of 800 °C and 30 minutes, is the order of 1.8% (Figure 9). This value is incomparable relative to crude phosphate (9.2%) (Figure 4). It does not seriously affect the quality of calcined phosphate.

The diffraction pattern of the calcined phosphate reveals the presence of the following phases: the fluorapatite $Ca_{10}(PO_4)_6F_2$ and the calcite $CaCO_3$ (Figure 10), the latter exists is of shape endogangue or exogangue. we note that, the interferences presented between dolomite, calcite and quartz with fluorapatite in phosphate rock are removed during calcination. The disappearance of the phases due to the decomposition of carbonates and quartz transformation of amorphous calcium silicate [42].

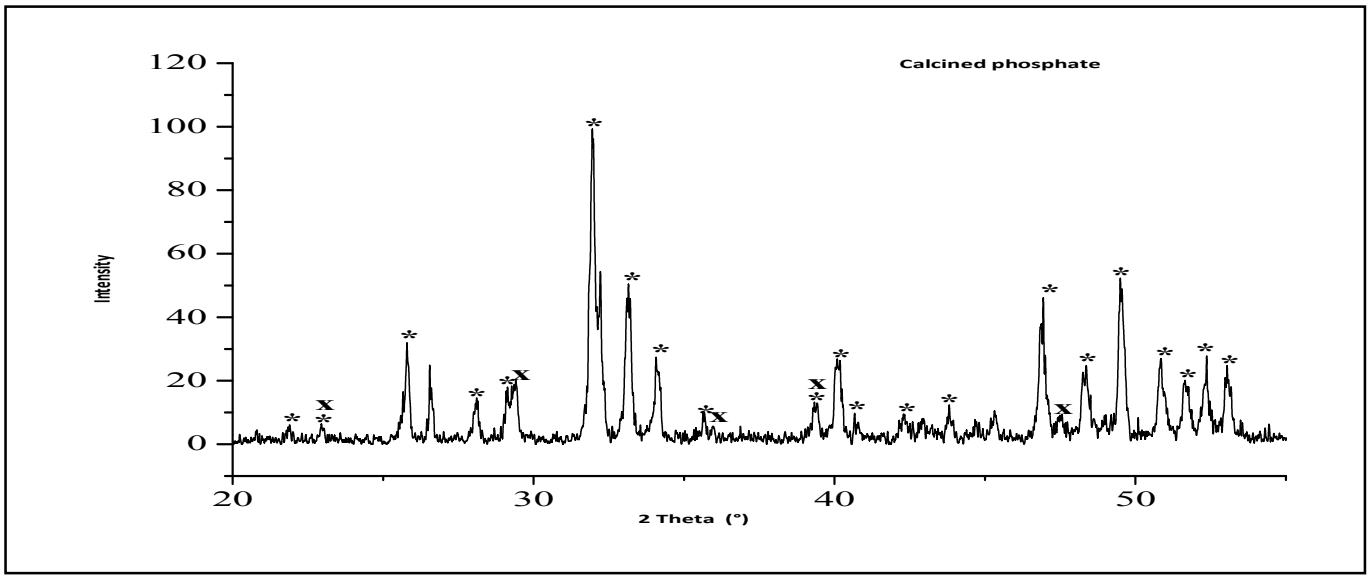

Fig. 10. Diffractogram of X-ray of a sample of Bouchane phosphate calcined (: Fluoroapatite and x: Calcite)*

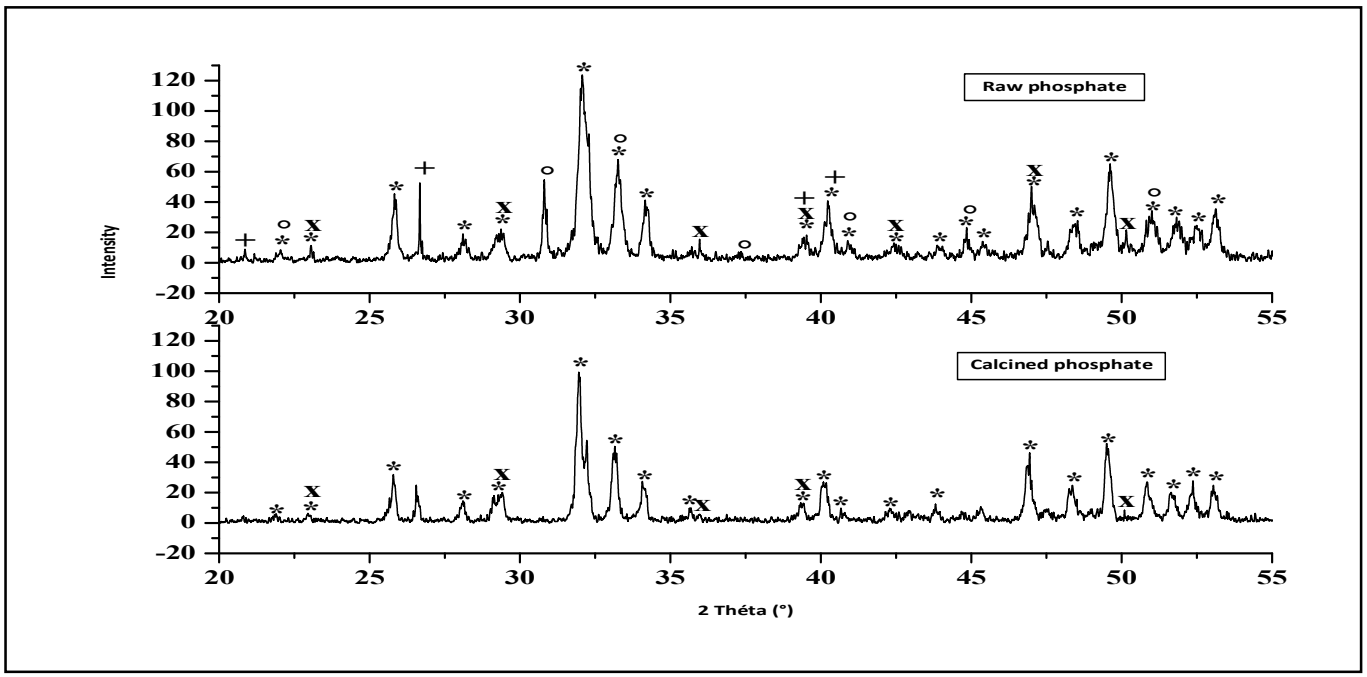

Fig. 11. Diffractograms of X-ray of a sample of raw phosphate and calcined Bouchane (: Fluoroapatite, +: Quartz,* x *: Calcite and ○: Dolomite)*

The diffractograms, presented in figure 11, shows that crude and calcined phosphates are composed of phases with completely different intensities. Therefore, under the conditions of calcination, the temperature of 800 °C and a residence time of 30 minutes, the diffraction lines of the RX are refined and become resolved and less intense. The width at half height and background noise are lower in the calcined phosphate causing a good crystallinity. These findings are reflected in the thermal decomposition of carbonates that can be associated with some structural changes in the apatite. However, the improvement of the crystalline quality of calcined phosphate depends on the mass percentages of the remaining impurities, notably the fluorine, the calcite and the carbonates. We note that, the studies on other types of phosphate show that the crystallinity is only good for calcination temperatures above 700 °C [43].

5 BEHAVIOR OF THE MINERAL MATRIX DURING CALCINATION

5.1 EVOLUTION OF THE SURFACE AREA AND THE DENSITY AS A FUNCTION OF TIME AT DIFFERENT TEMPERATURES

During the calcination of phosphates, the combustion of organic matter and the decomposition of carbonates provoke a volumetric strain. This leads to a change in physical properties such as the size of the unit cell, the crystal size, surface area, density, porosity and chemical reactivity that are interdependent [16]. Therefore, it suffices to consider two or three parameters to predict the behavior of other physical properties.

The figures 12 and 13 illustrate, successively, the evolution of the specific surface area and the density as a function of time at different temperatures (T = 600°C, T = 700°C, T = 800°C and T = 900°C).

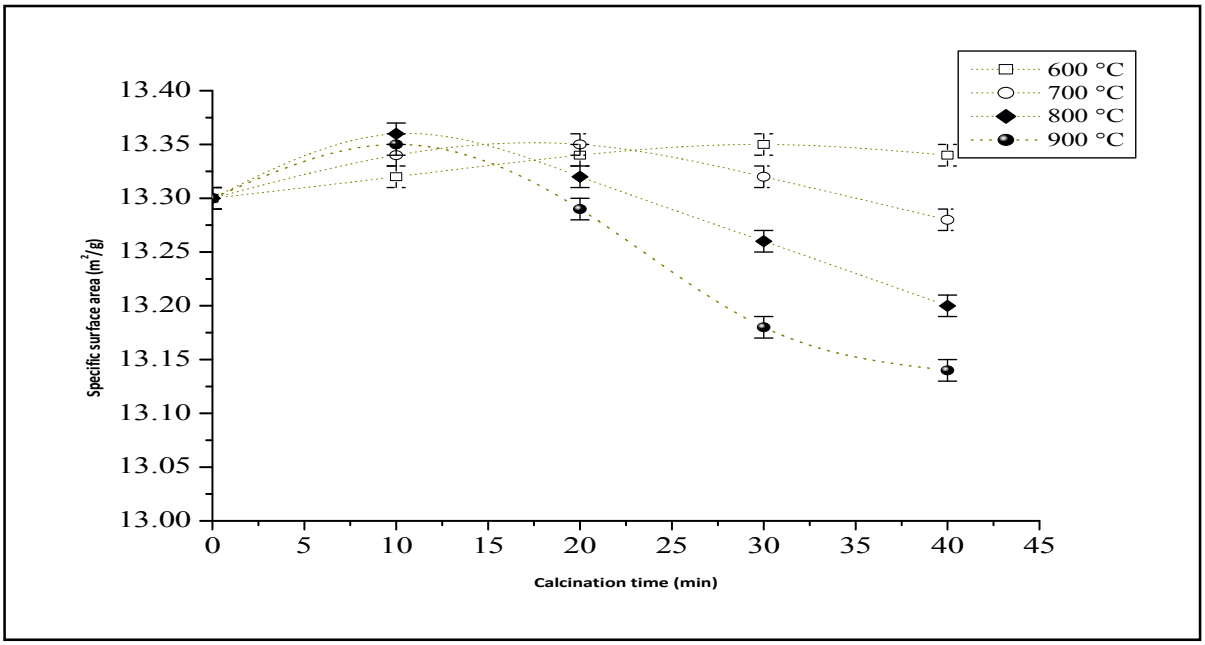

Fig. 12. Evolutions the specific surface area of phosphate as a function of time at different temperatures

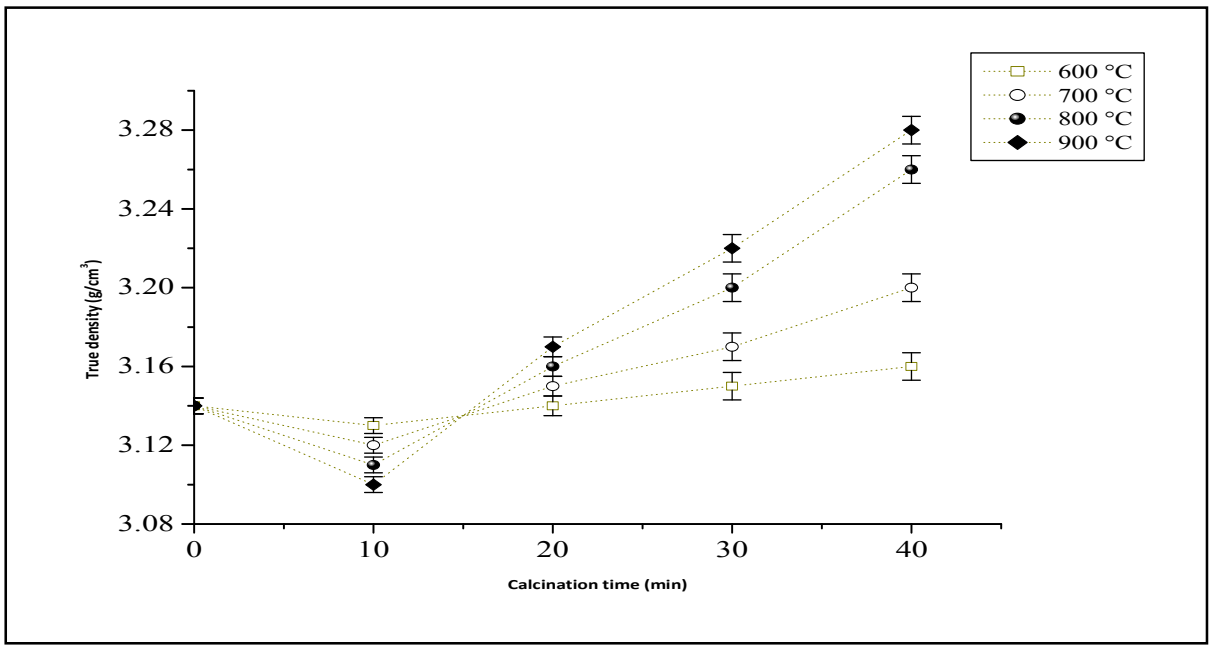

Fig. 13. Evolutions the density of phosphate as a function of time at different temperatures

It was found that the specific surface area and density of the phosphate are affected by two distinct phenomena:

While the first ten minutes, an increase is observed of the surface area and a decrease in density, as a function of calcination temperature. These variations are due to the degradation of unwanted materials, above all the mesh of the organic matter and decomposition of carbonates, which favor destruction of pores, following the breakdown of volatile gases, and therefore the increase in porosity.

Beyond the first ten minutes and 700 °C, we note a decrease in surface area and increase the density. Thus, the calcined phosphate becomes more mineral and denser. These changes become very significant with temperature due to the extent of the sintering phenomenon [44], [45].

As a result, in the first minutes of calcination and a temperature of about 700 °C, the density and the specific surface varies in the direction to increase the chemical reactivity of the phosphate. We note that, the solubility and chemical reactivity increases with decreasing density and increasing the specific surface [2]. Therefore, the organic matter and carbonates may cause slight variations on the measurement of physical properties after the calcination.

5.2 EVOLUTION OF THE SIZE DISTRIBUTION AS A FUNCTION OF TEMPERATURE

The particle size distribution of the phosphate, of between 40 and 500 μm, is requested in phosphoric workshops. Indeed, it promotes reactivity, and therefore the chemical yield. It appears therefore interesting to follow the evolution of the particle size distribution and grain size during calcination. We note that, the particles do not necessarily have spherical shapes. They may have several sizes and forms. For this, the mean diameter (d_m) which is defined as the diameter of the sphere having the volume of the particles are commonly used. This parameter is calculated by the following formula:

$$d_m = \frac{1}{\sum \frac{x_i}{d_{pi}}} \tag{6}$$

Where x_i is the weight fraction of particles having an average diameter d_{pi}.

Overall, it appears that the residence time (30 min) and calcination temperature (800 °C) are necessary to minimize the content of organic matter and carbonates of crude phosphate. These conditions depend on the particle size of the phosphate, the nature and amount of impurities and the manipulation itself.

The evolution of the particle size distribution as a function of calcination temperature, for a residence time of 30 minutes is illustrated in Table 3.

Table 3. Evolutions of the particle size distribution of the phosphate as a function of the temperature

refusal (μm) / T(°C)	500 >	315 >	250 >	200 >	160 >	80 >	40 >	40 <	d_m (μm)
T_{amb} [(1)]	0	37.66	24.75	15.85	9.98	9.88	1.88	0	188.44
600	0	36.96	24.25	15.45	10.20	9.94	2.16	1.04	170.77
700	0	36.60	23.85	15.30	10.65	10.30	2.40	0.9	167.11
800	0	32.27	26.21	20.20	11.30	8.56	1.43	0.03	191.15
900	1.40	32.40	26.38	20.30	11.34	7.56	0.60	0.02	202.41

[(1)] *T_{amb} : ambient temperature*

There is a decrease in particle size from 600 to 700 °C, above all refusal than 160 microns (decrease of the mean diameter). This change of the grain size is attributed roasting of organic matter and decomposition of carbonates and aggregation of fine grains with large grain and destruction of the structure of the pores in the coarse ore. Beyond 700 °C, there is a slight grain growth which resulted in the outbreak of the sintering phenomenon which intensifies from 800 °C (increase in average diameter), at this stage densification increases and pores begin to disappear. This is associated with a change in the microstructure of the phosphate [24].

This result confirms a correlation between the average grain diameter, the specific surface area and density. The evolution of these physical properties is improved in the direction of increasing the reactivity of phosphate during his attack, to a temperature below 800 °C. This led us to think about reducing the residence time of the calcination by reducing the cycle cooling by adjusting the cooling rate without affecting the final product.

6 CONCLUSION

The temperature, the time and the particle size are significant parameters to optimize the calcination of phosphate. In this study, we found that, the calcined phosphate meets the merchant profiles and the use requirements under the conditions of a temperature of about 800 °C and a time of 30 minutes. In these conditions, we observed a decrease of the organic carbon to 89.29% and carbon dioxide to 72.72% with an increase in weight of bone phosphate lime (BPL) to 12.63% without affecting the ratio of CaO/P_2O_5 which is equal to 1.6. However, under these conditions the calcination causes a volumetric strain, and consequently a textural evolution resulting from a different variation of physical properties which can affect the reactivity of product phosphate. The latter depends on the operating parameters and the cooling cycle of the calcination. This pushed us to think about reducing the time of the phase of cooling the calcined product.

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An Optimized Gamma-ray Densitometry Tool for Oil Products Determination

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ABSTRACT: Gamma-ray densitometry or nucleonic gauges have been widely used in industries to improve the quality of products, optimize processes and save energy and materials. Compared with common time-consuming and expensive chemical analyses, the proposed method is relatively fast and more reliable. Density measurement is normally based on the absorption of gamma radiation as it passes through the process material. The absorption which is proportional to the changes in material density indicates product density as the measuring path is held constant. In this study, a number of Monte Carlo simulations have been performed using the MCNP-4C code to optimize the arrangement of gamma densitometer. The dimensions of the proposed system have been chosen to coincide with the industrial specimen of gamma densitometer. The geometry of source to detector in different angles was investigated and optimized angles were chosen. The simulation as well as experimentally measurements has been performed for 4 different fluids including water, gasoline and diesel engine oil used with iron and PVC pipes of 4 inches diameter. The gamma source and detector have been a ^{137}Cs and NaI(Tl) scintillation detector. Our experiments and simulations results show that the transmission mode present, better results than the scattering one in densitometer. The single detector response of the detector located at 180° can distinguish the gasoil, gasoline and water densities.
By optimized counting time and source-detector geometry, the densities of above mentioned fluids within the precision of 0.1 g/cm^3 were achieved.

KEYWORDS: Gamma-ray Densitometry, MCNP-4C, Oil Products, Measurements, scintillation detector.

1 INTRODUCTION

Simple nucleonic gauges (NCS) first began to be used in industry over forty years ago. Since then, there has been a continuous expansion in their usages. The competition from alternative methods shows that the nucleonic gauges have survived and prospered in the past because of their superiority in certain areas to conventional methods. The success of NCS is due primarily to the ability conferred by their unique properties, to collect data, which cannot be obtained by other investigative techniques [1].

Density measurement has found important applications in various industries, such as oil and gas productions, mining and mineral ore processing, environmental monitoring, paper and plastics industries, cement and civil engineering industries, where the benefit is enormous and the technology competes effectively with conventional techniques. The observed trends and new developments include the use of Monte Carlo simulations for design optimization, calibration and data processing [1], [2], [3].

There are basically three main categories of nucleonic gauges used in industry:

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(1) Transmission gauges used to measure the density, thickness, etc. In these gauges the source housing and the detector are on opposite sides of the material and the radiation is attenuated as it travels through the material.

(2) Backscatter gauges used to measure the thickness of coatings, well logging, etc. Here, the detector and source housing are on the same side of the material and therefore the detector has to be shielded from the primary radiation. The radiation enters the material, interacts with it and scatters back out.

(3) Reactive gauges (e.g., used for elemental analysis). In these gauges, certain low-energy gamma and X-ray sources cause fluorescent X-ray emissions in the material being investigated [1]. In this paper, the optimum position of detector toward source has been determined using the Mont Carlo simulations, and then the corresponding experimental set-ups have been prepared to verify the simulation results.

2 METHODS

Density measurement is normally based on the absorption of gamma radiation as it passes through the process material. The absorption which is proportional to the changes in material density indicates product density as the measuring path is held constant.

With several detectors installed over the same pipe cross-section both transmitted and scattered radiation, the measurements can be performed in several positions. Basically, the energy of scattered photons depends on the scattering angle. Therefore, there is a relationship between the detected radiation energy/ intensity, and the distribution of oil and gas inside the pipe. A Monte Carlo simulation model has been developed and implemented in order to compare the accuracy of both transmitted and scattered photons over the pipe line.

3 RESULT AND DISSCUSION

3.1 SIMULATIONS VS. EXPERIMENTS

MCNP is a general purpose Monte Carlo code for calculating the time-dependent, continuous energy, neutrons, photons and electron transports in three dimensional geometries [4]. A number of benchmark studies have been published using the Monte Carlo transport code, MCNP [5], [6]. Here, two simulation models according to the nucleonic gauges including the transmitted and back scattered ones, have been developed to measure the density of fluids as shown in Figure 1. It seems necessary to develop a model for the simulated one to locate the detectors, on the basis of the sensitivity of densitometer. In the case of water, gasoil and gasoline, 11 simulations have been performed, in which the detector angle ranges from 40 to 180 around the pipe with a 0.5 mCi ^{137}Cs gamma source. The choice of the gamma-ray source depends on the characteristics of the experiment such as the pipe material, pipes body thickness, diameter, detection sensitivity, and shielding considerations. The 662 keV gamma-rays from the ^{137}Cs source easily pass through the pipe wall materials, and therefore the uncertainties due to the counting statistics can be reduced. The densities of typical water, gasoil and gasoline at 30 °C under laboratory conditions are 0.920, 0.720 and 0.820 g/cm^3, respectively.

The tally F8 of the MCNP code has been considered as the detector pulse-height equivalent and hundreds of millions of computer runs have been performed for source particles. The final experiments setups were found to be consistent with the obtained results at simulation.

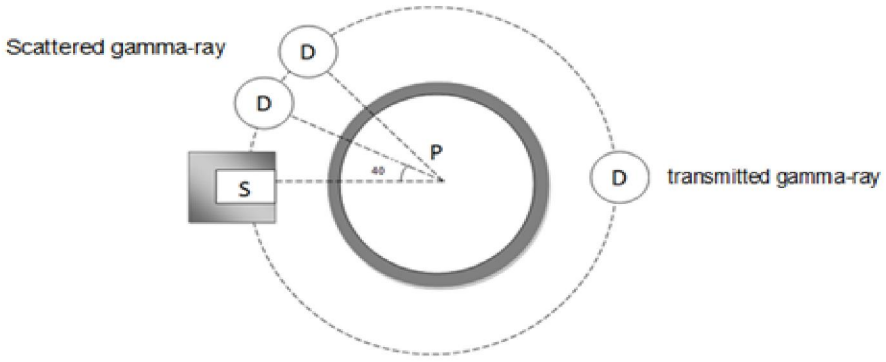

Fig. 1. Different configuration setups of density measurement system.

Figs. 2 and 3 show the detector count rates for several positions around the pipe for both scattering and transmission measurements for PVC and iron pipes, respectively.

As it can be seen, when the detector is located at the 3 specific angles (150,170,180 degrees), the highest count rates are obtained a procedure which determines the optimum detector position. The average counts for the detector located at 40°, 60°, 80°, 90°, 110° and 130° represent very small values only concerning the scattered photons detected in these angles. Therefore, the transmitted method has more sensitivity than the scattered one that means the transmitted-based gauges can determine and control the material density in the pipe more accurately.

The single detector response of the detector located at 180° can distinguish the gasoil, gasoline and water densities with the accuracy of 0.1 g/cm^3.

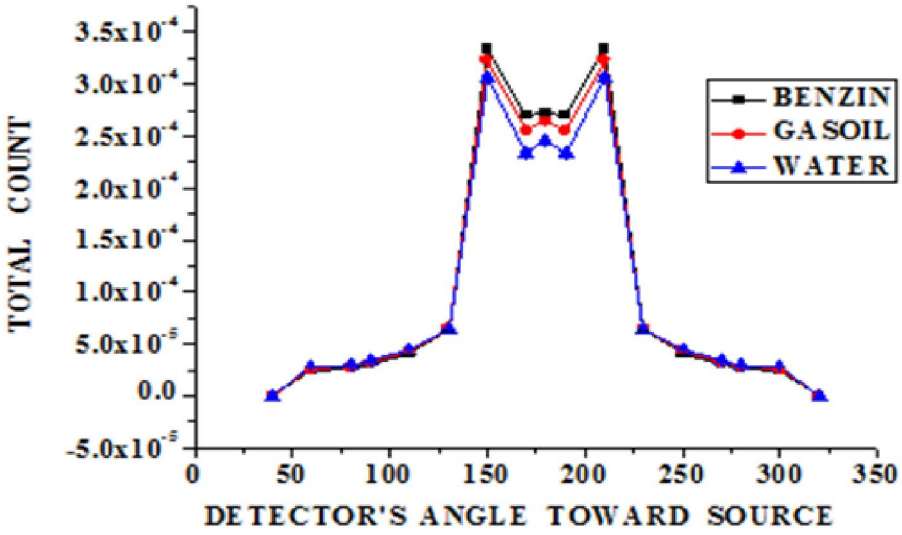

Fig. 2. Count rate vs. detector angle for iron pipe (MCNP simulation)

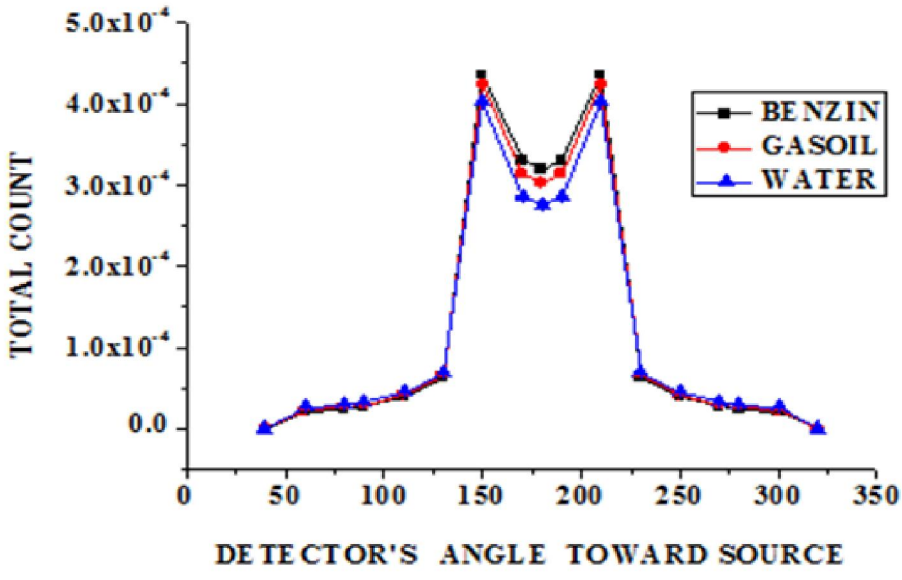

Fig. 3. Count rate vs. detector angle for PVC pipe (MCNP simulation)

Furthermore, as it can be seen in Figs. 4 and 5, the agreement between the experimental and simulation results is excellent. A small difference between the two curves may be partly corresponded to (1) the fact that the detector has not been fully simulated, (2) the background count rate variations and also (3) the environmental conditions. However, one may conclude that the MCNP code is an efficient tool for the simulation of nuclear gauging instruments.

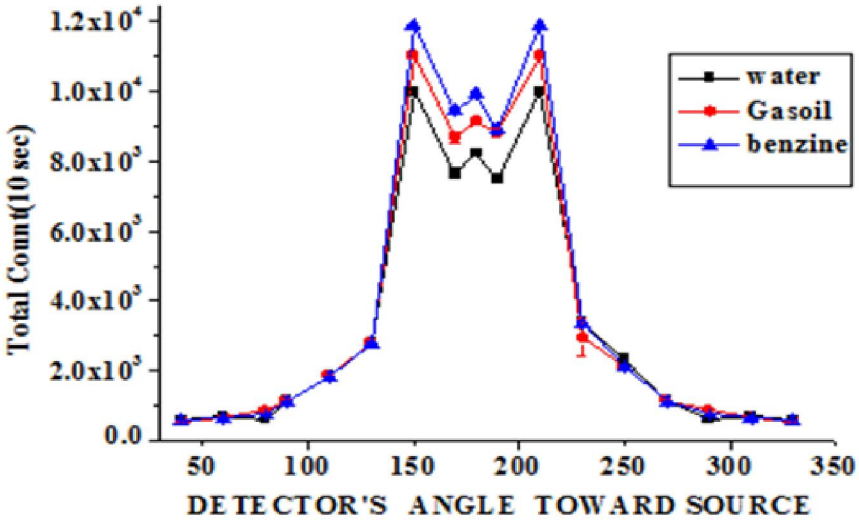

Fig. 4. Count rate versus detector angle for iron pipe (Experiment)

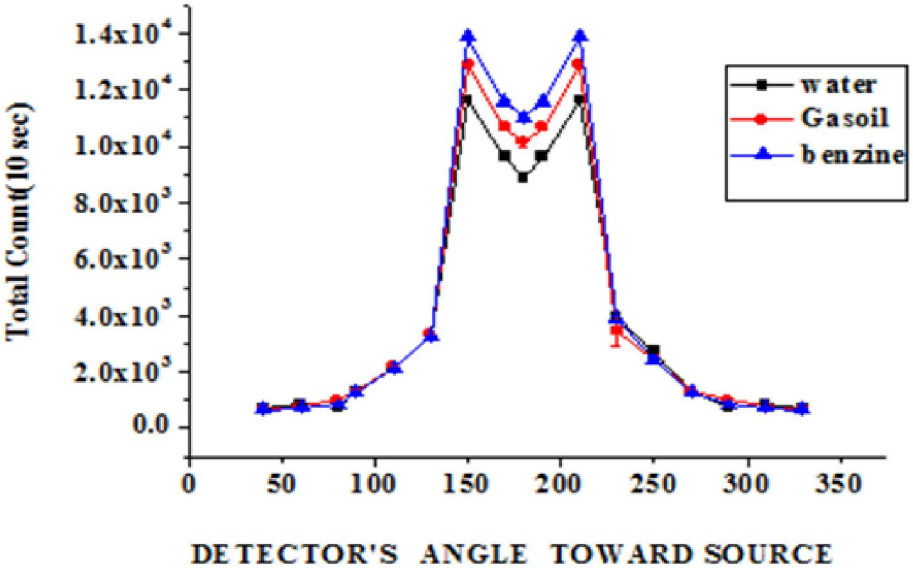

Fig. 5. Count rate versus detector angle for PVC pipe (Experiment)

Straight angle as the optimum detector position was selected for designing and setting up experiment. the experiment and simulations were performed for gasoil pipe using mentioned densitometer.

4 CONCLUSION

Our experiments and simulations results show that the transmission mode present, better results than the scattering one in densitometer. Based on the both MCNP4C code simulation and our experimental results, fluid densitometer device can be developed for industrial applications to distinguish the material with similar densities from one another with the accuracy of 0.1 g/cm^3

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Communication Practices and Quality Service Delivery Tradition: Uganda's Local Government Perspective

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ABSTRACT: This study examined the relationship between communication practices (formal and informal) and quality service delivery in Uganda's local Governments. The study findings are derived from a sample of 212 Local Governments in Uganda. Service delivery recipients - Heads of department and sectors comprised the unit of inquiry whose responses were aggregated to Local Government level, which formed the unit of analysis. Questionnaires were used to collect data from the respondents. Data analysis involved running correlations and regressing communication practices (formal and informal) on quality service delivery. The findings revealed that both formal and informal communication practices positively and significantly predicted quality service delivery in Uganda's Local Governments. The major study implication is that Local Government authorities need to focus and reform communication practices for delivery of quality services to the people. The study was however, limited by the fact that it relied only on cross-sectional research design and only utilised a single methodological approach. The study offers empirical evidence on the sparsely investigated public sector. The evidence indicates the immense role of both formal and informal communication practices on quality service delivery in the Uganda's Local Governments.

KEYWORDS: Informal Communication, Formal Communication, Local Government Structure, Public Sector, Quality Service.

1 BACKGROUND

The issue of quality in public sector has since 1980's become a recurring theme. This is perhaps due to increased demand by the public for quality services [1], [2]. The quality shift in public sector, is therefore a component of a series of reforms and transformation effort geared towards total eradication of the traditional bureaucratic model, and its eventual replacement with a more client – oriented paradigm [3], relevant in the delivery of best value to the public. Provision of quality services that satisfy client needs, has therefore become a critical issue, and a dilemma affecting modern service delivery sector [4], [5].

Teicher, Hughes, & Dow [6] have observed that the challenges facing Local Governments in the delivery of quality services are attributed to the fact that: quality tradition in Local Governments is slow; and further worsened by difficulties in measuring outcomes; greater analysis and examination from the public and media; limited autonomy to act in a subjective fashion; and a requirement for decisions to be based on a restrictive policy, or legal frame work.

Recent legislations evidenced by the 1995 constitution of the Republic of Uganda, and the Local Government Act (CAP 243), have placed a new responsibility of delivery of quality services on Uganda's Local Government authorities. This argument is premised on the fact that devolution of power closer to the local people has a positive link with the quality of services delivered [8]. This finding, has however been negated by a study by Khan [9], & Alam [10]. In view of this contradiction, no empirical study has been undertaken to establish the prospect and outlook of the Local Government

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system in Uganda, in regard to quality services that they deliver, though what is clear, is that Local Governments increase popular participation [11], and allows local level services to be conditioned according to local preferences [12].

The duty bestowed upon Local Governments to deliver quality services conversely, require among other things that Local Government authorities embrace and reform their communication practices and systems [13], [14], [15]. This is so because communication has been singled out as a dominant and critical activity for organizations to meet their mandate [16].

Whereas theoretical evidence indicates that communication practices positively and significantly influence quality service delivery [15], [17], [18], [19], empirical studies in respect to the same are scanty, for example Manolias [20] and lacking in the context of Uganda's local governments. The need to ascertain the influence of communication practices on quality service delivery triggered this study. This study is therefore likely to facilitate academicians and local government practioners develop a concrete and definite understanding of the role of communication practices on the capacity of local governments to deliver quality services.

Similarly, while a plethora of literature demonstrate that quality service delivery has received much attention in private sector [21]-[22], the same cannot be said with certainty in public sector, especially where there is still considerable debate as to what constitute public services quality [23]-[24]. This is a clear indication of knowledge gap to which this study aspires to fill. More so, no dominant empirical study in Uganda's Local Government has been done, to ascertain how quality service delivery is predicted by communication practices. This study is expected to permit scholars and Local Government practioners to have a more distinct and direct understanding of how communication practices can enhance Local Government capacity to deliver quality services to the public.

2 LITERATURE REVIEW

2.1 LOCAL GOVERNMENT

The current Local Government system was introduced in Uganda under the 1995 Republican Constitution, and the Local Government Act (CAP 243), with the cardinal responsibility of: provision of democratic, and accountable government of local communities; ensuring provision of public services in a sustainable manner; promotion of safe and healthy environment; and above all, to encourage the participation of communities in matters of local governance.

The term '*Local Government*' describes a system of government of an area by elected representatives of the people who reside there, and are charged with the provision of services [25]. Lawal [26], on the other hand, considers a Local Government to be a government tier close to the people, and mandated with powers to oversee and man local issues of the people under its jurisdiction. A broader conceptualisation of local governments has been given by [27], who observed that Local Governments are a measure for promotion of popular participation of the people at local levels in all decision making process. This makes a local government to be perceived as an instrument of improved service delivery. This conceptualisation is premised on the view that contemporary states are evidently too big to be administered from a single power centre.

Uganda adopted a five tier system of local governance based on the district as a unit under which there are lower Local Governments and Administrative Units [25]. Uganda's Local Government system, ranges from Local Council I at village level, to Local Council V at district level (LGA Cap 243) as illustrated by figure 1. The Uganda's Local Government multi-layered structure bestows upon local government actors, the necessity and duty to communicate both horizontally and vertically in pursuance of role achievement which is critical and central in the delivery of quality services to the public, considering the fact that service delivery policies and operations need to exist in mutuality [28]. Still, the Local Government multi-layered structure requires effective communication system. Planning, supervision and co-ordination function of local government authorities demand a culture of regular information flow through proper communication structure to support quality service delivery endeavors [29].

The basis for Local Government system, is the view that it promotes financial efficiency and ensures quality, as resources and decision making power is directed to Local Governments with the aim of improving on the quality of services [8], [31]. As Local Governments are closer to the people, it is presumed that identification and analysis of client needs, besides fulfilling them in a quality and concerted manner becomes possible [32]-[33].

Based on this, we draw from the Freeman's Stakeholder theory [54] that attempts to explain the relationship between organisations, people and groups. Guided by this theory, interests of all those with stakes in a particular Local Government need to be factored in, through understanding their needs, expectations and values [34]. It is this that makes analysis and involvement of clients in service delivery frame work, a requirement.

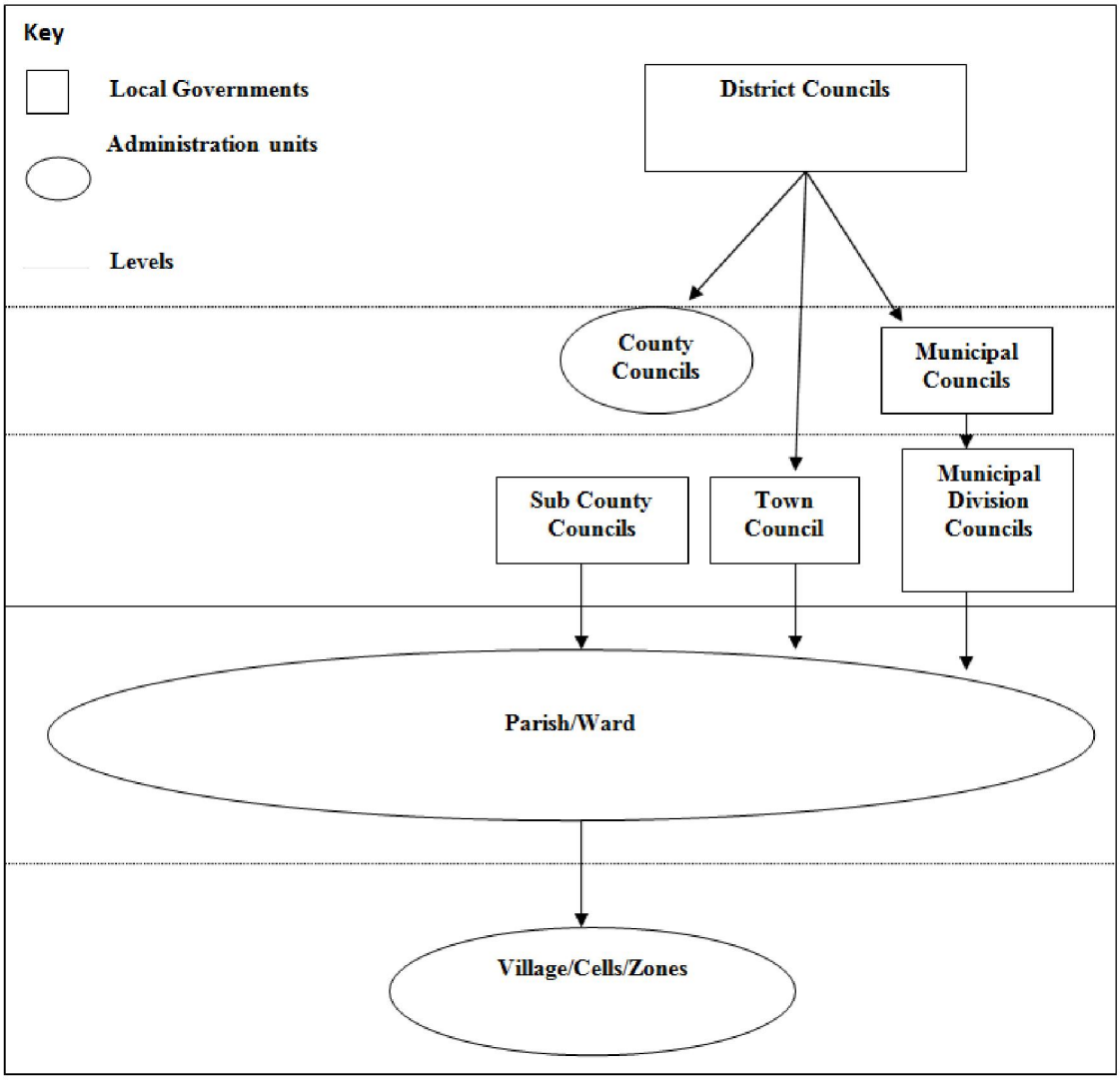

Fig. 1. Local Government Structure

Source: Adopted and Modified from Steffensen, Tidemand and Ssewankambo [35]

Administrative Units in a district include:

a) County Council
b) The Parish/Ward Council
c) The Village Council

2.2 SERVICE QUALITY

There is no universal definition of the concept 'quality'. It is therefore, apparent that its definition can be based on multiple perspectives. Quite often, the circumstance in which quality is referred to, indicates contradictory perspectives, and the apparent conceptualisation. The contexts can either be business, service, marketing sector, and public service sector. The previous definitions of quality, related to how delivered services conformed to requirement [36], and conformance to specifications [37]-[38]. These definitions have roots from manufacturing sector.

Based on the works of Parasuraman et al [21], service quality is conceptualised to imply overall judgment of a service to determine whether it meets customer satisfaction. It precisely refers to organization's capacity to meet or exceed customers' expectations. Zeithmal et al [39], perceive service quality as the difference that exists between customer expectation, and what actually is received. In this perspective, where customer expectations of service quality exceed performance, their

perceived quality becomes less satisfactory, resulting into dissatisfaction [40], [41]. Garvin [42], defines quality to mean excellence. This definition is however limited, based on the view that it shifts focus from the client to the supplier, a scenario which may result into the organization not to give due attention to the demands and needs of the customer [43].

There are basically two opposing paradigms in service quality literature: the expectation -disconfirmation paradigm, and the performance paradigm. The former posits that perceived service quality emanates from comparison between expectation and actual performance [44]. The latter tends to consider customer expectations as non - essential and only emphasises performance as critical. The two opposing paradigms generated two alternative frameworks of service quality measurement namely: SERVQUAL [40], [45] and SERVPERF [22].

2.3 COMMUNICATION PRACTICES AND QUALITY SERVICE DELIVERY

Greenberg and Baron [46] have singled out communication practice as a unique feature for all organisations. Organisations are structured in a manner indicative of their communication patterns. Communication practice also known as structure represents the pattern of interaction existent in every organization [15]. Berger [15] has identified two communication practices: formal channels and informal channels. Formal communication structure or practice exists where communication follows formally established channels of the organization's structure purposely established by the organization's legitimate authority through which instructions and orders are passed over to subordinates, while information is transmitted upwards [47], [17].

Informal communication practice on the other hand, represents communication patterns that exist out of the formally recognized communication modes [15], [47], [48]. It is therefore assembled around social relationship of staff within the organization, and arises out of personal needs of the employees to communicate. This form of communication is often unplanned and consists of concise "*impromptu*' conversations among staff within the organizations [49]. Obstacles to effective and efficient information flow within the organization often give rise to development of informal patterns of communication [15], [47]-[48].

The role of communication practice in influencing the quality of services that organizations deliver, has been well documented [15], [50], [17]-[19]. Both formal and informal communications strengthen employee relationships and foster their performance potential towards the goal of the organization [51]. A study by Manolias [20] about police organisation; identified break down in the communication structure arising out of poor consultation and communication, as a prime cause of stress that inhibited the institutions capacity to deliver quality services.

According to Semler [52], organizations can only realize their mandate when employees determine the worthiness of working together. Both formal and informal communication practices have been singled out as an integral component in developing relationships relevant in securing extra effort among workers. This extra effort is critical in stimulating delivery of best value to the public. A study by Coffey International Development [53], demonstrated that communication which is accomplished through both formal and informal channels, allow clients to lodge their demands to their respective governing entities, and influence decisions that are critical in generating quality public services.

In Local Government context for instance, the regular consultations in planning process and in budgeting cycle, specifically at budget conference phase allow multiple stakeholders like Non Government Organisations, employees and clients determine direction of resources in a bid to deliver quality services. This links well with the Freeman's Stakeholder theory [54] that requires involvement of all with interests or stakes in the service delivery framework. The same study established that the use of citizen score cards as a mode of formal communication practice significantly improved leadership and enhanced on the quality of public services delivered by public institutions.

Researchers have proposed that informal communication at work is a precursor to collaborative work and organization innovation [55], [14]. It sustains information sharing concerning work among employees, eases coordination of activities by actors, strengthens potential for collaborative prospect, and above all, improves the bond between co-workers, all of which are necessary requisites to quality service delivery [55], [14]. Canary [13] has noted that informal communication is necessary specifically for easing the process of coordination among workers within the organization. As a consequence of this, lateral information flow is permitted hence allowing units and departments to work with each other appropriately. This scenario allows service delivery sectors and institutions to deliver quality services to the public. Based on the above review of literature, the following hypotheses are formulated.

H_1: Formal communication practice and quality service delivery are positively associated in Local Governments in Uganda.

H_2: Informal communication practice and quality service delivery are positively related in Local Governments in Uganda.

3 MATERIALS AND METHODS

3.1 STUDY DESIGN AND METHODOLOGY

A cross- sectional research design was used to resolve the formulated hypotheses since it is the most commonly used in social sciences to gather data from a sample of a population at a particular time [56]. A total sample of 302 Local Governments for this study was selected based on the rule of thumb as suggested by Krejcie and Morgan [57]. This sample was drawn from a total population frame of 1488 local Governments in Uganda which are registered members of Uganda Local Government Association (ULGA). Since Local governments are spread out under five (5) levels: District Councils, Municipal Councils, Municipal Division Councils, Town Councils and Sub County Councils, we relied on proportionate sampling procedure to draw 23 Districts, 4 Municipal Councils, 13 Town Councils, 35 Municipal Division Councils and 227 Sub County Councils. Using simple random technique thereafter, we wrote all names of Local Governments and placed them in a marked bowls from where we drew random samples without replacement, until we realized the number of 302.

The unit of analysis was the local government whose heads of department and sections, comprised the unit of inquiry. Guided by Gay [58], this study accepted a minimum of 3 respondents per local government. A total of 212 Local Governments responded generating a response rate of 70.1 per cent which was judged usable for this study. The sample size of 302 and the subsequent response rate of 212 Local Governments is convincing enough, as it is consistent with Bailey [59], who noted that a sample size of 100 is sufficient and Roscoe's [60] rule of the thumb, indicating that a sample size between 30 and 500 is sufficient for any study. The sample size for this study meets the suggested minimum requirement.

Since clients are in better position to offer judgment on quality, Fitzsimmons & Fitzsimmons [61], quality service delivery section of the instrument was completed by a total of 1365 respondents enlisted through non probability convenience sampling technique. Clients leaving Local Governments' public service delivery units were intercepted, talked to and those willing to participate in the study, were given the survey tool to complete. The 1365 respondents were aggregated to unit of analysis level which was the Local Government.

3.2 QUESTIONNAIRE DEVELOPMENT

3.2.1 COMMUNICATION PRACTICE

To measure communication practices, we used self generated measurement scale based on the extant review of literature on communication practice. Consistent with this review, a set of items for the two communication dimensions of formal and informal communication practice was generated. This measurement scale was later submitted to experts in the area of management for evaluation, who deemed it fit for the study with a Content Validity Index of **.80** well above the suggested minimum of .**70** [62]. A sample of a question items read, '*superior often inform us of new happening in the organisation through written memos (*Formal*);* and *'the content of Local Government communication we engage in is rich (*Informal*).'* Items were anchored on a six point Likert like scale (1 - 6) ranging from Strongly Disagree to Strongly Agree.

3.2.2 QUALITY SERVICE DELIVERY

Quality Service Delivery was measured using the works of Parasuraman et al [21] and Pivot – Core – Periphery (PCP) model developed by Phillip & Hazlet [63]. In this study quality service delivery dimensions included: responsiveness; empathy; reliability; assurance; tangibles adopted from the works of Parasuraman and deliverables/outcome derived from [63]. A sample of a question items read, '*prompt services are delivered to clients.'* Items were anchored on a six point Likert like scale (1 - 6) ranging from Strongly Disagree to Strongly Agree.

3.3 RELIABILITY OF THE INSTRUMENTS

Reliability of the scale was determined using Cronbach Alpha (α). The internal consistence of scale used to measure the study constructs on the scale was measured using Cronbach Alpha (α) coefficients. The generated results indicated that the instrument was reliable since all the alpha levels were above the suggested minimum of 0.7 [62] as shown in Table 1 below.

Table 1. Test for reliability

Variable	Cronbach's Alpha Coefficient (α)
Communication Practice	0.78
Quality Service Delivery	0.94

Source: Primary data

We tested for Common Methods Bias (CMB) so as to minimize the potential measurement errors in the process of data collection, which if not taken care of, threaten the validity of the findings about the associations between measures [64]-[65]. Aware of the potential problems of CMB and its likely grave consequences on this study, we adopted Podsakoff et al [64] recommended solutions to minimise and manage CMB namely: procedural remedies which require use of different scores and sources. In this regard, we collected data from different heads of department and section heads, and from different Local Governments. We also used psychological separation procedure in an attempt to make it appear as though measurement of exogenous variables was not related to the measurement of the endogenous variable. In this respect, scale items were clustered together under different sections so as to make them appear unrelated to the study respondents.

Data were checked and cleaned to ensure their completeness. Data were aggregated to unit of analysis level (Local Government). Through frequency inspection and missing value analysis, MCAR test was not significant and we proceeded to replace missing values using linear interpolation due to its ability to connect data points and ensure continuity without necessarily distorting the data structure Dodge [66].

We screened our data to ascertain whether it conforms to the assumptions of parametric tests. We tested for the assumptions of normality, equality of variance, linearity and multi-colinearity. We tested for multi-colinearity using Variance Inflation Factor (VIF) and Tolerance Statistics. The multi-colinearity tests produced Variance Inflation Factor (VIFs) for all study constructs below 1.2 and Tolerance statistics well above 0.9 and for all study variables. The results demonstrate tolerable intensity of multi-colinearity problem as the values above were below the recommended threshhold of VIF < 5; Tolerance value > 0.2; and Condition Index of < 30 [67].

4 RESULTS

Two hundred and twelve (212) Local Governments out of 302 responded indicating a response rate of 70.1 per cent. The majority of Local Governments that responded were District Councils, constituting 39 per cent, followed by Sub County Councils 38 per cent, and Town Councils with 20 per cent. Municipal Division Councils with 2 per cent and finally Municipal Councils with 1.4 per cent. The majority of Local Governments (73.6 per cent) had existed for more than 9 years, 18.9 percent between 5 to 9 years, while 7.5 per cent had existed for less than 4 years (1-4). The majority of respondents were males constituting (65%) and female comprised 35 per cent.

In order to explore and test the theoretical structure of the study area, besides the necessity to reduce our data to manageable levels, we performed factor analysis with Principal Component Analysis (PCA) [67]. Items were inter- correlated and rotated using varimax rotation method because of its ability to produce autonomous factors [67]. The analysis above produced two factors for communication practice (Formal and informal communication practices) explaining 61.9 per cent of the total variance. Similarly, the Kaiser Meyer Olkin (KMO) measure of Sampling Adequacy of (.80) and the Bartlett's test of Sphericity which was significant ($p < 0.01$) indicated that the data structure was likely to factor well. For quality service delivery, the analysis generated five factors (reliability, empathy, responsiveness, deliverables and tangibles) accounting for 65 per cent of the total variance. Similarly, the (KMO) measure of sampling adequacy of (.93) and the Bartlett's test of sphericity was significant at ($p <.000$). Both diagnostic tests therefore allude to the view that the data were likely to factor well.

4.1 CORRELATION AND REGRESSION ANALYSIS

Pearson's bi-variate correlation coefficient was used to determine the relationship between the independent variable: communication practice (formal and informal) and the dependent variable quality service delivery. The results of analysis are displayed in the table II below:

Table 2. Zero-order correlation between communication practices (formal and informal) and Quality Service Delivery

		1	2	3
1	**Formal Communication**	1.00		
2	**Informal Communication**	0.198**	1.00	
3	**Quality Service Delivery**	0.451**	0.250**	1.00
	N = 212; **Note:** ** correlation is significant to less than 0.01 level (2.tailed).			

Table 3. OLS regression results of formal and informal communication practice on Quality Service Delivery

		unstandardized			Model	R^2	Adjusted	ΔR^2
	Variable	**B**	**SE B**	**B**	**F**		**R^2**	
Model 1	Intercept(constant)	-.062	0.097		.185	0.002	- .008	0.002
	LG type	.004	0.011	.022				
	LG tenure	.017	0.033	.037				
Model 2	Intercept (constant)	-.956	0.149		18.431**	0.210	.199	0.208
	LG type	.013	0.010	0.077				
	LG Tenure	.012	0.029	0.026				
	Formal comm. practice	.200	0.027	0.460				
Model 3	Intercept(constant)	-1.309	0.199		15.956**	0.236	.221	0.026
	LG type	.011	0.010	0.066				
	LG tenure	.014	0.029	0.031				
	Formal comm. practice	.185	0.027	0.426				
	Informal comm. practice	.084	0.032	0.164				
	N = 212; **p < .01; *p < .05 **LG type = Local Government type: LG Tenure = Local Government Tenure**							

The results in Table II above indicate that formal communication practices have a positive and significant relationship with the quality of services that Local Governments deliver *(r = 0.451, p < 0.01*) thus providing support to ***(H_1).*** Further, the multi-variate regression analysis in Table III indicate that 20.8 per cent of the total variance in the quality of services that Local Governments deliver is explained by formal communication practices (R^2 *=0.208, p < 0.01*). These results therefore support *(H_1).* Further, a positive and significant relationship was established between informal communication practices and quality of service delivered by the Local governments in Uganda (*r = 0.250; p < 0.01*). This finding is supported by multiple regression results that revealed that 2.6 percent of the total variation in the quality of services that local Governments deliver is accounted for by informal communication practices thus supporting *(H_2).*

5 DISCUSSION

This study examined the extent to which independent variables: formal and informal communication practices, jointly and individually predicted quality service delivering within Uganda's Local Governments. The findings of this study demonstrated that both formal and informal communication practices are positive, and significantly predicted the quality of services that Local Governments deliver in Uganda. The findings further revealed that about 24 percent of the unique variance in the quality of services that Local Governments deliver is jointly accounted for, by a linear combination of both formal and informal communication practices. These findings are in tandem with those of Berger [15], Nardi [14], Johnson et al [55], & Canary, [13], who established significant predictive power of both formal and informal communication practices on organizations' capacity to meet their mandates (quality service delivery) in the context of this study.

The results further revealed that whereas both communication practices are essential in the delivery of quality services, the effect of formal patterns of communication was stronger (*r = 0.451, p < 0.01; R^2 =0.208; p < 0.01*) than informal communication practices (*r = 0.250, p <0.01; R^2=0.026 ; p < 0.01*) indicating that formal communication practices has had an

edge in easing, the local governments' capacity to deliver quality services than informal communication, as it allows accurate and detailed information flow among Local Government stakeholders. Based on this pattern of communication, periodic service delivery circulars, service delivery manuals, and invitation letters to heads of department to attend Technical Planning Committee meetings have been issued from time to time and these have been instrumental in aiding Local Governments to deliver quality services. These documents act as reference points to those tasked with service delivery responsibility, thereby facilitating their work.

Despite the low predictive power of informal communication practices on the quality of services that Local Governments deliver, the findings revealed that informal communication practices are handy, and therefore complement formal communication patterns in aiding quality service delivery in local governments. This mode of communication is particularly useful considering the fact the majority of the masses are illiterate, yet they need to be regularly consulted to ensure that services that local governments deliver are demand driven rather, than being supply led. Informal patterns of communication also ensure harmony, considering the view that it evolves along social networks. This is therefore not in variance with Canary [13], when he noted that informal communication is necessary specifically for easing the process of coordination among employees within the organisation.

Consequently, lateral information flow permits units or departments and individuals to work together, and in harmony which is a critical factor to the delivery of quality services to the people. Finally, these results demonstrated that reforming communication practices (formal & informal) provided opportunities for the Local Government stakeholders particularly staff to execute their tasks with ease and in co-ordinated manner, which is a key precursor to better service delivery.

6 CONCLUSIONS

The findings of this study indicate that communication practices (formal and informal) positively and significantly influence the quality of services that Local Governments deliver. It however revealed that while both patterns of communication are relevant in the delivery of quality services, the role of formal communication practice was so immense within Uganda's Local Government context. In view of this, Local Government authorities ought to streamline their formal communication systems, but without necessarily abandoning the informal structure if only they are to realise their mandate of quality service delivery.

7 IMPLICATIONS

The study findings suggest important aspects that require consideration by Local Government managers and researchers. The implication of these findings is that the significance of both formal and informal communication practices should be tackled or considered by both academic scholars and Local Government practitioners if quality service delivery decisions are to be appropriately derived. In this regard, these findings permit Local Government authorities to have a deeper and thoughtful understanding of how communication practices enhance quality service delivery. Thus, Local Government authorities should be enlightened about the benefits to be achieved from reforming communication practices in Local Government.

8 LIMITATIONS AND FUTURE STUDIES

This study acknowledges the following limitations. Firstly, the study measures communication practices and quality service deliver in a single moment thereby rendering causal links difficult to ascertain. Future studies could therefore consider employing longitudinal approach so as do overcome this glaring limitation. Secondly the study employed a unitary methodological approach. Therefore future studies should also consider use of qualitative approach (interviews) to form a basis for triangulation. Finally, this empirical study concerns a single Country Uganda, thereby making generalisation of results to other setting difficult given the fact that quality service delivery approaches and communication practices vary from country to country. Our service delivery model therefore needs to be tested in other countries to ascertain its functionality.

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Validation of Monte-Carlo Geant4 code for Saturne 43 LINAC

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ABSTRACT: The aim of this study was to model the 12 MV photon beam from a Saturne 43 LINAC configuring a 10×10 cm^2 radiation field, this by finding the required adjustments to the electron source parameters namely the spot size, shape and energy distribution. The MC simulation tool Geant4 version 4.9.4 was used with rocks clustering software and Geant4 MPI Interface to parallelize our Geant4-based application. In this work, we have developed a user code for Saturne 43 LINAC simulation. This code has the capabilities to run multiple simulations at the same time, perform our own variance reduction techniques, writing and reading phase-space data using IAEA routines, and calculate dose distributions in a water phantom. In aim to speed up the treatment head simulation, we have developed two variance reduction techniques; the first one is based on stacking mechanism and called GAMMATEC, where the second one is a particular implementation of bremsstrahlung splitting and called BREMSPE. The combination of these two techniques can reduce required CPU time about five times. After optimization it was found that the appropriate mean energy, sigma and its full width at half maximum are 11.5 MeV, 0.4 MeV and 1.177 mm.

KEYWORDS: Geant4, LINAC, MPICH2, Rocks Cluster, Monte Carlo.

1 INTRODUCTION

Monte Carlo (MC) [1] is a technique for simulation of the passage of particles through the treatment head of a linear accelerator (LINAC) used in radiotherapy. It is widely accepted that MC simulation of radiation transport is one of the most accurate methods for predicting absorbed dose distributions in radiation therapy. In the past, the major disadvantage of the MC method is principally due to a long computational time and a high cost of powerful computer. But in the present it has become much less severe due to the rapid increase in speed and decrease in cost of computers. There are several general purpose MC codes used for radiation transport simulation such as Electron Gamma Shower Version 4 (EGS4), Monte Carlo N-particle (MCNP), PENELOPE and Geant4.

Geant4 toolkit [2] is a simulation toolkit for the simulation of the passage of particles through matter. Its areas of application include medical and space science, high energy and accelerator physics. The main players in its development are in the discipline of high-energy physics, combining the efforts of more than 100 workers from facilities such as CERN in Europe, KEK in Japan and SLAC in the US. The Geant4 code calculates a physical evolution of each particle step-by-step by Monte-Carlo method. Geant4 has components to model the geometry, the materials involved, the fundamental particles of interest, the generation of primary particles for new events, the tracking of particles through materials and external electromagnetic fields, the physics processes governing particle interactions, the response of sensitive detector components, the generation of event data, the storage of events and tracks, the visualization of the detector and particle trajectories. The verity is, Geant4 is indeed very powerful, but also very complex. The acquisition curve is both steep and long. A superficial knowledge of C++ is insufficient to optimally use the toolkit. Currently Geant4 simulations are painfully slow; it can take up to week on our fastest computer to accurately simulate problems such as patient-dose calculations in radiotherapy.

Geant4 version 4.9.4 has been considered to simulate a Saturne 43 LINAC, used at CEA LIST LNHB for 12 MV photon beam for field size of 10×10 cm^2. In this paper we present in full details the methodology used to find wanted initial electron beam properties, using rocks clustering software [3] to launch multiple simulations at same time. Also we provided the description

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of our own variance reduction methods used to decrease the CPU time consumed by our simulation programs. The MC Geant4 simulation was divided into two parts; the simulation of the LINAC treatment head using our program called ParaSaturne43Writer and the calculation of dose distributions in a homogeneous water phantom using our program called ParaSaturne43Reader.

The accuracy of the calculation of the beam data from MC simulation depends on the accurate input data for modeling the accelerator treatment head. The basic information required for a MC simulation of a treatment head is the specifications of the accelerator geometry such as positions, directions, materials that can be supplied by manufacturer. The least known parameters in a MC simulation of a treatment head are often the properties of the initial electron beam because the manufacturers rarely supply any information for this parameter. Thus, the knowledge of the characteristic of incident electron beam parameters such as the mean energy, sigma and its full width at half maximum is critical to validate Geant4 code for a typical treatment head employed in radiotherapy. In order to compare the calculated data namely percentage depth dose and cross beam profile with measured ones in a homogeneous water phantom (40x40x40 cm^3), the gamma criterion was considered. The tolerance value assigned to relative dose was fixed at 1.5% and the tolerance value for measured positions was considered as 0.1 cm.

2 MATERIALS AND METHODS

2.1 MODELING THE HEAD OF LINAC

2.1.1 SIMULATION PROGRAM

We have developed our own C++ code dedicated to simulate Saturne 43 LINAC treatment head and called ParaSaturne43Writer. This C++ program has the capabilities to:

- Construct model geometry.
- Launch multiple simulations at same time; the parallelization of our program was established using rocks cluster software with Geant4 MPI Interface [4]. Geant4 MPI Interface is a native interface with MPI libraries, with this interface Geant4-based simulation can be parallelized with different MPI compliant libraries, such as LAM/MPI, OpenMPI, and MPICH2. The last one is adopted in our cluster.
- Perform our own reduction variance methods: BREMSPE and GAMMATEC.
- Store the simulation outline in a phase-space file with IAEA format [5], the plane where the particles were stored was located just after jaws components (SSD 50 cm).
- Visualize the whole geometry using the two graphics system namely RayTracer and HeppRep.

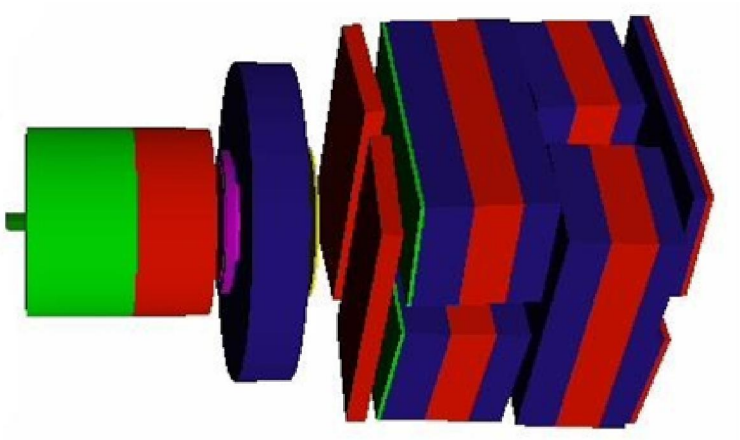

Fig. 1. Illustrating head Geometry using RayTracer

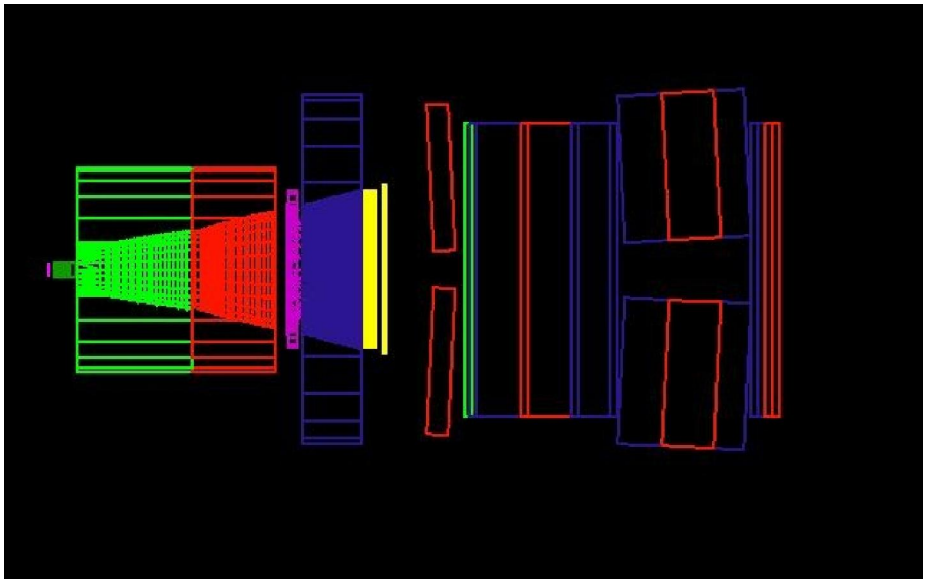

Fig. 2. Illustrating head Geometry using HeppRep

The accelerator head shown in Figure 1 and 2 with different system of visualizations consists of the following elements:

1. A Titanium window.
2. A target.
3. A primary collimator.
4. A secondary collimator.
5. A flattening filter.
6. An ionization chamber.
7. An aluminum plaque.
8. Secondary movable collimators (jaws).

Since the contents of main() program will vary according to the necessity of a given simulation application and must supplied by the user. Thus, we have created our own implementation of main() program that required to build a simulation which able to do the parallelization of independent runs and the Geant4 MPI Interface library was included to build this parallelization. We present now an extract of our code that describes the implementation of our main() program which provides a parallelization of independent runs:

```
G4String command = "/control/execute ";
G4String fileName ;
G4int rank= G4MPImanager::GetManager()-> GetRank();
if (rank==0) {fileName="12.3-0.56-0.5";}
if (rank==1) {fileName="12.2-0.54-0.5";}
if (rank==2) {fileName="12.1-0.52-0.5";}
if (rank==3) {fileName="12-0.50-0.5";}
if (rank==4) {fileName="11.9-0.48-0.5";}
if (rank==5) {fileName="11.8-0.46-0.5";}
if (rank==6) {fileName="11.7-0.44-0.5";}
if (rank==7) {fileName="11.6-0.42-0.5";}
if (rank==8) {fileName="11.5-0.40-0.5";}
if (rank==9) {fileName="11.4-0.38-0.5";}
if (rank==10){fileName="11.3-0.36-0.5";}
 UImanager->ApplyCommand(command+fileName+".mac");
```

2.1.2 CHOOSING PRIMARY INCIDENT GENERATOR

As known modeling sources in realistic setup soon required relatively more complex sources, G4ParticleGun cannot be used in this case. The general particle source (GPS) offers as predefined many common options for particle generation (energy, angular distribution, and spatial distribution). GPS is a concrete implementation of G4VPrimaryGenerator as G4ParticleGun but more advanced. As we can see in below example, how it is easy to fill parameters related to electron beam proprieties using GPS generator:

```
/gps/particle e-
/gps/direction 0 0 1
/gps/pos/type Beam
/gps/pos/centre 0. 0. -28 cm
/gps/pos/halfx 0 mm
/gps/pos/halfy 0 mm
/gps/pos/sigma_x 0.5 mm
/gps/pos/sigma_y  0.5 mm
/gps/ene/type Gauss
/gps/ene/mono 11.5 MeV
/gps/ene/sigma  0.4 MeV
```

Note that Geant4 code uses the sigma parameter instead of FWHM parameter for Gaussian spatial and Gaussian energy distributions.

2.1.3 CHOOSING APPROPRIATE PHYSICS LIST

Geant4 provides several physics lists, from geant4/source/physics_lists/builders we can found six model. The Table 1 shows the use case [6] of each model. emstandard_opt2 has been chosen as default physics model, which have been optimized to model transport of photons and charged particles for radiotherapy applications. In order to enhance bremsstrahlung photons, we have implemented our own bremsstrahlung splitting method, called BREMSPE, the description of this method can be found in “reduction variance methods” section.

Table 1. Physics model and their use case

model	Description
emstandard_opt0	recommended standard EM physics for LHC.
emstandard_opt1	best CPU performance standard physics for LHC.
emstandard_opt2	recommended for precision medical electron accelerator studies
emstandard_opt3	best current advanced EM options.
emlivermore	low-energy EM physics using Livermore data.
empenelope	low-energy EM physics implementing Penelope models.

2.1.4 CUT PRODUCTION ADJUSTMENT

Each kind of particle has a suggested production threshold or cut, the cut value defines the extent to which a particle is tracked, below production cut no secondary particle is produced but the energy loss is computed as deposited energy at the end of the step. In Geant4 the production threshold is defined in distance converted into energy based on the material. Two different cuts may be set: one for gammas that affects the bremsstrahlung process and one for electrons that affects the ionization process. The global photon cutoff energy was set as 10 KeV; this energy was used as the bremsstrahlung creation threshold and photon transport cutoff. While the energy cutoff for electron transport was set as 183 KeV.

The Table 2 describes the cut values in distance range assigned to all relevant materials composed the treatment head.

Table 2. Cut value for all materials used in treatment head

Material	production threshold (mm)	
	electron/positron	gamma
XC10	0.068	0.25
WNICU	0.0412	0.0185
Tungsten	0.037	0.0148
Titanium	0.067	0.339
Stainless_steel	0.0675	0.252
Pb	0.0652	0.0212
Kapton	0.28	21.6
Al	0.172	2.2

2.1.5 REDUCTION VARIANCE METHODS

Variance reduction techniques (VRTs) are used to reduce computing time taken to calculate a result with a given variance. Since for Geant4 code the user is free to implement their own biasing techniques; we have implemented our own reduction variance methods used to decrease CPU time consuming by treatment head simulation. We discuss in this section these two powerful methods used to tune our simulation. Thus, we can save a lot of CPU time by not tracking the particles that are not going to contribute to the results. We have defined in a clear way which is the results we don't want to change when applied this two methods; the number of particles reaching a scoring region was considered as observer.

BREMSPE (Bremsstrahlung **S**plitting for **P**rimary **E**lectron)

The implementation of this method is based on the class BremSplitting from HandOn5 [7] example. The bremsstrahlung splitting process has been established just for secondary photons resulting from only primary electrons bremsstrahlung interactions and our simulation efficiency was improved considerably when this technique was applied. On the other hand, we have done some changes in physics list, particularly in the implementation of emstandard_opt2 model, in order to make the bremsstrahlung splitting process possible. Our interest was to enhance photon production by applying splitting when a bremsstrahlung interaction occurs, but as mentioned above the splitting process will be take only secondary photons created when the bremsstrahlung process is invoked by primary electrons.

Al thought the number of splitting is a essential parameter which affect the simulation efficiency. Thus, we have doing many simulations where the number of bremsstrahlung splitting was the parameter to be evaluate. We have found that if the photons was split up 60 times, the simulation efficiency increases approximately two times.

GAMMATHEC (**GAMMA THE**TA **C**UTOFF)

We have developed this technique which based on stacking mechanism; the purpose was to manage the behavior of the stacks by implementing a G4UserStackingAction class. Secondary particles are created as G4Track objects and they are pushed on the stack using C++ standard containers. We can define the track not to be stacked so to be killed. Proper selection of tracks with well designed stack management provides significant efficiency increase of the entire simulation. This technique takes the action required to kill inutile photons according to their angles, this action not will take all photons who participated in our simulation but only photons those leaving target and not reaching (or their chance to reach this plane are considerably low) the scoring plane located just after jaws (at SSD 50 cm); an angle threshold has been assigned to photons those leaving the target. Although our interests was to study the impact of applying photons angle threshold in the speed of our treatment head simulation, since we have do an analysis to see a spectrum that describes the gamma angular distribution below jaws (at SSD 50 cm) as shown in Figure 3.

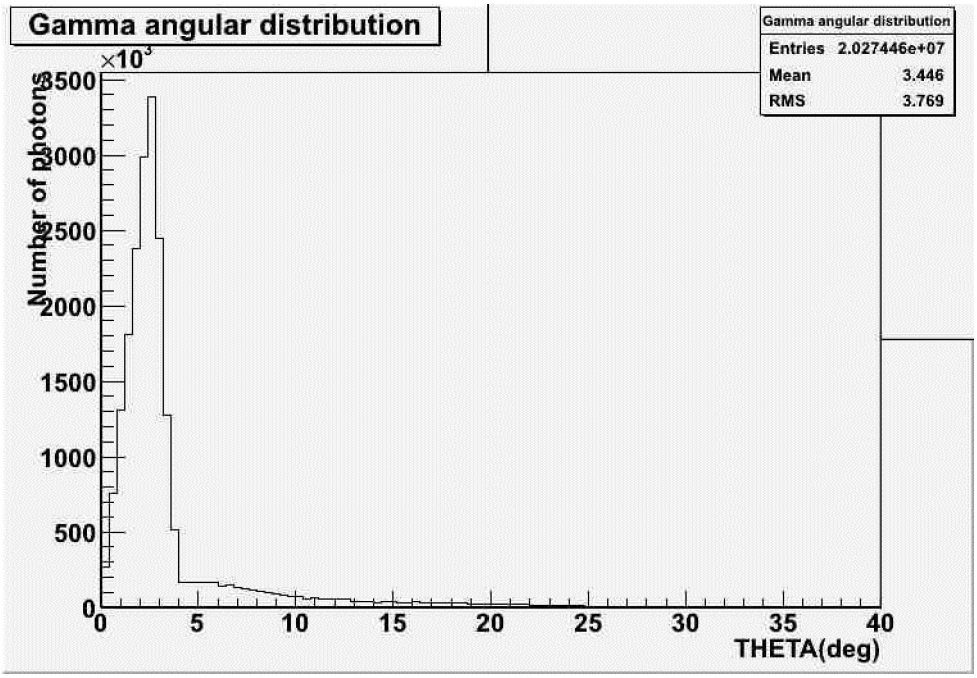

Fig. 3. Gamma angular distribution below Jaws (SSD 50cm)

The main purpose of this technique is to kill inutile tracks (photons originally created in the W-Target) those establish one of the following conditions:

A) If the track is created in W-Target and propagates in the negative z direction.

B) If the track has an angle greater than the angle threshold. The value of this threshold can be retrieved from Figure 3 which it provides a spectrum of gamma angular distribution below jaws; we can assume that the threshold angle is nearly equal to 22 degree. After applying this technique, the computing time taken by treatment head simulation was decreased about two times.

In the Table 3 we resume the set of parameters used for the treatment head simulation.

Table 3. Parameters used for the treatment head simulation

Parameter	value
Physics list	emstandard_opt2
Electron/Positron cut	10.058 KeV
Photon cut	183.6 KeV
BREMSPE, Split number	60
GAMMATHEC, Angle threshold	22 degree

2.2 CALCULATION OF THE DOSE DELIVERED IN THE PHANTOM

2.2.1 PHANTOM GEOMETRY

The Figure 4 shows the geometry of a homogeneous water phantom (40x40x40 cm^3) using HeppRep visualization system. The thickness of PMMA crossed by the beam is 4 mm (15 mm for the all other walls of the phantom). The distance from the top of the target to the external entrance window of the water phantom is 90 cm. The depth in water is expressed from the external side of the entrance window of the phantom. Thus, a measurement of 10 cm depth means 4 mm of PMMA plus 9.6 cm of water. The data used for comparison were the central axis percentage depth dose (The ratio of the dose at a given

point on the central axis of an electron beam to the maximum dose on the central axis multiplied by 100) and the cross beam profile at 10 cm depth.

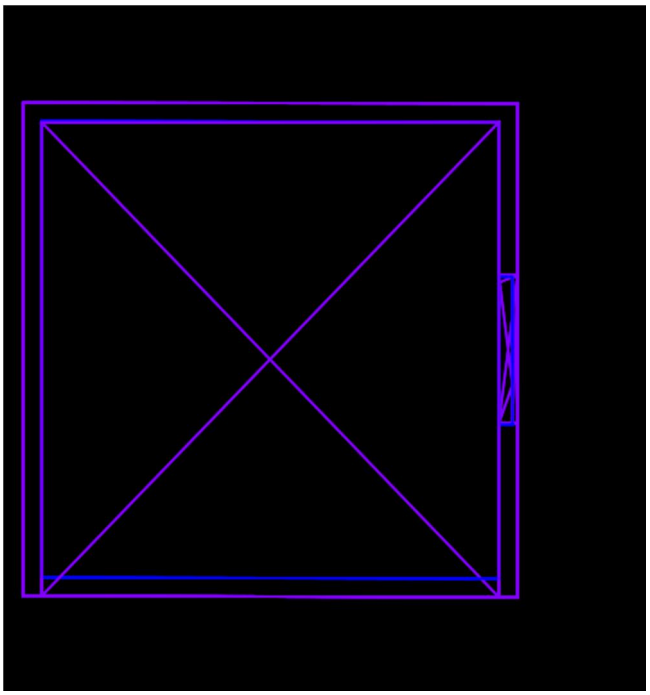

Fig. 4. Illustrating phantom Geometry using HeppRepp

2.2.2 SIMULATION PROGRAM

We have created our own simulation program called Parasaturne43Reader, this program has the Capabilities to:

- Simulate doses deposition in water phantom.
- Run multiple simulation at time (eleven independent runs), the parallelization of our program was established by using rocks cluster software with GEANT4 MPI interface.
- Read phase-space files using IAEA routines, the obtained phase-space files were used as an input to the Monte Carlo dose calculations.
- Generate the beam data of 12 MV photon beams, i.e. the central axis percentage depth doses, cross beam profiles.
- Visualize the whole geometry using HeppRep graphics system.

The main purpose of this program was to simulate energy deposit in a phantom filled with water for a typical LINAC (Saturne 43) used for intensity modulated radiation therapy. The 12 MV dose calculations were performed for field size 10 x 10 cm^2 and the voxel size for the 40 x 40 x 40 cm^3 water phantom was 5 x 5 x 5 mm^3. The simulation was run in parallel on a 11 node Linux cluster. The voxelised phantom size was 11.25 x 11.25 x 11.75 cm^3 and the number of voxels along x, y and z were 45, 45 and 47, respectively.

Useful efficiency improving techniques such as histories recycling is available in G4IAEAPhspReader [5] class, it can improve the efficiency of dose calculations without significantly changing the results. The Table 4 describes the set of parameters used in dose calculations program.

Table 4. Parameters used for dose calculations simulation

Parameter	value
Physics list	emstandard_opt2
Electron/Positron cut	10 KeV
Photon cut	10 KeV
Histories recycling	24 times

2.3 METHODOLOGY OF STUDY

It is well known that the least known parameters in a MC simulation of the treatment head are often the electron source parameters. Thus, our work consist to find required adjustment to this parameters related to the electron spot for a 12 MV photon beam, namely the spot size, shape and energy distribution for a single energy and a single field (12 MV photon; 10x10 cm^2 field at 100 cm from the source; 10 cm depth in water). At the first time we have followed the suggested methodology proposed by Verhaegen and Seuntjens [8], but unfortunately we have not arrived to optimize electron beam proprieties, even so we have advised the following method for selecting the electron beam properties to be evaluated:

1. The electron beam is characterized by a Gaussian-shaped energy spectrum.
2. We started with the following initial electron beam properties: 11.3 MeV as mean energy, sigma equal to 0.36 MeV, and a 2-D Gaussian distribution in the plane XY, with full width at half maximum (FWHM) fixed at 1.177 mm (Standard deviation = 0.5 mm).
3. For each independent run, we increase simultaneously the energy by 0.1 MeV and the sigma by 0.02 MeV. The FWHM value was fixed at 1.177 mm. The rocks clusters software was employed to run multiple simulations at same time and the Geant4 MPI Interface was considered to parallelize our simulation programs.
4. Gamma index program was employed to select the good electron beam proprieties between those suggested in this study.

In Table 5 we show the eleven initial electron beam proprieties used in this study.

Table 5. Properties of the initial electron beams

Gaussian energy parameters		*Gaussian spatial parameters*	
Mean (MeV)	*Sigma (MeV)*	*Mean(mm)*	*FWHM(mm)*
11.3	0.36	0	1.177
11.4	0.38	0	1.177
11.5	0.40	0	1.177
11.6	0.42	0	1.177
11.7	0.44	0	1.177
11.8	0.46	0	1.177
11.9	0.48	0	1.177
12	0.5	0	1.177
12.1	0.52	0	1.177
12.2	0.54	0	1.177
12.3	0.56	0	1.177

3 RESULTS AND DISCUSSION

3.1 LINAC HEAD SIMULATION SPEED UP

As stated in early paragraphs that Geant4 code is painfully slow; it can take up to week on our fastest computer to accurately simulate problems such as patient-dose calculations in radiotherapy. To accelerate the treatment head simulation we have developed the two variance reduction techniques namely BREMSPE, in order to increase the production of photons by the bremsstrahlung process and GAMMATHEC that use the stacking approach. In order to ensure that these two techniques can be safely used without biasing the simulations, we have launched two kinds of simulations with and without VRTs and a comparison between calculated data for these two kinds of simulations has been established. The Figure 5 shows the percentage difference between PDD data points for two kinds of simulations; all data points have a percentage difference less than 0.9%.

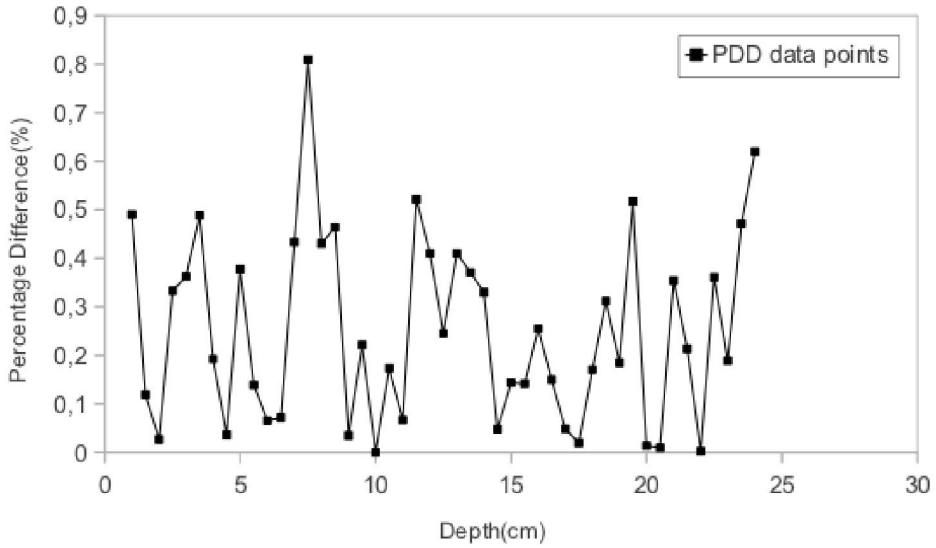

Fig. 5. Comparison between PDD data points for simulation with/without VRTs

Now we will see how these two methods can reduce CPU time required by treatment head simulation. The Table 6 gives such results.

Table 6. The numbers of bremsstrahlung photons per incident electron, the simulation times, and and the rates of photons reaching the scoring plan below jaws

Number of events processed: 10000	Photons /incident e-	CPU time /incident e-	Photons /second	Efficiency increase
Referenced simulation	0.0042	0.000457	9.19	1
BREMSPE	0.0883	0.00511	17.279	1.88
GAMMATHEC	0.0046	0.000262	17.55	1.91
BREMSPE+*GAMMATHEC*	0.083	0.001823	45.529	4.95

As we can conclude; that this two methods able to reduce the CPU time taken to simulate Linac treatment head and the simulation efficiency was found to be five times higher when using these two techniques.

3.2 PHOTON ENERGY SPECTRA

The MC method is a convenient and accurate tool allowing the calculation of spectra possessing the essential features of real spectra. Photon energy spectra of Saturne 43 treatment head was calculated with Geant4 (version 4.9.4), using GPS generator. The X-ray energy spectrum used was obtained after a 12 MV Gaussian electrons hit with the tungsten target.

The Figure 6 shows the results obtained for energy dependent flux of a 12 MV photon beam at 90 cm SSD. The X-ray energy spectrum was created by simulating 10^9 photons. The Energy bins have an homogeneous width of 0.1 MeV.

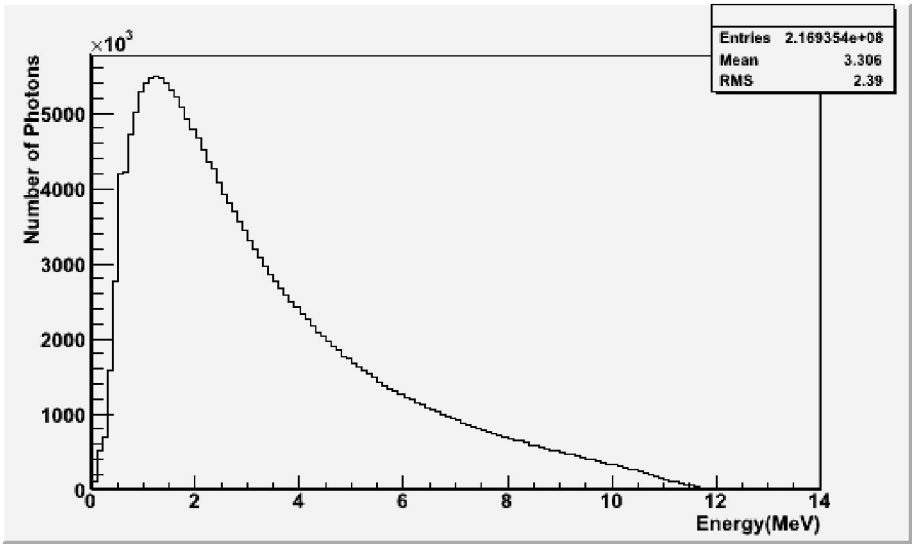

Fig. 6. Monte Carlo calculated spectrum photon energy spectrum at SSD 90 cm for 12 MV photon beam

The weighted mean energy of photon spectrum is 3.30 MeV which is comparable to the value 3.29 MeV published by M.Zoubair [9] and the value 3.24 MeV published by Blazy et al. [10] for a similar Linac.

3.3 COMPARISON BETWEEN SIMULATED DATA AND MEASURED ONES

The determination of absorbed dose within a patient is based on the measurement of absorbed dose in water, since mean electron density of soft tissues is close to that of water. The correction factor is given in the dosimetric code of practice and is based on the value of a beam quality index (QI). QI is defined for a fixed source-to-skin distance, SSD, of 100 cm, with the surface field size defined at 10×10 cm^2. The quality index for this definition is the ratio of depth doses on the central axis, at 20 cm and 10 cm, respectively (D20/D10) [11]. As mentioned in early paragraphs, the adjustment was performed by comparing our simulated data calculated in a homogeneous water phantom (40x40x40 cm^3) with the experimentally measured cross beam profile and the percentage depth dose (PDD) curves for a 10x10 cm^2 field. These data are provided by LNHB. In order to compare the results and to select the requested parameters (energy spectrum etc), the gamma criterion was used.

We have suggested our methodology to establish the electron beam tuning stage; the results of our study for selected electron beams proprieties are plain explained in the Table 7 where the tolerance value assigned to relative dose was fixed at 1.5% and the tolerance value for measured positions was considered as 0.1 cm.

Each phase-space file generated by ParaSaturne43Writer program for each electron beam proprieties announced in Table 5, contains in average about 4.5 millions particles as a consequence of simulation of 25 millions histories where the bremsstrahlung photon was split up 60 times. The average CPU time consuming by the ParaSaturne43Writer program was about two days. The Table 7 resumes the outputs obtained from ParaSaturne43Reader program where the number of histories was fixed at 5.10^8 particles, each one was recycled 24 times, the simulation average CPU time consuming by ParaSaturne43Reader program was about six days and the average statical uncertainly were less than 0.2% for PDD and less than 0.8% for cross beam profile. Parasaturne43Reader generate at the end of simulation two text files contains information about simulated data, one for percentage depth dose and one for cross beam profile.

Table 7. Comparison between calculated data for different electron beam proprieties used in the study

Beam proprieties			Index of Gamma < 1%		Index of Gamma < 0.5%		$TPR2_{0/10}$	Z_{Dmax} (cm)
Energy (MeV)	Sigma (MeV)	FWHM (mm)	PDD	Profile	PDD	Profile		
Measure	--	--	– –	– –	– --	– –	0.6282	2.5
11.3	**0.36**	**1.17**	97.90%	77.8%	70.2%	66.7%	0.6181	2.0
11.4	**0.38**	**1.17**	97.90%	80.4%	89.40%	58.7%	0.6210	2.5
11.5	**0.40**	**1.17**	97.90%	91.1%	95.7%	77.8%	0.6289	2.5
11.6	**0.42**	**1.17**	100%	73.9%	91.50%	56.5%	0.6236	2.5
11.7	**0.44**	**1.17**	100%	82.2%	91.50%	60.0%	0.6285	2.5
11.8	**0.46**	**1.17**	97.90%	86.7%	95.70%	71.1%	0.6327	2.5
11.9	**0.48**	**1.17**	100%	86.7%	89.40%	68.9%	0.6287	2.5
12	**0.50**	**1.17**	100%	80.0%	97.90%	62.2%	0.6295	2.5
12.1	**0.52**	**1.17**	100%	88.9%	100%	75.6%	0.6268	2.5
12.2	**0.54**	**1.17**	100%	77.8%	100%	53.3%	0.6303	2.5
12.3	**0.56**	**1.17**	100%	80.0%	89.40%	68.9%	0.6355	2.5

From these results one notices that the appropriate mean energy, sigma and its FHWM are 11.5 MeV, 0.4 MeV and 1.177 mm, as we can see for this electron beam proprieties that the simulated data agreed well with measured data, except data points who located in the penumbra region, where the dose profile has a high gradient, after all, 91.1% of the calculated data points seems agree with experience within 1.5% /1 mm. The percent difference in this region was about 6%. The ambiguities may possibly come from inaccuracies in the simulation geometry, the approximation of the initial source configuration or uncertainties in the measured data. The Figure 7 shows the cross beam profiles for measured and calculated data points.

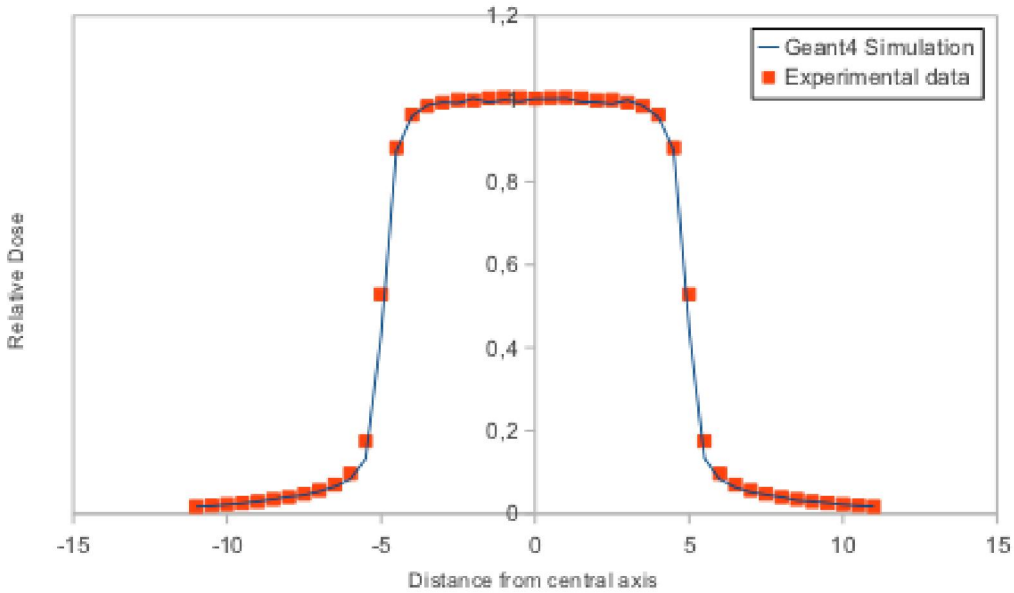

Fig. 7. Comparison of calculated and measured dose profile at the depth of 10 cm due to 12 MV photon beam in homogeneous water phantom, for a 10 × 10 cm^2 field size

For the depth dose curve, it's seems that 97.6% of the calculated data points agree within 1.5% / 1mm with the experimental measurements for depth 10 cm, so except the first data point all others ones were accepted, The ambiguities may possibly caused by inaccuracies in the approximation of the initial source configuration or uncertainties in the measured data. The Figure 8 shows the depth doses curves for measured and calculated data points.

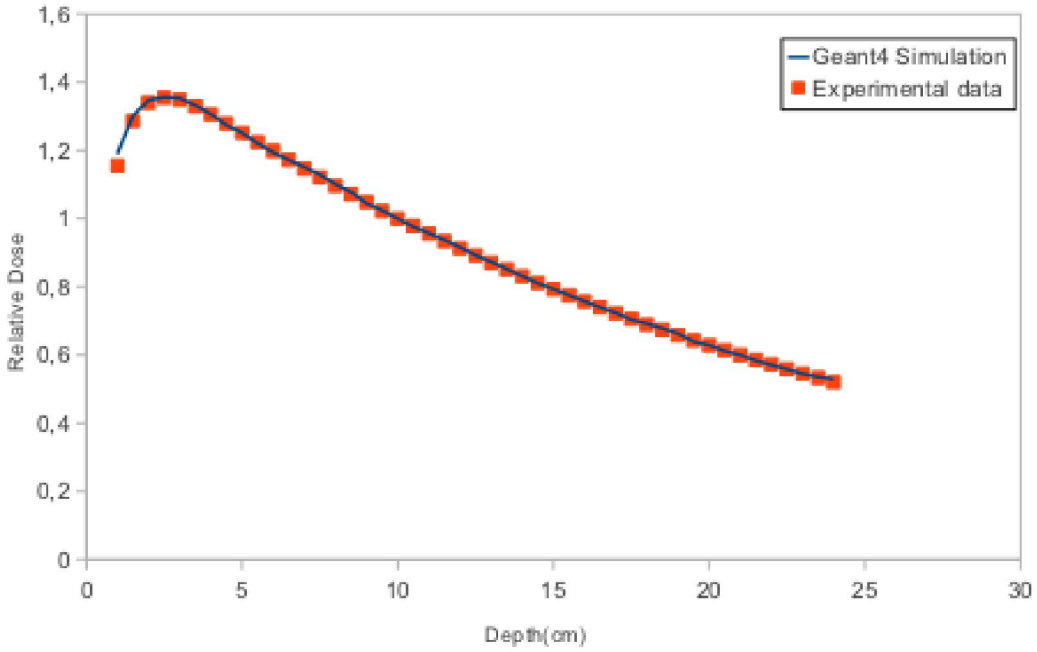

Fig. 8. Comparison of calculated and experimental relative depth dose due to 12 MV photon beam in homogeneous water phantom, for a 10 × 10 cm^2 field size. Results are normalized to the dose at the depth of 10 cm

4 CONCLUSION

This theoretical study has shown that it is possible to use Geant4 to model a typical linear accelerator used in radiotherapy with accuracy within 1.5% / 1mm. The goal was to evaluate and elaborate the ability of Geant4 to model the 12 MV photon beam from a medical linear accelerator Saturne 43 installed at CEA LIST LNHB and configuring a 10×10 cm^2 radiation field. During this work we have observed that MC Geant4 is very slow, even so we have developed two variance reduction techniques namely BREMSPE and GAMMATEC to speed up the treatment head simulation with a factor of five times. The knowledge of the initial electron beam proprieties is crucial to validate such linear accelerator. Thus, the parallelization of our Geant4-based application using rocks clustering software and Geant4 MPI interface has been considered to running multiple simulations at same time; each simulation has a different electron beam proprieties then the appropriate one was selected using gamma criterion.

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Fabrication and Radiocharacterization of Boron Carbide and Tungsten Incorporated Rubber Shields

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ABSTRACT: Radioactive ray safeguard is a physical impediment which is placed between radioactive source and the protected object in order to decrease the amount of rays' radiation in the protected area. Different materials such as lead, iron, graphite, water, poly ethylene, concrete, or rubber can be used for protection against nuclear radiations. In safeguard's common designing, two types of Gama and Neutron radiations are usually considered. The weakening amount of Gama radiations is proportional to the mass and atomic number of the safeguard's material. Covering Neutron source varies with regard to the source power and its application. However, what is always true is having the least dose with the least dimensions outside the safeguard. The dose of the safeguard's outside partition is resulted from quick, slow and thermal neutrons, and also from the source's Gammas and secondary Gammas. Neutrons use retarding and neutron-absorbing materials in order to reduce the dose. Due to the weak mechanical characteristics of the pure elastic composites, fillers are used to strengthen and improve their characteristics. Strengthening the elastic material is often defined through increasing the characteristics such as hardness, module, refraction energy, solidity, tear resistance, tensile solidity, lassitude resistance, abrasion resistance. In this paper, rubber shielding materials with boron carbide and tungsten as impurities have been fabricated. The optimum boron carbide contents (5% weight percent) have been evaluated using the Monte Carlo code, MCNP. The gamma attenuation coefficients for different boron carbide and tungsten contents have been measured for a number of rubber shields with dimensions of $1\times9\times16cm^3$.

KEYWORDS: Rubber Shielding, Boron Carbide, Tungsten, Gamma Attenuation, MCNP.

1 INTRODUCTION

Radioactive ray safeguard is a physical impediment which is placed between radioactive source and the protected object in order to decrease the amount of rays' radiation in the protected area. Different materials such as lead, iron, graphite, water, poly ethylene, concrete, or rubber can be used for protection against nuclear radiations. In safeguard's common designing, two types of Gama and Neutron radiations are usually considered. The weakening amount of Gama radiations is proportional to the mass and atomic number of the safeguard's material. Among the effective materials in absorbing the Gama ray are lead, steel, tin, bismuth, iron and tungsten [7]. Tungsten is not a toxic material and in terms of weakening power is better than lead and unlike it, can easily be mixed with polymeric materials. So, it is possible to make flexible safeguards that have great applicability in protecting rays by using composite materials with polymer and tungsten base [6]. Covering Neutron source varies with regard to the source power and its application. However, what is always true is having the least dose with the least dimensions outside the safeguard. The dose of the safeguard's outside partition is resulted from quick, slow and thermal neutrons, and also from the source's Gammas and secondary Gammas. Neutrons use retarding and neutron-absorbing materials in order to reduce the dose [8]. Some examples of retarding materials are: water, poly ethylene, paraffin, and other hydric materials. Among neutron-absorbing materials which have high area for absorbing hot neutron are

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cadmium, boron, and lithium which in case of mixing with polymers besides reducing the hot neutron's dose outside the safeguard, can decrease the possibility of interactions like H(n,γ)D and generation of secondary high-energetic Gama within the safeguard. These compound safeguards can be applied in coverage of neutron's source like radio-isotopic source of 241Am-Be, and in analyzing materials through making use of instant Gama (PGNAA). In PGNAA method, neutron's radiation to the sample and spectroscopy of Gammas resulting from neutron's interaction with the core of targeted elements happen simultaneously. Therefore, any gamma which has a base other than the targeted material is considered as the base Gama and the obtrusive factor [3].

2 EXPERIMENTAL STUDY

Due to the weak mechanical characteristics of the pure elastic composites, fillers are used to strengthen and improve their characteristics. Strengthening the elastic material is often defined through increasing the characteristics such as hardness, module, refraction energy, solidity, tear resistance, tensile solidity, lassitude resistance, abrasion resistance. Practically, strengthening is the improvement in the work life of the elastic pieces [9]. After Vvlkansh phenomenon, strengthening phenomenon in the elastomers, especially elastomers with general usage, is the most important process of strengthening the mechanical characteristics. The effect of common strengthening fillers like soot on the composite is as follows: generally by the increase of the amount of soot, module, tensile solidity, and hardness will increase and the length will decrease. By increase of reactive fillers even in the small amount, module, tensile solidity and length will increase simultaneously which is a feature of reactive fillers. The main purpose of adding different fillers to the elastic composite is to improve its special characteristics and to decrease the final cost of the product [10]. Among all the fillers, soot has fully been known as the effective strengthening filler for rubbers and elastic composites. However, adding soot to the composite gives black color to the piece. Because of that, researchers in two recent centuries have focused on other strengthening elements to replace soot [11]. In order to simulate the characteristics of boronic poly ethylene to find the proper percent of boron carbide in the composite a geometry like that of figure 1 was used. To investigate the effect of designed safeguards against neutrons, am-Be neutron source with energy spectrum ranged 100 keV – 11/3 MeV was used. The one-way plate source radiates with the area of 50 cubic centimeters and in the negative direction of the Y-axis and the area of this source is in a way that covers all the surface of the safeguard [2], [4].

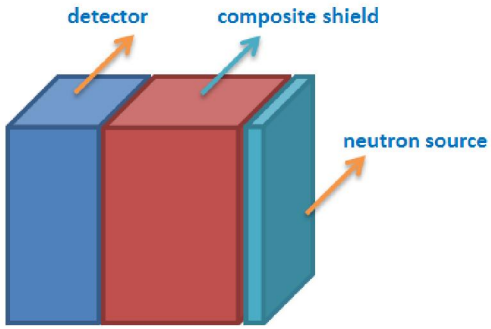

Fig. 1. Simulation geometry in order to find the optimal amount of boron in the safeguard [12]

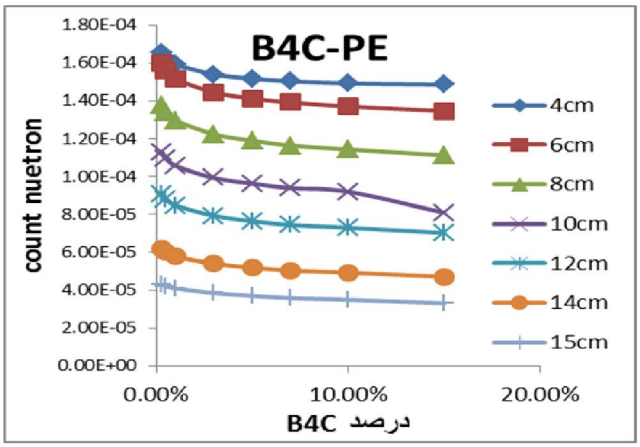

Fig. 2. Neutron's count changes due to adding boron to the safeguard's different thicknesses [19]

As can be seen in figure 2, by increasing the percent of particles, the number of neutrons will decrease up to 5 percent and after that it follows almost a fixed procedure. It can be concluded that the maximum of strengthening material to be used in making the composite is 5 percent [18]. Of course, by increasing the thickness of composites, the number of neutrons will be decreased and it should be considered in the measurements. With regard to the previous studies, most of the composite safeguards are from polymeric materials and have boron or lithium compounds. When using boronic composite safeguards, in addition to hydrogen energy peak of 2.2 MeV, the peak of 478 KeV related to boron appears with the intensity of about 2500 times in comparison with the reaction of neutron with hydrogen. But the positive point is the more weakening of the 478 KeV Gama in heavy elements like tungsten and bismuth. In the present study, in order to prepare the proper safeguard for weakening the flux of neutron, boron-carbide was used which based on the previous simulation study by MCNPX code, by having 5 percent of B4C with micro dimensions would include the best index for weakening the neutron. Also, tungsten was identified the best for protection against Gama [6]. Besides, elastic composites composed of 5 % boron carbide with 5 % tungsten, 5 % boron carbide with 15 % tungsten, and 5 % boron carbide with 30 % tungsten were made for the purpose of comparison. In this research, NR/CR compounds have been used to make elastic safeguards. Also, other required materials for preparing usual rubber are as follows: The materials of first group are considered as the polymer's bases which have multiple links with each other [2]. These two combinations have been used so that the sample is resistant against Ozone's conditions and has high mechanical characteristics as well as high capacity for accepting fillers. The materials of second group are cure systems which after weighing are put in a dish. The materials of third group are fillers which include soot and oil. Composites were prepared by the laboratory two-roll mill with the speed of 50 rpm and in the mixing temperature of 30-40 degrees of centigrade. After softening the rubber CR and NR on the roll for 5 minutes, the activator and catalyzer elements and at the end, the sulphuric cooking element were added to the compound. After the final mixture on the roll for 20 minutes, first 5 % boron carbide powder was mixed with the compound on the roll and at the final stage the tungsten powder with 5, 15, and 30 percent was added to the elastic compound. The plates were prepared by the hot press in the 19 degrees of centigrade and under the pressure of 25 mega Pascal in the form of pressurized molding. From each sample, two safeguards were cut in the dimensions of 16*9*1. The examples of the made rubbers are presented in figure 3. In order to measure the reduction of Gamma's flux, cesium 137 plate source along with NAI collimator and detector were applied [5].

Fig. 3. Three examples of elastic safeguard made with boron carbide and tungsten impurity

3 RESULTS

In this research, for the first time in Iran, by using hard phase of boron carbide and moving toward making flexible plates, safeguards have been designed and made which are very light, and resistant against Ozone's demolition, have high resistance against heat, and by including different amounts of neutron-absorbing materials like boron and lithium have a very good weakening index for absorbing hot neutrons. The plate composites are easily used and with no need for expertise can be cut by simple tools like scissors and cutter [11].

Table 1. The amount of reduction of Gama's flux in three Samples of Safeguard

sample	Sample thickness(Cm)	reduction in gamma flux(Percent)
first sample	1	11%
	2	20%
Second sample	1	14%
	2	24%
third sample	1	18%
	2	30%

4 CONCLUSION

They can also be installed on the wall, around the oval tanks, and other forms according to user's need. Composite safeguards can be used in all the operations which contain radioactive substance. In table 1, the amount of reduction in cesium 137 source's Gama flux is presented by the help of NAI detector by putting the three safeguard samples with thickness of 1 and 2 centimeters [12]. According to the spectroscopy illustrated in the table 1, by the increase of tungsten in the samples, the amount of reduction in the Gama's flux will increase. That is, the increase of tungsten in the samples has direct relation with decrease of flux. Also, by the increase of safeguard's thickness in each sample, the amount of Gama's flux between source and detector will decrease [5], [1].

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Rectangular Ring Microstrip Patch Antenna for Ultra-wide Band Applications

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ABSTRACT: The printed antenna is one of the best antenna structures, due to its low cost and compact design. In this paper, we present a new approach to improve the radiation effectiveness and the performance of antennas by miniaturization of the size. Indeed, we have studied the performance of ultra wideband antenna which consists of a ring-shaped patch. This study was made for the whole frequency band of UWB ranging from 2.5GHz to 9.4GHz and the geometry of the antenna and the results were obtained using the simulation software CST Studio microwaves. The detailed design and the results are shown and discussed in this paper.

KEYWORDS: Microstrip, Patch, Antenna, Planar, Broadband, Ultra Wide Band.

1 INTRODUCTION

Developments in communication systems Ultra Wide Band (UWB) in recent years have generated significant research activity dedicated to antenna wide bandwidth [1], [7], [9]. This technology is based on signals from the baseband which their band is not limited, of course levels of spectral densities; they must be limited not to interfere with existing systems. As an example, the United States, the Federal Communications Commission (FCC) emission limits -41 dBm / MHz in the band 3 GHz to 10 GHz levels [3], [7]. The FCC defines UWB as any radio technology that has a bandwidth greater than 500 MHz or greater than 25% of its center frequency. The field of UWB transmission technology for wireless data speeds up to several hundred Mbit/s. It comes as a result of development and Bluetooth wireless USB versions. This is a radio technology which is based on the generation of pulses with very short duration that gives rise to spectral components on a very wide frequency band, hence its name [2], [4]. UWB, the issue of useful signals is performed at a level below the level of ambient radio noise (- 41 dB / MHz), which limits the scope to ten meters (in the current regulatory framework proposed by the FCC) and has the advantage of not receiving multiple signals reflected by the obstacles encountered propagation. In other parts of the spectrum, the transmission power can reach - 75 dB / MHz. The UWB signals are digital signals that are modulated by the carrier frequency. Reaserchs are ongoing to define the degree of UWB compatibility with the existing applications. In various studies, the printed monopole antenna has received a great attention due to its wide band, its omnidirectional and its low dimensions [5]. Thus, a major challenge for ultra-wideband communications (UWB) terminals for small or very small, for short range radio and in combination with sensors or networks of information transfer in the context domestic, multimedia or professional. The low power consumption (and thus performance), ease of integration, and especially the cost are essential aspects that are incompatible with the performance [8], [6], [10]-[18].

In this paper, we propose a monopole antenna which consists of a ring-shaped patch fed by a 50Ω impedance feeder. The advantages of this antenna, consists of his small size and simple structure easing the manufacturing. The antenna design was performed using the CST microwaves studio software. The following sections describe the configuration, design and implementation of the proposed antenna.

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2 ANTENNA GEOMETRY

The antenna proposed is composed of a rectangular patch-shaped ring and printed on a substrate (FR4) having a length Lsub = 30mm and Wsub = 20mm width. The relative permittivity of 4.4 and thickness of 1.5 mm. The antenna is fed by a microstrip line of 50Ω, 12mm length and width w = 2.9mm, all placed on a ground plane of 20x10mm2 dimension as shown in Fig.1. Patch ring constitutes the radiating element of the antenna. The design and study of the proposed antenna with a bandwidth of operation below - 10dB, which extends from 2.5 to 9.16GHz, are presented.

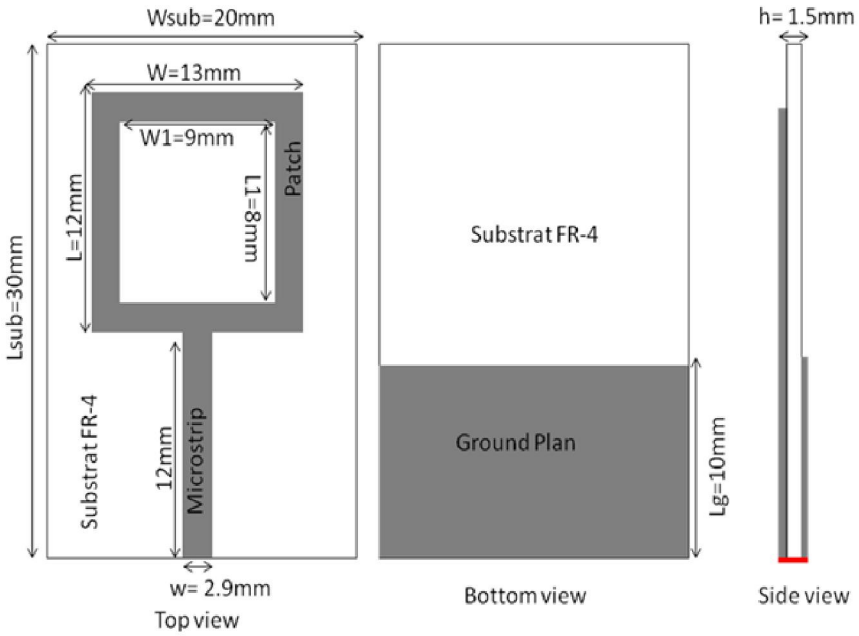


Fig. 1. Geometry of the proposed antenna

3 SIMULATED RESULTS

The simulation gives us three resonance modes centered on 3.17GHz, 6.38GHz and 9 GHz frequencies respectively. and a return loss of -10dB 2.5GHz to 9.16GHz which has a bandwidth for Bluetooth / ISM 2.5/3.5/5.5GHz, WiMAX and WLAN 5.2/5.7 GHz bands, with three resonant modes are mainly excited by the presence of a rectangular patch ring. Fig.2 shows the return loss of the proposed antenna. We note that this is an ultra-wideband antenna with a bandwidth between 2.5GHz and 9.16GHz. Two resonance modes are observed, one centered around 3GHz and the other around 6.2GHz. The presence of these resonances can be explained by the presence of the rectangular ring-shaped patch.

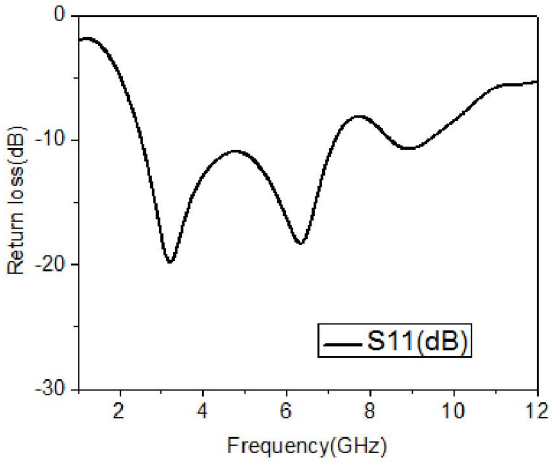


Fig. 2. The return loss S11 of the proposed antenna at L1 = 8 mm, W1=9mm, Lg = 10mm

Fig. 3 shows the variation of the return loss S11 as a function of the width (W1) of the rectangular slot in the center of the patch.

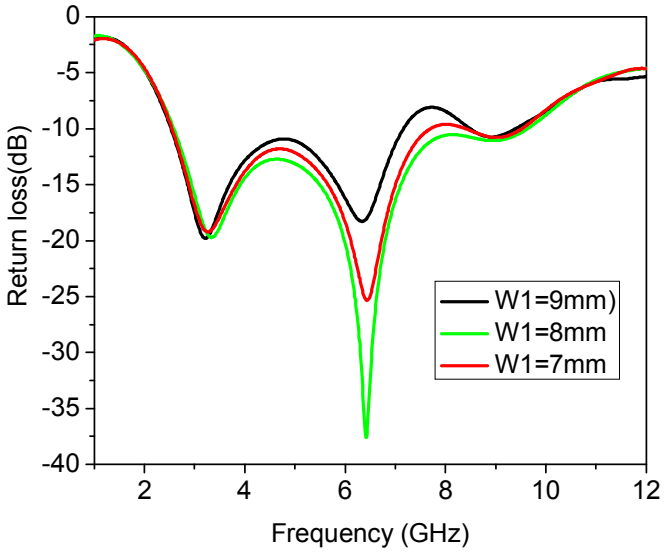


Fig. 3. The return loss S11 of the antenna functions W1.

Fig. 4 shows the variation of the return loss S11 as a function of length L1 of the slit.

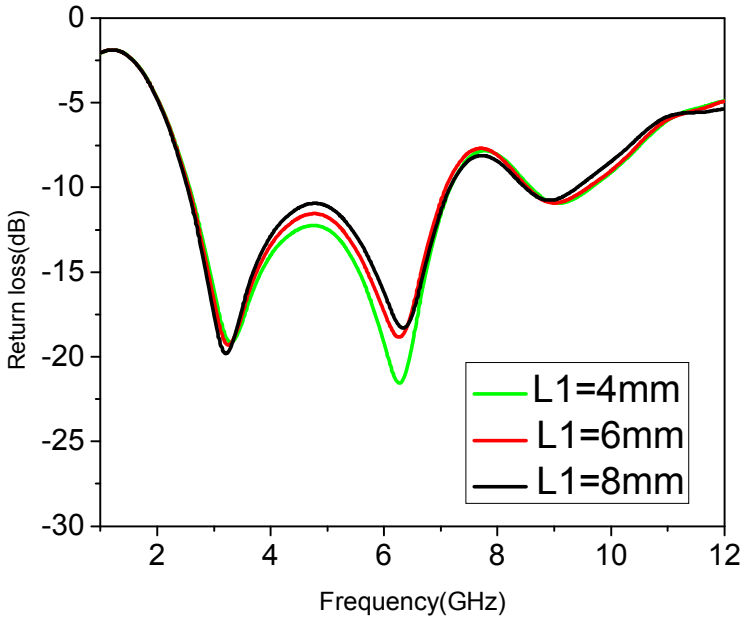


Fig. 4. The return loss of the antenna functions (L1)

The fig. 5 shows the variation of the S11 parameter as a function of the length of the ground plane. Note that the variation of the width (Lg) between 9.5mm and 10.5mm gives a shift of S11 parameter as shown in the figure below.

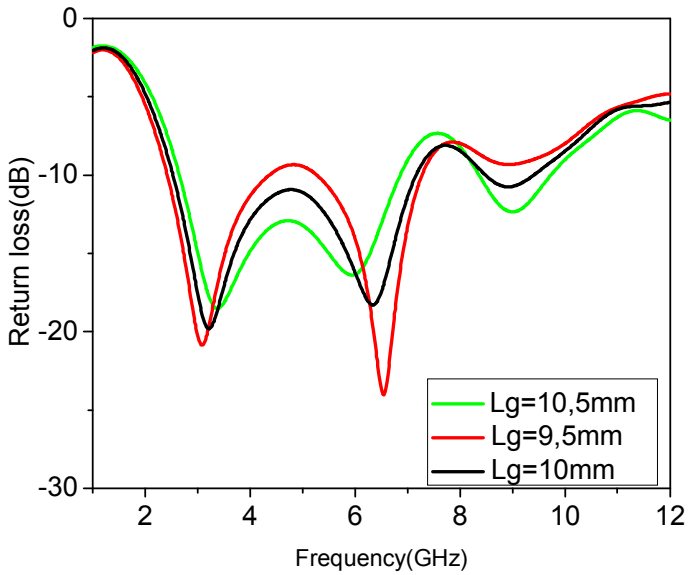


Fig. 5. The reflection coefficients of the antenna functions (Lg)

The fig. 6 presents the proposed antenna gain. The maximum value is obtained at 7GHz. The gain increases steadily from -2 to -5 dB between 2GHz and 7GHz, then decreases steadily until 2dB between 7 and 9 GHz before returning to growth.

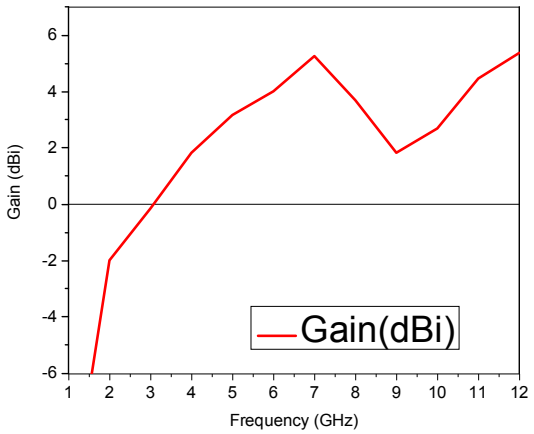
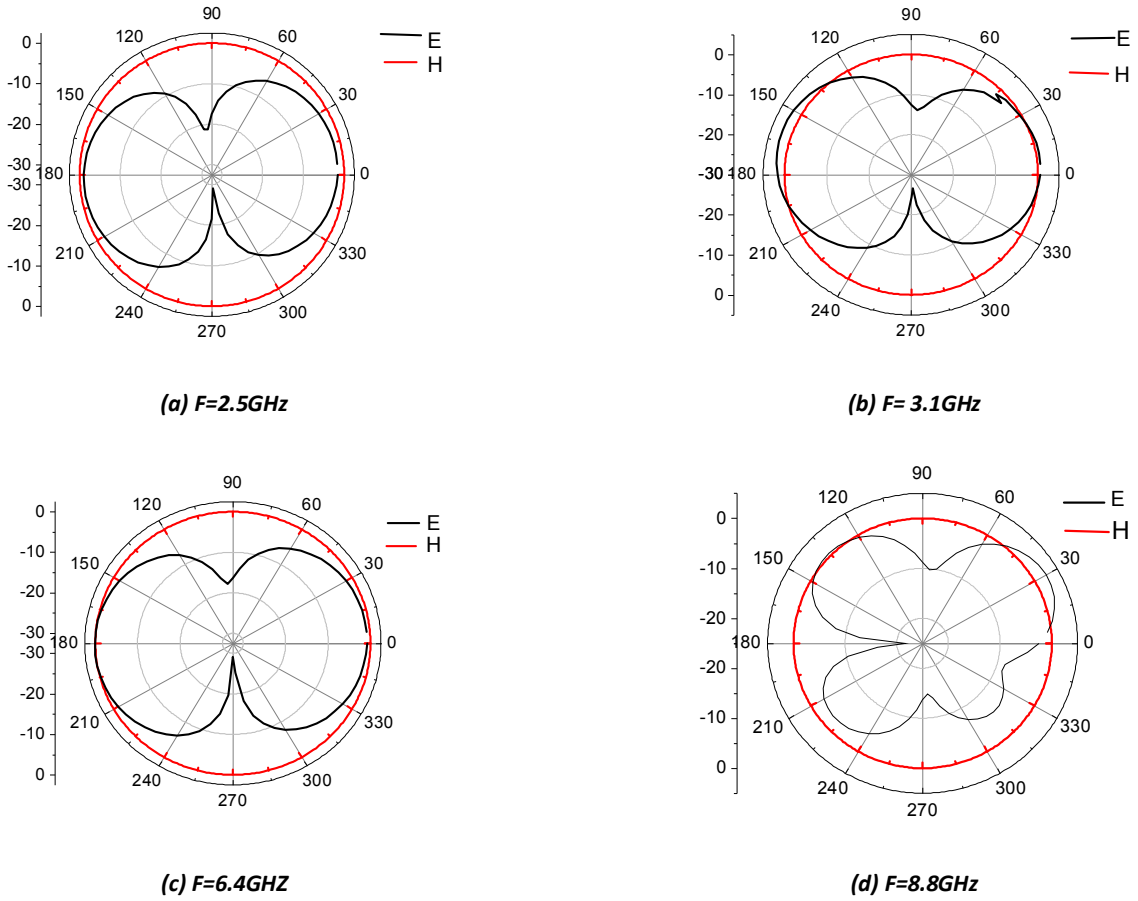


Fig. 6. gain of the proposed antenna

The fig.7 show the different types of radiation patterns for several frequencies: 2.5GHz, 3.17GHz, 6.4GHz and 8.8GHz can be seen that the radiation patterns are almost bidirectional.



(a) F=2.5GHz *(b) F= 3.1GHz*

(c) F=6.4GHZ *(d) F=8.8GHz*

Fig. 7. Radiation pattern of the antenna, (a) f = 2.5GHz, (b) f = 3.1GHz, (c) f = 6.4GHz and (d) 8.8GHz

4 CONCLUSION

The rectangular patch antenna ring ultrawide-bandwidth radiating between 2.5GHz and 9.4GHz in order to achieve the operation Bluetooth / ISM, 2.5/3.5 GHz and 5.2/5.7 GHz WiMAX WLAN. Simulation results show diagrams of acceptable radiation and are almost omnidirectional over the entire bandwidth with a significant gain.

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An Approach to Design & Development and Evaluation of Aceclofenac Floating Pellets Using Sodium Alginate and HPMC (HPMC K4M & HPMC K100LV) as polymer

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ABSTRACT: The present study was conducted to investigate the effect of Na-alginate and hydroxyl propyl methyl cellulose (HPMC) polymer combination of Aceclofenac floating pellets. The Aceclofenac pellets were prepared with two different grades of HPMC polymers in the ratio of 2:1, 1:2 and 1.5:1.5 respectively while the amounts of Na-alginate used in the formulations was 3.50, 5.25 and 7.0g. Prepared pellets were evaluated by Particle size and Morphology, Contraction ratio, Moisture content, Friability Test, Swelling study, Buoyancy time and floating time of the pellets were examined on the basis of polymer concentration. The contraction ratio of the particle was highest when pellets were prepared with 1.5% Na-alginate solution and the polymer ratio was 1:2 (BX, BY, BZ). In case of Buoyancy of Pellets, When Alginate concentration was 1% and HPMC K4M & HPMC K100LV ratio was 2:1 then, the Aceclofenac pellets were not floated for long time. When the concentration of Na-Alginate increased to 1.5%, 2%, then all pellets were floated. In case of swelling study, CY, BZ, CZ showed highest swelling of approximately 8% when Na-alginate concentration was (1.5 % , 2%, 2 %) and BY and CY batches showed lowest swelling of 2.9% at 4hrs when Na-alginate concentration was 1.5 %. Friability values for each formulation were recorded in table the values of the preferred formulas are within acceptable limit. Thus, the selection and use of suitable polymers in appropriate ratio is very important in designing floating pellets of Aceclofenac.

KEYWORDS: Na-alginate, Aceclofenac, Methocel, Floating Pellet, Polymer.

1 INTRODUCTION

Some solid dosage forms may be designed to release their medication to the body for absorption rapidly and completely. Sustained release, sustained action, prolonged action, controlled release, extended action, time release, depot, and repository dosage forms are terms used to identify drug delivery systems that are designed to achieve a prolonged therapeutic effect by continuously releasing medication over an extended period of time after administration of a single dose. The term "controlled release" has become associated with those systems from which therapeutic agents may be automatically delivered at predefined rates over a long period of time. Products of this type have been formulated for oral, injectable, and topical use, and include inserts for placement in body cavities as well [1]. Aceclofenac is a non-steroidal anti-inflammatory drug (NSAID). It is used for the relief of pain and inflammation in rheumatoid arthritis, osteoarthritis and ankylosing spondylitis. Aceclofenac has higher anti-inflammatory action than conventional NSAIDs [2]. It is a cytokine inhibitor. Aceclofenac works by blocking the action of a substance in the body called cyclo-oxygenase. Cyclo-oxygenase is involved in the production of prostaglandins (chemicals in the body) which cause pain, swelling and inflammation. Aceclofenac shows high anti-inflammatory, antipyretic and analgesic activity with moderate incidence of gastric side effects and a high therapeutic index [3]. Our literature survey revealed that there were no research publications on floating pellets of Aceclofenac using Na-alginate and hydroxy propylmethyl cellulose blend (Methocel® K4M Premium USP & Methocel® K100LV Premium USP) [4]. Hence, the present research study was designed to develop floating pellets of Aceclofenac using

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Na-alginate, Methocel® K4M Premium USP & Methocel® K100LV Premium USP indifferent amounts as polymers and the Aceclofenac Floating Pellets were evaluated with respect to Particle size and Morphological Study by Scanning Electron Microscopy (SEM), Contraction ratio, Moisture content and Friability Test, Swelling study, Buoyancy time and floating time of the pellets.

2 MATERIALS AND METHODS

2.1 CHEMICALS, REAGENTS AND EQUIPMENTS

Aceclofenac was obtained as a gift sample from United Pharmaceuticals Ltd., Chittagong, Bangladesh. Na-alginate (LOBA Chemicals Pvt. Ltd., India), Methocel® K4M Premium USP and Methocel® K100LV Premium USP were received from BASF Bangladesh Ltd. Calcium chloride (CaCl2) (Merck, Germany), disodium hydrogen phosphate (Merck, Germany), potassium dihydrogen phosphate (Merck, Germany) were collected from Glaxo Smith Kline, Chittagong, Bangladesh. All the chemicals and reagents used for the present research work were of analytical grade. The equipments used in the entire study were Scanning Electron Microscopy (Hitachi S-3400N), Dissolution tester (Erweka-DT70), Digital pH meter (WTW-pH 3000), Magnetic stirrer (Heidolh), Electronic balance (Toledo B303-S) and UV-Visible spectrophotometer (Shimadzu, Japan).

2.2 PREPARATION OF ACECLOFENAC FLOATING PELLETS

Drug, polymers **(**Na-alginate, Methocel® K4M Premium USP & Methocel® K100LV Premium USP) and other excipients were weighed separately according to the proposed formulations of floating pellets. In the present study, nine formulations of *Aceclofenac* floating pellets coded as AX, BX, CX, AY, BY, CY, AZ, BZ and CZ were pr*e*pared using various quantities of polymers and other excipients as shown in table 1.

Table 1. Codes & composition of various formulations of Aceclofenac floating pellets (Weights are expressed in g)

Formulation Materials	Formulations								
	AX	**BX**	**CX**	**AY**	**BY**	**CY**	**AZ**	**BZ**	**CZ**
Aceclofenac	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sodium alginate	3.50	3.50	3.50	5.25	5.25	5.25	7.00	7.00	7.00
Methocel® K4M USP	2.00	1.00	1.50	2.00	1.00	1.50	2.00	1.00	1.50
Methocel®K100LV USP	1.00	2.00	1.50	1.00	2.00	1.50	1.00	2.00	1.50
Calcium Chloride	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
Water up to	350	350	350	350	350	350	350	350	350

To prepare the *Aceclofenac* floating pellets, Na-alginate (1% w/w) gel was prepared by overnight soaking with sufficient quantity of demineralized water which was homogenized by using electronic stirring at 4000 rpm for half an hour. Then required amount of Methocel® K4M Premium USP & Methocel® K100LV Premium USP for each formulation was added to form suspension and the resultant mixture was homogenized for half an hour. A requisite quantity of Aceclofenac was also added to the obtained mixture which was further homogenized for another 45min. The homogenized solution was sprayed on to cationic solution (CaCl2, 0.1%) and 15min reaction time was provided for the formation of pellets which were collected and washed for four times with distilled water. Finally, they were dried at room temperature for approximately 12h. During the entire experiments, all of the parameters such as stirring time, rpm, reaction time, drying time and temperature were optimized by error and trial method [5],[6].

2.3 EVALUATION OF ACECLOFENAC FLOATING PELLETS BY SCANNING ELECTRON MICROSCOPY (SEM)

The morphology of Aceclofenac pellets was examined by scanning electron microscopy (SEM) at the Bangladesh Center of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh). The sample was carefully observed with SEM (Hitachi, S-3400N). The particle sizes (n=2) of Aceclofenac pellets were measured with a digital slide calipers and the contraction ratio of the beads was calculated by dividing the mean volume of dried gel (dried pellet) by that of the hydrogel (wet pellet) [7].

Table 2. Diameter of pellets according to slide calipers

Batch No.	Mean Diameter of Dried pellets (n=10)	Standard Deviation (S.D)	Standard Error (S.E)	S.D±S.E
AX	1.244	0.0442	0.052	0.0442±0.052
BX	1.071	0.0438	0.0139	0.0438±0.0139
CX	1.072	0.051	0.0145	0.051±0.0145
AY	1.071	0.044	0.013	0.044±0.013
BY	1.626	0.034	0.010	0.034±0.010
CY	1.492	0.026	0.008	0.026±0.008
AZ	1.072	0.049	0.0156	0.049±0.0156
BZ	1.267	0.015	0.004	0.015±0.004
CZ	1.339	0.041	0.013	0.041±0.013

n= No. of Pellets

Table 3. The contraction ratio of Aceclofenac pellets

Batch no.	Diameter of hydrogel pellets(mm)	Diameter of dried pellets(mm)	Contraction ratio(CR)
AX	2.28	1.367	0.599
BX	2.313	1.396	0.6035
CX	2.27	1.144	0.504
AY	2.390	1.1134	0.467
BY	1.705	1.458	0.856
CY	1.9615	1.369	0.698
AZ	2.071	1.05	0.508
BZ	2.12	1.283	0.6051
CZ	2.106	1.338	0.631

2.3.1 DETERMINATION OF PELLET MOISTURE CONTENT

In order to assess the performance of the drying process, the residual moisture present in the pellets was determined by weighing the samples before and after the drying process using a thermo balance Mettler Toledo (Made by Mettler Toledo Group US).(Claudio Nastruzzi).

2.3.2 FRIABILITY TEST

Resistance to abrasion was determined using a Friability Test Apparatus (Manufactured by Remi Equipments US). To this end, o.1gm of pellets was uniformly tumbled for 10 min at 25 rpm. Weight loss from the tablet was measured afterwards. (*Claudio Nastruzzi*) [8].

$$\% \text{ Loss of weight} = (\text{loss of weight} \div \text{Initial weight}) \times 100$$

Table 4. Percent (%) of weight loss and moisture content

Batch Number	Percent of weight loss (%)	Moisture content (%)
AX	0.5%	0.3
BX	0	0.1
CX	0	0.4
AY	0.5%	0.3
BY	0	0.2
CY	0	0.4
AZ	0.6%	0.3
BZ	0.5%	0.15
CZ	0.6%	0.1

2.3.3 BOUNCY OF THE PREPARATIONS

Specific gravity of the test solution (distilled water, 0.9% NaCl solution & gastric fluid) was previously measured using a standard pycnometer. Sample pellets (ten pellets) were steeped in 50ml of each test solution and their buoyancy was observed visually. The preparation was considered to have buoyancy in the test solution only when all of the granules floated in it [9].

Table 5. Buoyancy time and Floating Time of Aceclofenac Pellets

Batch No.	*Buoyancy Time*	*Floating Time(hr)*
AX	-	12
BX	-	10
CX	-	14
AY	1	14
BY	1.2	8
CY	1.5	10
AZ	1.7	10
BZ	1.8	8
CZ	1.9	10

`-` means pellets were not bounced.

2.3.4 SWELLING STUDY

The extent of swelling was measured in terms of percent (%) weight gained by the beads. The swelling behavior of formulations of AX, BX, CX, AY, BY, CY, AZ, BZ,CZ of Aceclofenac beads were studied. In this test, 10 mg beads from each formulation were kept in petri dishes containing pH 1.2 phosphate buffers. At the end of 1 hour, the beads were withdrawn, soaked with tissue paper and weighed. Then for every 1 hour, weights of the beads were noted, and the process was continued till the end of 4 hours. Percent weight gained by the beads was calculated by the following formula [10], [11].

$$S.I = \{(Mt-Mo) / Mo\} X 100$$

Where, S.I = swelling index, Mt = weight of beads at time 't' and Mo = weight of beads at time, t = 0.

Table 6. Swelling time of Aceclofenac pellet

Batch No.	*Swelling index (%) (at 4 hours)*
AX	2.9
BX	3.1
CX	3.5
AY	3.6
BY	4.0
CY	5.3
AZ	8.4
BZ	8.2
CZ	9.1

3 RESULTS AND DISCUSSION

3.1 PARTICLE SIZE AND MORPHOLOGY OF ACECLOFENAC PELLETS BY SCANNING ELECTRON MICROSCOPY (SEM)

Aceclofenac floating pellets were prepared at different concentration of sodium alginate and HPMC. The magnifications were used for taking micrographs were 10-3500. (SE-Secondary Electron) Morphology and surface properties of the pellets were found to be affected by the extent of core loading and polymer type.

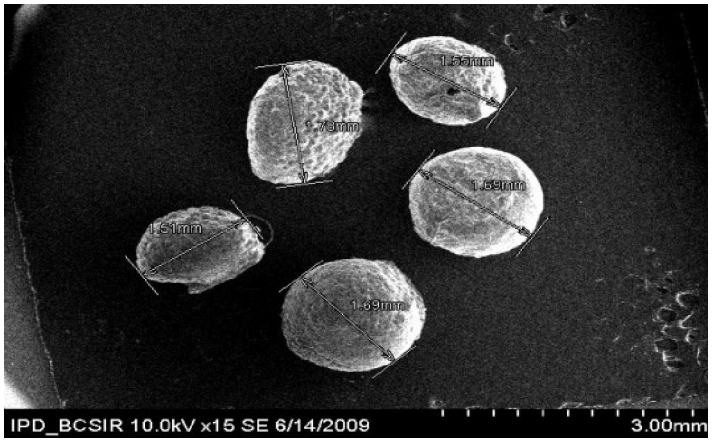

Fig. 1. SEM Photograph showing the diameter of pellets (Batch BY)

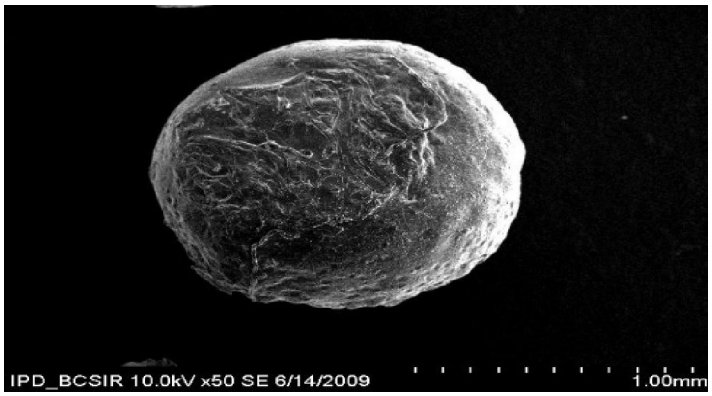

Fig. 2. SEM Photograph showing shape and surface of pellet (Batch BY)

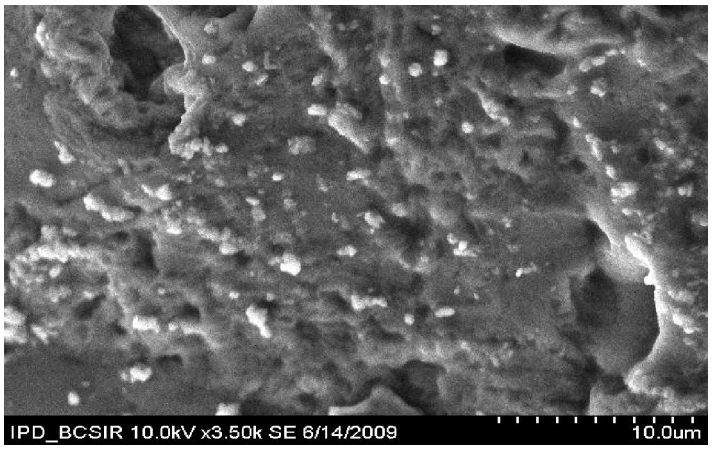

Fig. 3. SEM Photograph showing Drug distribution dried surface (Batch BZ)

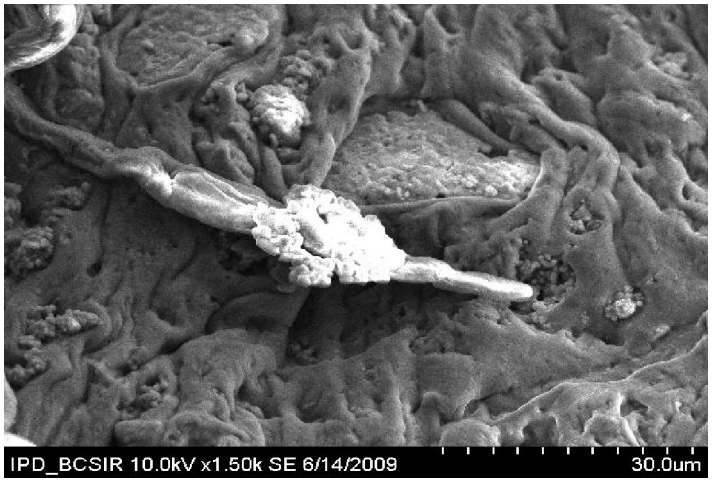

Fig. 4. SEM Photograph showing polymer in dried pellets (Batch AZ)

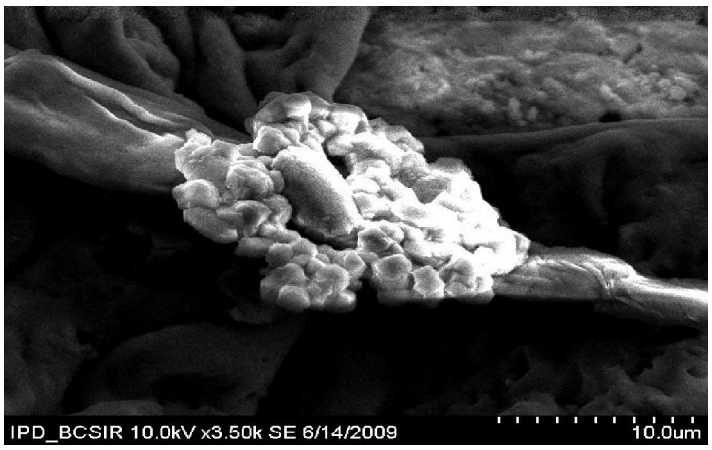

Fig. 5. SEM Photograph showing uncovered drug crystal on the surface (Batch AZ)

It is clear from the figures that magnifications provide the morphology of single pellet with diameter Table 2 and figure 6 and the pellet is roughly spherical in shape [12]. The magnifications also provide the idea of pellet surface, which is relatively smooth. It also showed the drug distribution, though the drug particles are present on the surface but they are scattered and amalgamated. The figures also give the idea of net-work between Na alginate and the polymer for the pelletization and this unique rearrangement satisfy the stability and strength of pellets [13].

SEM was performed on the prepared Aceclofenac pellet to access their surface and morphological characteristics in Figure 1 & 2. These figures also showing the diameter and shape of the pellets. Figure 3 shows the drug distribution in the polymer network. Figure 4 give idea about polymer network in the pellet surface. Figure 5 shows the presence of uncovered drug crystal on the surface could be attributed to formation of drug nucleus in the non-stirred layer surrounding the emulsified droplet during solvent evaporation [14].

3.2 CONTRACTION RATIO

The sizes (n=20) of Aceclofenac pellets were measured with a digital slide caliper (Fisher brand) and the contraction ratio of the bead was calculated by dividing the mean volume of dried gel (dried pellet) by that of the hydrogel (wet pellet) table 3. The contraction of particle increased with the increase of the polymer. This is also affects the release of polymer from Aceclofenac pellets which was showed in figure 7.

Fig. 6. Pellet Diameter Analysis

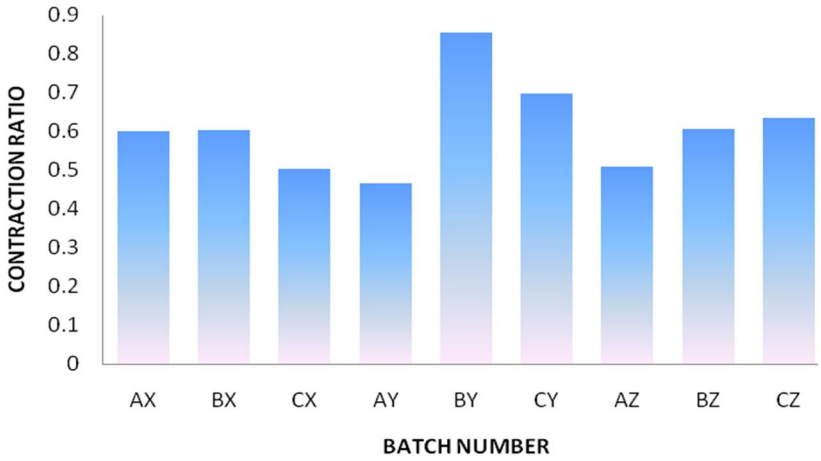

Fig. 7. Contraction ratio of Aceclofenac pellets

3.3 FRIABILITY TEST AND MOISTURE CONTENT OF PELLETS

Percent of loss of weight was minimum for designed batches. So the friability rate of the pellets of the prepared batches can be considered for stable formulation. Moisture content in percentage is shown in the following table 4. The residual moisture content was considerable for stable batches.

3.4 BUOYANCY OF PELLETS

When Alginate concentration was 1% and HPMC K4M & HPMC K100LV ratio was 2%, then, the Aceclofenac pellets were not floated for long time. When the concentration of Na-Alginate increased to 1.5%, 2%, then all pellets were floated in physiological saline, water or HCl solution for long time, even more than 8 hours. Pellets first sink & gradually released Aceclofenac and floated. When Alginate concentration was increased and HPMC concentration was varied like the table table 5 and figure 8 then the beads floated in physiological saline, HCl solution or the buffer solution (pH 1.2), all of which have specific gravity about 1.01. The Buoyancy time and floating time were calculated for each batch which are shown in the table.

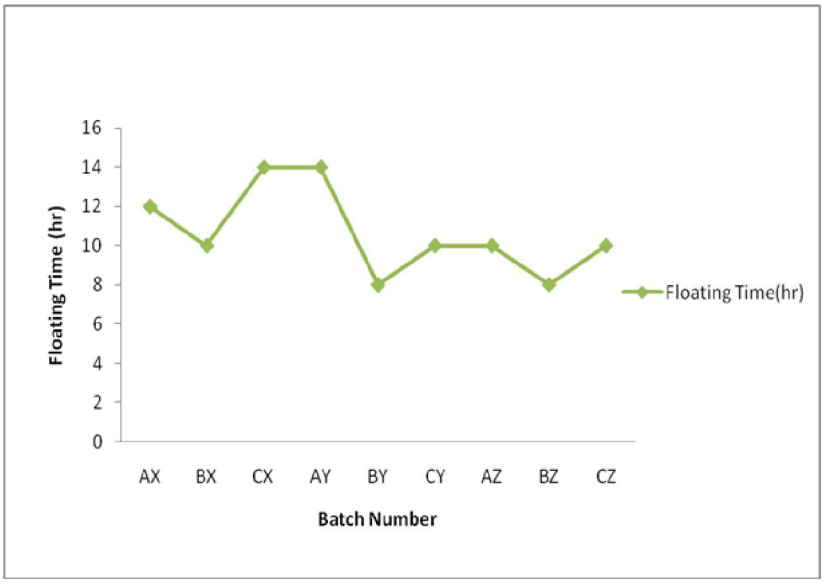

Fig. 8. Floating Time of Aceclofenac Pellets

3.5 SWELLING STUDY

In the formulation were prepared using different ratio of Sodium Alginate and HPMC (K4M & K100LV) polymer blend. Among the 9 batches CY, BZ, CZ contain 1.5 %, 2%, 2 % of Sodium Alginate table 6. These batches showed highest swelling of approximately 8%. BY and CY batches contain 1.5% Sodium Alginate and they showed lowest swelling of 2.9% at 4hrs. So from the result it was evident that with the increasing the polymer content the swelling index also increased figure 9.

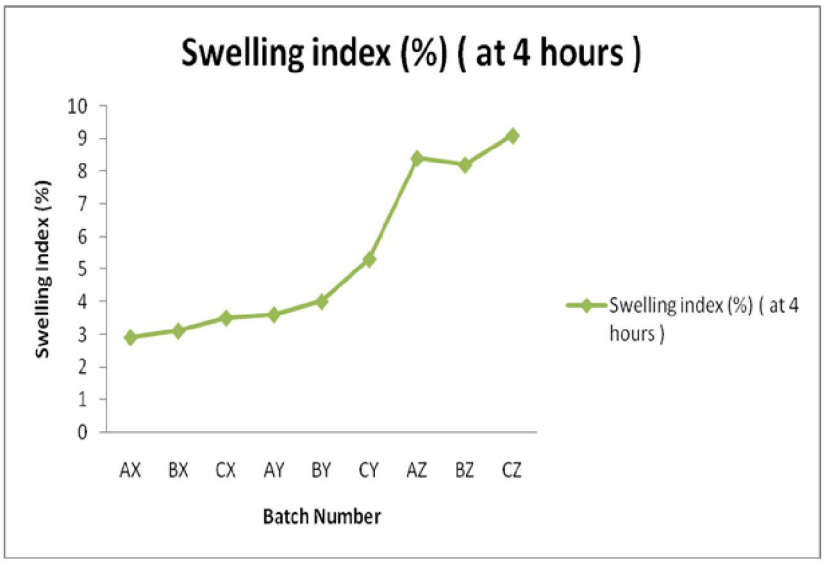

Fig. 9. Swelling time of Aceclofenac pellets

4 CONCLUSION

The Morphological Study and particle size by Scanning Electron Microscopy (SEM), contraction ratio, moisture content, friability Test, swelling study, buoyancy time and floating time of the pellets were investigated in this study. The scanning electron Microscopy gives us idea about the diameter, shape, surface and polymer network of the Aceclofenac floating pellet. The contraction of particle increased with the increase of the polymer. The floating time of Aceclofenac floating pellets increases with increasing drug and polymer concentration. The friability rate and moisture content was within the

acceptable limits. So, it can be concluded that the above parameter of Aceclofenac floating pellets is depend on the appropriate selection of drug polymer ratio. From results obtained, it was concluded that the formulation of Aceclofenac floating pellet containing a combination of both polymers (Sodium Alginate and HPMC (HPMC K4M & HPMC K100LV) was taken as formulation because, it fulfills all the requirement of sustained release dosage form. The further studies should be carried out determine the *in vitro* release kinetics of Aceclofenac floating pellets and to check the reproducibility of pellets by using *in- vitro- in -vivo* correlation .This will help to get information about the efficacy of Na- alginate and HPMC based floating pellets of Aceclofenac in *in- vivo* environment.

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An Efficient Analog Maximum Power Point Tracking (MPPT) Regulator for the Parallel Hybrid Photo Voltaic – Diesel and Wind Energy Systems

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ABSTRACT: In this research article we have proposed a new analog MPPT regulator with the high efficiency DC-DC converter for the photo voltaic and high efficient z- source converter for the variable speed wind energy systems. The both renewable energy output power is connected in parallel with the diesel generator and whole system provide the efficient hybrid energy systems to given the electrical power to the external grid. The MPPT regulator provides the control signal for the DC-DC converter and tracks the maximum power from the solar panel. In which here a logic truth table based perturbation and observation (P & O) algorithm used for the maximum power point tracking (MPPT) and hybrid bridge resonant DC-DC converter is giving the constant output voltage equal to the DC bus voltage by changing the proper modes. The parallel configuration is selected for the energy transformation from the solar panel, wind power and diesel systems to the load. The design includes a bidirectional inverter along with a dc-dc converter capable of interfacing a battery bank with the AC bus. The goals of the project included the implementation of two modes of operation: a battery discharge mode where current is being fed into the AC bus and a battery charging mode in which current is pulled from the grid and put into the batteries. A secondary goal of the design was to ensure that the current being injected into AC bus was at or near unity power factor by utilizing a hysteresis current control method.

KEYWORDS: MPPT regulator, P&O algorithm, Hybrid Bridge Resonant, DC-DC converter, Wind energy, Bi-directional Inverter.

1 INTRODUCTION

The demand for energy will continue to increase as long as world population increases and people continue to demand a higher standard of living. The global demand for electric energy has continuously increased over the last few decades. Energy and the environment have become serious concerns in the today's world. As per the Kyoto agreement from the world nations reduce the production of greenhouse gases, the Alternative sources of energy generation have drawn increasing attention in recent years. Among a variety of the renewable energy sources, PV sources are predicted to become the biggest contributors to electricity generation among all renewable energy generation candidates by prediction IMS research in 2040 of 35 GW [10]. Photo voltaic systems are become a promising alternate energy source because it has over advantages such as abundance, pollution free and renewability. Photovoltaic systems are converting the energy of sunlight into electricity by using photo voltaic effect. The sunlight on earth surface at noon is around 1KW/ m^2. Due to the non-linear relationship between the current and voltage of the photo-voltaic cell, it can be observed that there is a unique maximum power point at a particular environment, and this peak power point keeps changing with the solar illumination and ambient temperature.

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In recent year's large no. of techniques have been implemented for the maximum power point tracking (MPPT), such as constant voltage tracking (CVT), the incremental conductance (ICT), and hill climbing / perturbation and observation (P & O) algorithm [11]. Here Perturbation and Observation (P&O) method has a simple feedback structure and fewer measured parameters. It operates by periodically perturbing (i.e. incrementing or decreasing) the solar array terminal voltage and comparing the PV output power with that of the previous perturbation cycle. In this manner, the peak power tracker continuously seeks the peak power condition.

For the distributed MPPT application, it requires a MPPT controller to generate a proper reference signal for the DC/DC controller in order to ensure the PV module operating at its maximum power point. A cost-effective analog MPPT controller is proposed to form a single chip controller solution for the distributed MPPT stage. The operation of proposed MPPT controller is based on a logic truth table extracted from the perturbation and observation (P&O) algorithm [6]. The capacitor based storage cell concept is proposed to store the Vpv and Ppv in the last perturbation cycle. The perturbation frequency and step size may be adjusted by the user. MPP is tracked by using DC-DC converters. Much attention has been given to the hybrid bridge DC-DC converter topology. The resonant DC/DC converters, which are good candidates for the distributed MPPT stage application due to their simple structure, soft switching features and high efficiency [5].

Wind energy has the biggest share in the renewable energy sector. Over the past 20 years, grid connected wind capacity has more than doubled and the cost of power generated from wind energy based systems has reduced to one-sixth of the corresponding value in the early 1980s. The important features associated with a wind energy conversion system are Available wind energy, Type of wind turbine employed, Type of electric generator and power electronic circuitry employed for interfacing with the grid [14]. In this research article we are focusing on the induction generator coupled with the variable speed turbine fed with the z-source converter to get the maximum output from the wind energy and this whole system is connected in parallel with the photo voltaic and diesel system for the optimizing and efficient hybrid energy system [13].

In the bi- directional inverter the design was specified to use the same hardware in two modes of operation and thus have bidirectional power flow functionality. The discharge mode was specified as the process of extracting energy from the battery bank and using it to supplement the AC bus. This was accomplished by boosting the battery bank voltage to the necessary level and then converting it to ac with the proper frequency and phase needed in order to inject current into the AC bus [2]. This mode required a way to synchronize the inverter output current with the AC bus voltage in order to ensure a near unity power factor and thus minimize reactive power. Alternatively, the charge mode of operation utilizes the AC bus to recharge the battery bank and store energy. This is accomplished by rectifying the AC bus voltage and regulating the amount of current flowing into the batteries.

In this parallel configuration allows all energy sources to supply the load separately at low or medium load demand. The supplying peak loads from combined sources by synchronizing the inverter with the alternator output waveform. The capability to synchronize the inverter with diesel generator and the wind power allows greater flexibility to optimize the operation of the system [1].

2 PROPOSED SYSTEM CONFIGURATION

The block diagram of the proposed system is shown in figure1. It consists of PV array, MPPT regulator, hybrid bridge resonant converter, bi-directional inverter, wind power, diesel generator and battery. The main advantage of this systems are (1) the system load can be met in an optimal way (2) the diesel generator efficiency and maintenance can be maximized (3) a reduction in rated capacities of the device also meet peak loads. The MPPT regulator is achieve to track the maximum power from the solar array and given the control signal to the resonant DC- DC converter. The hybrid bridge resonant DC-DC converter having the maximum efficiency when the conversion takes place (wide range input voltage into constant output voltage) and given the constant output voltage to the DC bus. This DC bus voltage is ideal for the input of the battery bank and also the bi- directional inverter. For the production of power from the wind energy the double fed induction generator with the z-source inverter is used. The output of the z- source inverter is relate with constant alternating voltage and frequency related with the AC bus. Diesel generator is need only when the battery backup is dry and there is no power from the solar array (during night) and no power from the wind(very low wind session) in the medium load conditions which is directly connected to the load also the peak load conditions it will share the load by synchronizing. In this system seek to reduce the number of cycles and the depth-of-discharge for the battery bank, run the diesel generator in its most efficient operating range, maximize the utilization of the renewable resource, and ensure high reliability of the system.

For most efficient operation the generated power is supplied directly to the load from all energy sources which reduce the cycling of the battery bank. The high capacity sealed lead- acid battery is selected for the battery bank which is having the less maintenance and long life time.

3 MODES OF OPERATION

The design process of hybrid energy systems requires the selection of the most suitable combination of energy sources, power-conditioning devices, and energy-storage system, together with the implementation of an efficient energy dispatch strategy. For most suitable operations hybrid energy system controller set to operate in the difference mode. The modes are described as follows

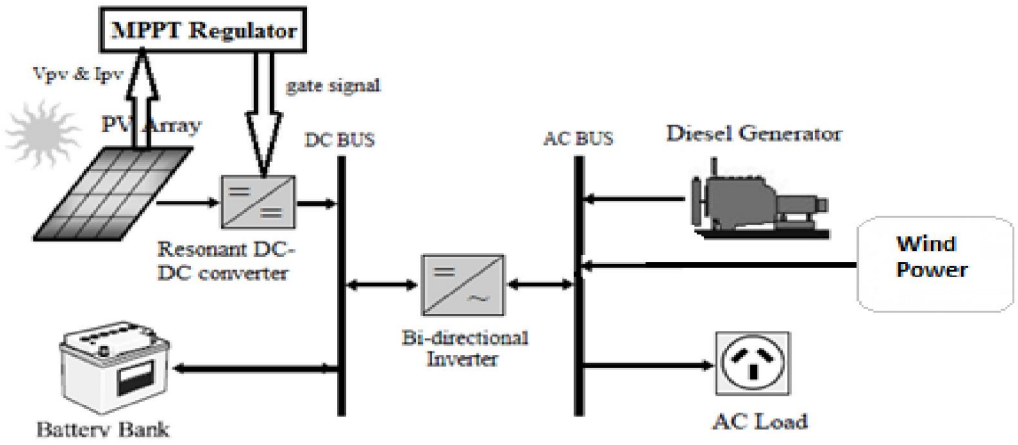


Fig. 1. Block diagram for parallel configuration of hybrid systems

Mode (I)
The base load, which is typically experienced at night and during the early morning hours, is supplied by wind power or energy stored in the batteries. Photovoltaic power is not available and the diesel generator is not started.
Mode (II)
PV power is supplemented by stored energy to meet the medium load demand.
Mode (III)
Excess energy is available from the PV generator, which is stored in the battery. The medium load demand is supplied from the PV generator and from the wind power.
Mode (IV)
The diesel generator is started and operated at its nominal power to meet the high evening load. Excess energy available from the diesel generator is used to recharge the batteries.
Mode (V)
The diesel generator power is insufficient to meet the peak load demand. Additional power is supplied from the batteries by synchronizing the inverter ac output voltage with the alternator waveform.
Mode (VI)
The diesel generator power exceeds the load demand, but it is kept operational until the batteries are recharged to a high state-of-charge level.

4 MPPT REGULATOR

At present many MPPT methods have been developed and they implemented digitally either in a microcontroller (MCU) or field programmable gate array (FPGA). The tracking performance of the MPP using digital controller is high. However the potential benefit of the analog solution is in MPPT can be integrated with DC/DC controller to form a single chip "MPPT Regulator" shown in figure 2.

The most desirable approach for universal analog MPPT is the P&O method. Moreover, for the target PV applications, the P&O method is capable of obtaining a satisfactory tracking result. However, there is an implementation problem with this method dealing with how to implement the algorithm with simple circuits and how to store the value of Vpv and Ppv in last perturbation cycle. This is a challenge for analog MPPTs.

In this research, a truth table is extracted from the P&O algorithm. Based on this table, the analog MPPT controller may only need to use several logic gates to realize the tracking algorithm. Meanwhile, the concept of a capacitor based storage cell is proposed to save the value of Vpv and Ppv in the last perturbation cycle. The minimum voltage step of perturbation may be set by the combination of amplitude of charge (discharge) current and the time duration of charge (discharge) action. Normally 0.5% of the open circuit voltage is selected [6].

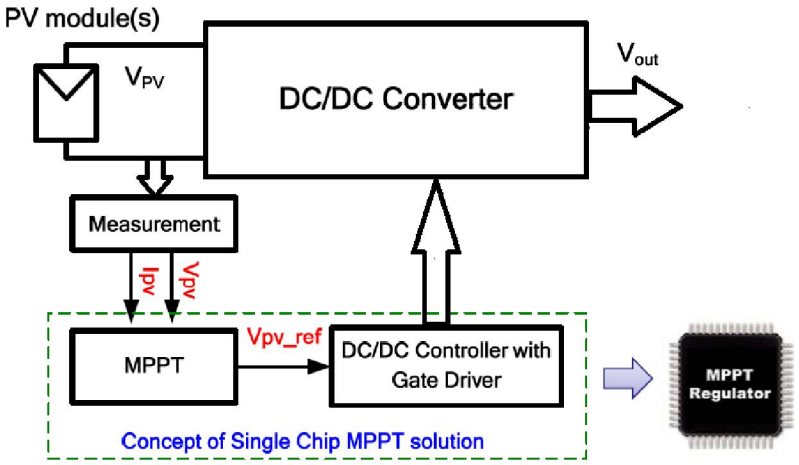


Fig. 2. MPPT Regulator

The analog MPPT controller has two input signals: PV panel voltage Vpv, panel current Ipv. The output signal from MPPT controller is a reference signal for DC/DC controller and its value will keep updating once MPPT starts running.

Table 1. Truth Table extracted from P&O algorithm

Present Perturbation	Change in power	Next perturbation
Positive	Positive	Positive
Positive	Negative	Negative
Negative	Positive	Negative
Negative	Negative	Positive

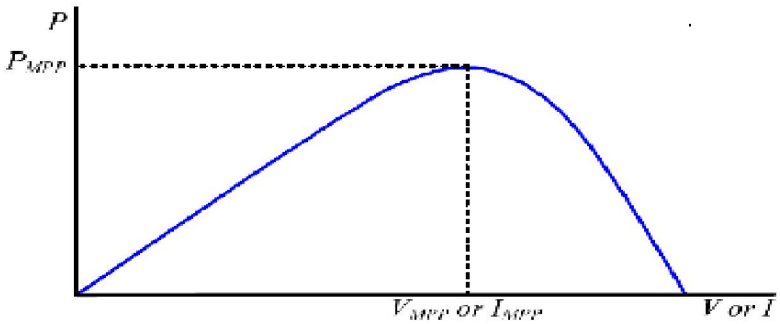
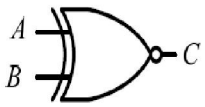


Fig. 3. Typical P-V curve of a PV panel

When operating on the left side of the MPP, incrementing the panel voltage will increase the power; whereas operating on the right side of MPP, incrementing the panel voltage will decrease the power. By continuously injecting perturbation onto the panel voltage or current and observing the variation of output power, the MPP may be reached when following the algorithm summarized in Table 1.



A	B	C
1	1	1
1	0	0
0	1	0
0	0	1

Fig. 4. Symbol and Truth Table of EXOR gate

In Table, "positive" is defined as logic "1" and "negative" is defined as logic "0", a truth table may be derived which implies that the algorithm may be implemented by simple logic circuitry. Moreover, if we take "perturbation" and the "change in power" as two inputs and the "next perturbation" as output, the logic relationship between the inputs and output matches that of an XNOR gate shown in figure4, As a result, with the derived truth table, the P&O algorithm may be implemented around an XNOR gate with some other logic circuitry [6].

5 HYBRID BRIDGE RESONANT DC-DC CONVERTER

The main challenge for the front end DC-DC converter in the photo voltaic system is to achieve the wide input voltage range with the high efficiency. The circuit diagram of hybrid bridge resonant DC-DC converter and their parameters are shown in figure 5. The Hybrid bridge resonant DC-DC converter is achieving the wide input voltage range with high efficiency by operating with the two modes of operation. In this converter a threshold voltage is defined as the half of the maximum open circuit voltage in panel. When the converter input voltage is above the threshold voltage (Vin > Vth), the converter is acts as a half-bridge converter. In half bridge mode the switches S_1 ans S_2 are conducting to achieve the mode and get the proper DC gain with high efficiency and when the input voltage of the converter is less than the threshold voltage (Vin < Vth), the converter acts as a full bridge converter. In full bridge mode all the four switches S_1, S_2, S_3, and S_4 are conducting to achieve the mode. In this mode we know the DC gain is doubled in full bridge, so we may get the proper high gain and good efficiency. Here the pulse signal for the switches S_1 and S_4 are identical and S_2 and S_3 are the same. A special gate logic generator is designed to the safe mode transition by generating proper gate drive signals [5].

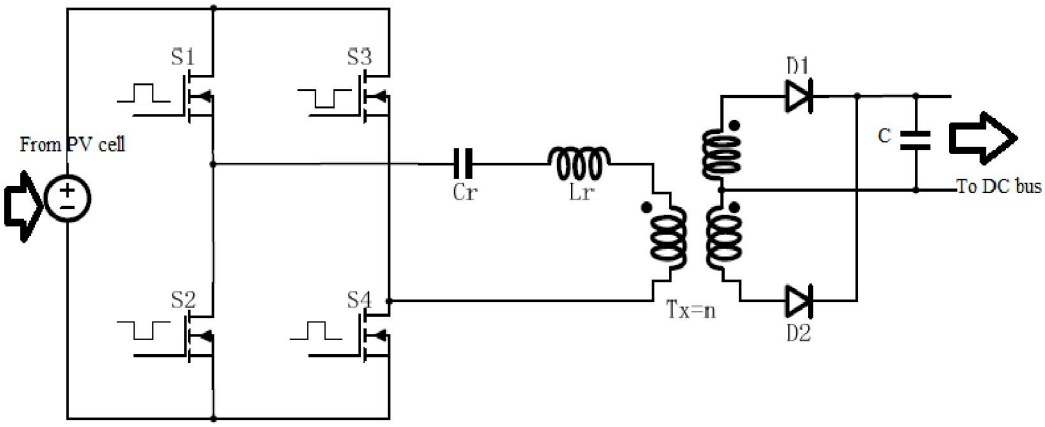


Fig. 5. Circuit diagram of Hybrid Bridge DC- DC converter

When designing the proposed DC/DC converter, it is important to choose a proper threshold voltage Vth. The basic rule for selecting Vth is that the converter's efficiency may be optimized throughout the whole input voltage range. Ideally, Vth should be the voltage at which the converter may have identical efficiency no matter in which mode it operates. For practical design, the half of the highest V_{OC} (happens in cold weather) of PV panel can be chosen as Vth for initial evaluation. Then design the resonant converter parameters with input range of 1/2 V_{OC}~V_{OC} and optimize efficiency at point Vnom, where Vnom is equal to V_{MPP}. The power loss should be analyzed for converter operating in both FB mode and HB mode with

Vin =Vth. In this condition, suppose η1 represents efficiency in HB mode and η2 is efficiency in FB mode. If η1>η2, Vth should decrease; otherwise, Vth increases. An optimal point can be obtained for Vth after several iterations.

Hybrid Bridge resonant DC-DC converter operates in either full bridge mode or half bridge mode based on the input voltage. Say the dc bus voltage 50 volt and the open circuit voltage is 36. So that threshold voltage is 18volts. When the input voltage is below the 18 volt it will operate as full bridge mode and above the 18volts it may operate as half bridge mode In variable speed wind turbines, power electronic circuitry partially or completely decouples the rotor mechanical frequency from the grid electrical frequency, enabling the variable speed operation. The type of electric generator employed and the grid conditions dictate the requirements of the power electronic interface. The electrical generator popularly employed for partially variable speed wind energy conversion systems are doubly-fed induction-generators. In this method where the rotor circuit is controlled by the power converter system via the slip rings and the stator circuit is connected to the grid. This method is advantageous as the power converter has to handle a fraction ~ 25% - 50 % of the total power of the system. The power converter system employs a rotor side ac-dc converter, a dc link capacitor, and a dc-ac inverter connected to the grid. The power converter enables vector control of the field which facilitates active/reactive power control.

6 Z- SOURCE BASED VARIABLE SPEED WIND ENERGY SYSTEMS

The variable speed turbine can generate electricity from winds with speeds ranging from 9 to 65 miles per hour. In conjunction with the variable speed feature, this wide operating envelope increases the turbine's energy capture by 10 to 15 percent or more over a comparably sized constant speed turbine, The variable speed turbine's rotor can turn faster as wind speed increases, storing some of the wind's energy as kinetic energy, which generates additional electricity when released. The rotor side converter controls the speed and torque of the rotor and the stator side convertor maintains a constant voltage across the dc link capacitor, irrespective of the magnitude of the rotor power. This method is more efficient than the fixed speed system; however it does not reflect the possible optimal efficiency. By employing a full scale ac-ac converter system the wind turbine can be completely decoupled from the grid, enabling a wider range of optimal operation. The variable frequency ac from the turbine is fed to the three phase ac-dc-ac converter. The generator side ac-dc converter is controlled to obtain a predetermined value at the terminal of the dc link capacitor [12]. The dc voltage is then inverted using a six-switch dc-ac inverter. Inversion is inherently buck operation hence the turbine side ac-dc converter has to ensure sufficient voltage level is obtained in order to integrate with the grid. If additional boosting of the voltage is required, an additional dc-dc boost converter can to be employed. This increases the overall cost and complexity. To overcome the shortcomings a Z-source inverter based conversion system can be employed.

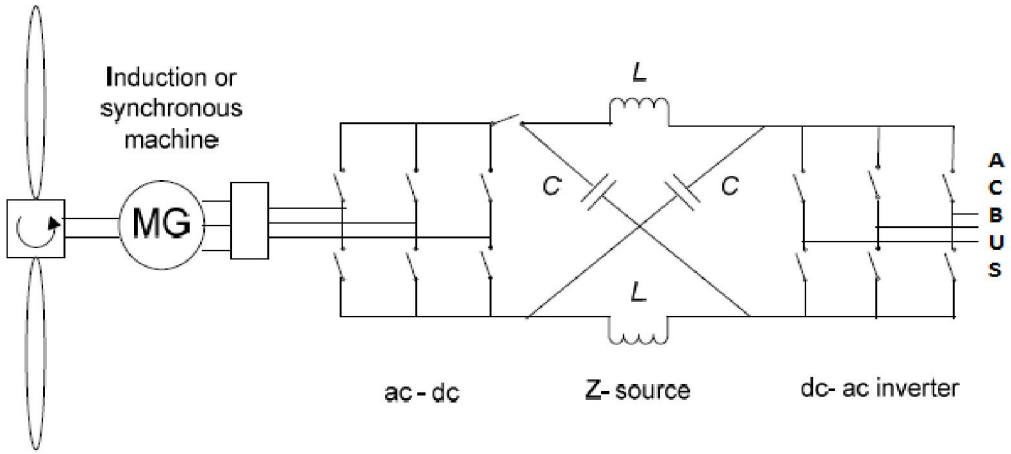


Fig. 6. Z-source based variable speed wind energy systems

Z-source inverter is a relatively new topology and has the following advantages over the conventional voltage source/current source inverters are Buck-boost ability, Inherent short circuit protection due to Z-source configuration, Improved EMI as dead bands are not required Z-source inverter based wind power conversion systems are relatively new, however researches are investigating its applicability [13]. A Z-source converter based wind energy system has been studied and presented in Figure 6 shows a Z-source based wind energy conversion system.

7 BI – DIRECTIONAL INVERTER

As discussed earlier in this bi- directional inverter to use the same hardware in two modes of operation and thus have bidirectional power flow functionality. The block diagram of bi-directional inverter with the energy management is show in figure 7. An H-Bridge inverter connected in series with a bidirectional dc-dc converter. In the discharge mode, the bidirectional buck/boost converter is used to boost the battery voltage to a level higher than the output of the transformer so that current will be allowed to flow from the batteries into the AC bus [2]. The inverter is used to chop up the DC voltage from the batteries into an unfiltered ac voltage. The chopped ac voltage is then passed through an output filter in order to smooth out the current waveform passing into the AC bus. The current is finally passed through a step-up transformer which provides isolation while stepping the voltage up to direct interface with the AC bus.

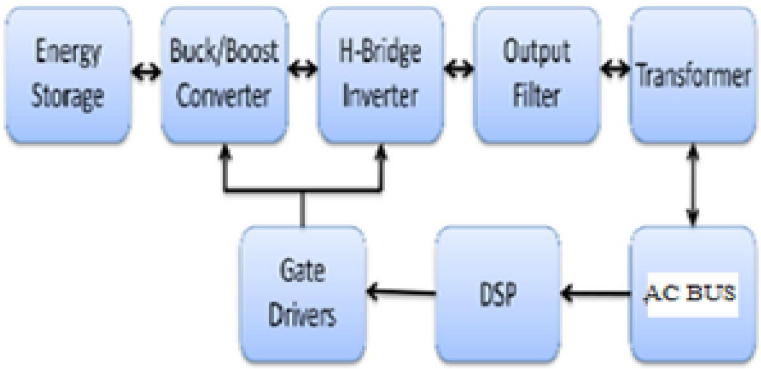


Fig. 7. Bi- directional Inverter block diagram

Since the voltage waveform is determined by the AC bus, the inverter will be of the current controlled type. A hysteresis control method was selected for this system because of its ease of implementation. This method works by setting a band around a reference signal and turning on and off switches according to when the current crosses the band boundary. Additionally, the boost converter was controlled by using a proportional-integral (PI) control strategy.

The benefit of the charge mode lies in the fact that it only adds one additional switch to those required for the discharge mode. The charge mode utilizes the freewheeling diodes on the inverter as a bridge rectifier while the dc-dc converter regulates the amount of current that is allowed to flow into the batteries. This aspect of the design was the easiest to implement since it only requires the modulation of a single switch and does not require any special phase locking considerations. This mode was considered a secondary goal to some extent for this reason. The battery charging was accomplished through a simple trickle charge method.

Hall Effect sensors and voltage level shifting circuits are measuring the current and voltage respectively. The bi-directional inverter operation is controlled by the DSP TMS320F2808.

The boost converter utilized a PI controller to regulate the increased voltage to a desired level. The H-bridge inverter used a hysteresis control to chop up the boosted voltage and regulate the current flowing into the AC bus. The PI control was initialized whenever the battery bank is connected and a voltage greater than required voltage was sensed by the DSP.

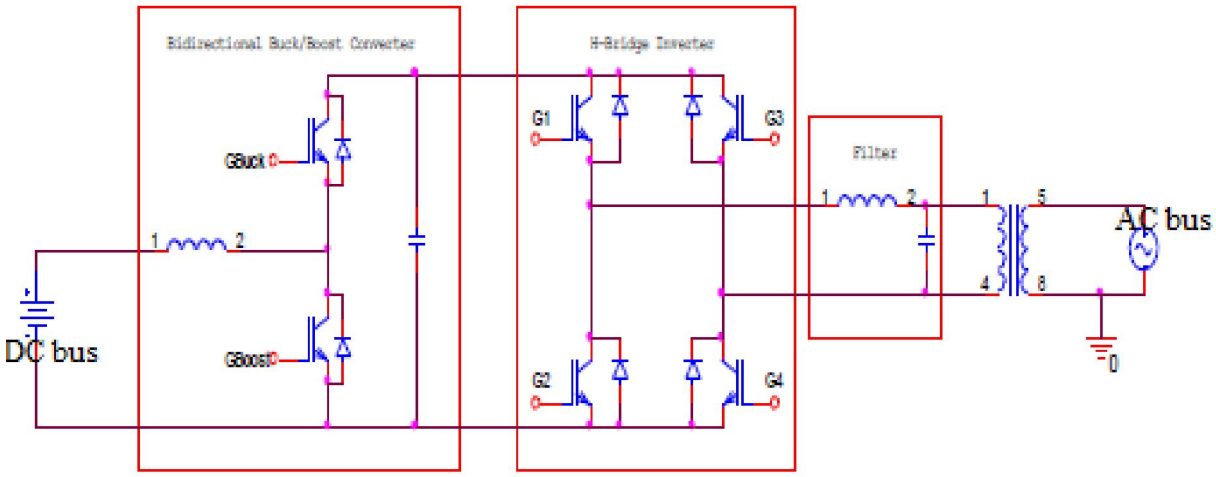


Fig. 8. Circuit diagram of Bi- directional Inverter

The hysteresis control begins whenever the boost voltage becomes greater than the transformer input voltage. The system was designed to continue running until stopped manually by disconnecting the battery bank and AC bus.

8 CONCLUSION

In this research, a simple MPPT analog regulator based on a Logic truth table perturbation and observation is presented to deliver the highest possible power to the DC converter from the solar arrays. The hybrid bridge resonant DC/DC converters are given the excellent performance, low noise for solar energy systems and give the efficiency of 98 %. The Z-source based variable speed wind energy systems are giving maximum output from the wind energy and the advantage of short circuit protection and improved EMI as dead bands. The Bi-directional inverter is works based on the mode of operation with the hysteresis loop control method. High capacity sealed lead acid battery is use for the battery bank for the long life, low maintenance operation. Parallel configuration gives the system load can be met in an optimal way and gives the full efficiency operation.

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Ger Districts in Ulaanbaatar, Mongolia: Housing and Living Condition Surveys

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ABSTRACT: Mongolia has been facing an onslaught of rural migration to the urban areas with negative consequences. Traditionally the country's economy was based on a survival livestock herding. Nowadays, the country's economic prospects are bright due to rich and abundant mineral deposits. Some researchers believe Mongolia will be the next Dubai. However, the general panorama of the country is not completely brilliant. In Mongolia's growing cities migrants have erected rural nomadic felt tents, known as a ger. The traditional ger are sustainable structures very well adapted for a nomadic society but, when they are located in high-density, unplanned, informal settlements they create many issues. These informal urban areas lack sanitation, adequate vehicular access and other basic services. The traditional use of wood and coal for heating contributes to heavy air pollution, especially in winter. This paper presents some of the findings of more than 100 householder surveys, held in the summer of 2011, related to housing conditions in four informal Ger districts of Ulaanbaatar. This paper describes some aspects of ger households, discusses how quickly the Ger districts are growing and explains their relation to the increasing problems of the city. Finally it concludes how Mongolia needs to develop and grow according with sustainable parameters or its pristine nature and cultural values such as the vernacular architecture will be lost.

KEYWORDS: Mongolia economy, Ger districts, informal settlements, householder surveys, felt tents.

1 INTRODUCTION

This paper presents some findings of more than 100 householder surveys related to housing conditions in four informal Ger districts of Ulaanbaatar. The capital of Mongolia is growing fast thus creating many urban problems associated with a developing country's booming economy.

1.1 MONGOLIAN ECONOMY

In order to understand the vicissitudes of the traditional rural Ger in Mongolia and its transformation into urban informal settlements it is necessary to comprehend the shift of the country's economy. Mongolia was considered a predominately nomadic society until recently. The region has been influenced during its millenary history by its two giant neighbors, Russia and China. As with other developing landlocked countries, it depends on their neighbors' infrastructure to access ports and international markets. As a result, landlocked countries often lag behind their maritime counterparts in overall development and external trade [1]. Among the independent countries of the world, Mongolia has the lowest population density. The country's rural population has been decreasing proportionally to the urban population's exponential growth, especially in Ulaanbaatar. It is notable that the country's high-density areas are located in the capital and few smaller administrative regions related with manufacturing or mineral exploitation [2].

Even though the total population of the country has increased by eighty percent since 1979, in most Mongolian rural areas the population has either remained low or decreased, particularly in the last 20 years. The population growth has been mostly in urban cities, chiefly in Ulaanbaatar. There are two periods of urban population growth in Mongolia; the first was during the Soviet era and the second was after their independence. Following the introduction of the Socialism system,

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policies encouraging fixed residency were adopted [3]. The establishment of factories and industries in communist Mongolia and the resulting construction of thousands of concrete apartment buildings established a more urban society. Under the socialist regime, Mongolia made great progress in improving its economy and human development indicators. When the Soviet assistance to Mongolia collapsed starting in the 90's, the country went into a deep recession [4].

The livestock collectives of Mongolia depended on the machinery and subsidies from the communist regime. With the failure of the Soviet Communist Regime, they transformed into individual or family ownership ventures. Those private ventures were able to expand 27%, from 1990 to 1998; Mongolia livestock augmented from 26 million to 33 million animals. The majority of the livestock growth can be attributed to the increase of goats. Mongolian goats are renowned for the quality of their cashmere and their numbers have more than doubled, from 1990 to 1998, as a result of strong demands for cashmere products [5]. Additionally weather conditions were favorable and the numbers of almost all types of livestock grew during that period. However, the situation is tentative as the country is very vulnerable to climate change.

1.2 CLIMATE CHANGE

Mongolia has been affected by the dzud or extreme winter conditions during the past years. Dzud consist of extremely cold temperatures accompanied by a lack of snow resulting in a winter drought, or by heavy snow or rain which freezes over the grass. These situations affect a large percentage of the animals with some dying of starvation. For example, the harsh winter in 2010 resulted in the loss of nearly one fifth of the nation's livestock. About nine thousand herders lost their entire herd and several thousand herder households lost a majority of their livestock. The vulnerability of Mongolia is highlighted in the connections between its environmental, economic and social aspects. The changes in the number of livestock can be seen on Table 1.

Table 1. Livestock in Mongolia 1990-2010

	1990	1998	2002	2009	2010	% Change 90-98	% Change 98-02
Horses	2.3	3	1.1	2.8	3.3	33	-64
Cattle/Yak	2.9	3.7	1.9	2.2	2.1	30	-49
Camels	0.5	0.4	0.3	2.6	0.26	-26	-35
Sheep	15.1	11.1	9.1	19.3	14.4	-3	-28
Goats	5.1	11.1	9.1	19.6	13.9	117	-18
Total	53.3	69.9	39	44	63.31	26	-44

Source: [6]

In 1998 the count of animals was 69.9 million but diminished in 2002 to 39 million. Since the beginning of the transition to a market economy, herders in Mongolia are encountering enormous challenges. Degradation of pastureland, as a result of overgrazing, seriously jeopardizes the vulnerable livelihood of small herder households. According to the United Nations Development program, in 2012 Mongolia had the highest proportion of people living on degraded lands within Asian countries, but due to the low population density it still a relatively pristine country. The numbers of livestock have improved in the last few years despite Mongolia's extreme climate changes, ranging from freezing temperatures and heavy snow in the winter to strong droughts in the summer, that have proven fatal to livestock which are a fundamental resource to the nomads [7]. When the nomadic families were unable to be self-sufficient some of the members migrated to the cities, especially to Ulaanbaatar, in search of better jobs.

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Climate change and economic development are the main reasons explaining the growing rate of the urban population in the country. In 30 years the population of the country's capital, Ulaanbaatar, grew from 400,000 inhabitants to more than 1.2 million. Still, more than 30% of Mongolians live in the countryside and most of them are nomads.

2 MONGOLIAN TRADITIONAL DWELLINGS

In Mongolia nomads live in traditional dwellings called ger. The ger, also known as yurts in Russian, are round felt tents which are a very common housing type among nomads in many Central Asian countries from Turkey to China [7]. Tents are recognized as one of the most interesting examples of vernacular architecture in Central Asia and the Middle East. Mongolian ger are composed of a primary structure consisting of a circular lattice wall made out of wood. On the top of the wall a number of wood beams are set to create a circular roof with the structural support of two columns and the circular wall. (Fig 1) On the top of this igloo-shaped structure, a thick layer of felt and a traditional white cotton fabric complete the ensemble. Ger can be built in a couple of hours by a group of four people. The gender division of the space in the ger is harmonious because the objective is to reinforce the accord of the family [8].

As a rural dwelling, ger are sustainable and have many advantages: they are portable, made out of traditional materials, structurally sturdy and they are highly resistant to the strong winds of the Mongolian steppes. During the summer the layers of the ger cover can be folder in the ger base allowing for natural cross-ventilation, an important characteristic of sustainable architecture. They are impressively adaptable to the changing weather conditions of the continental climate countries where summers can be hot and winters are very cold. Ger have been recognized as a very adequate dwelling, supporting the nomadic lifestyle, in the harsh climate of the country.

Fig. 1. Building a ger is a fast process. A small group of three or four people can built a ger in few hours.

Fig. 2. Traditional ger in the outskirts of Ulaanbaatar. In the Ger districts there are also dwellings made of wood and masonry.

The use of ger is considered sustainable and adequate for a nomadic population. Due to the low density of the rural sector, the impact can be controlled and Mongolians have a strong tradition of respecting nature. Unfortunately, when a ger appears in an urban high-density district the impact can be very negative. As explained, because of economic growth and climate change more and more Mongolians are moving from the countryside to the cities. The only dwelling they can afford is a ger assembled in any available urban plot; some of which are then transformed into permanent dwellings. (Fig. 2) These urban ger in Mongolia are built without plans or services, such as sewers and water supplies. This phenomenon of land invasion is unfortunately similar to the uncontrolled growth of urban slums in many developing countries. One of the particularities of Mongolian informal settlements is their residual pollution due to their location in a cold climate. The use of wood and coal in burning stoves pollutes the city's air at an alarming rate. [9].

The Mongolian economy has always been linked to a pastoral livestock production and its importance has been increasing even during economical crisis [10]. However, the discovery and exploitation of vast mineral resources are transforming the economy, diminishing the importance of livestock, and increasing the growth of the ger informal settlements in the cities. Experts believe there is one trillion dollars-worth in minerals that have already started to be exploited [11]. The economy of Mongolia can be a roller coaster; an example is the decrease in metal prices, especially copper which was down 65% from July 2008 through February 2009, that diminished the exportations and the country stock market fell again. Nevertheless, in late 2009 and the beginning of 2010, the market had begun to recover once again.

In 2013 the Asian Development Bank calculated the economical growth of Mongolia to about 14% still other international forecasters put the figure at 20% while some others even believe it can be 40% if the informal market economy is taken into account [12]. How the growth of cities like Ulaanbaatar can be successfully planned is a difficult question. Like many other developing countries, Mongolia has not been able to build cheap dwellings for the new migrants and it may not be able to do it in the future. However, as many other informal neighborhoods, Ger districts could be relatively successful, if some sanitary service conditions are met.

3 SURVEY METHODOLOGY

Economists tend to analyze the progress of the inhabitants through financial data, although, the personal opinions and the daily life of the common people are also an important part of any society that wants to be progressive. For this study surveys collecting the householder's data were planned in several Ger districts of Ulaanbaatar. Since the collapse of Socialism and the rapid expansion of the Ger districts, surveys have become a tool increasingly relied upon for assessing rapidly unfolding social demands in Mongolia's Ger districts—often for public health situations, but including those impacted by infrastructural components [13].

Some examples are environmental sanitation studies in Darkhan [14] and the evaluation of energy government programs in Ulaanbaatar [15].With the help of the Japanese International Cooperation Agency (JICA) several studies were founded years ago. One interesting study divided in three parts was made by Sugimoto, Kawagishi and et al, comparing the living environment of nomads in the outskirts of Ulaanbaatar and a permanent Ger district in the capital [16], [17], [18], [19]. Some studies about the urban planning of Ulaanbaatar are related with ger conditions [20]. Finally, part of the results of the research, here presented, were analyzed by the author in a study of householder satisfaction [21].

To establish a general picture of current conditions in the Ger districts, a lateral survey was given to about 114 householders in four different Ger districts of which over one hundred households were completed. It is important to understand that in a Ger district not all dwellings are ger. Some of them have been improved for dwellings made of permanent materials such as brick, concrete or wood. Also a few dwellings in Ger district are very well constructed and even luxurious. Not all dwellings in Ger districts are oflow-income households. The term 'lateral' is used in characterizing this survey, which takes place across several Ger districts of the city. In contrast to a longitudinal survey, the data were collected over the brief span of a few days, with the portions related to any one neighborhood collected in a single day [13].

This survey was administered using a form specifically designed by the author containing thirty-three questions and data was recollected in the summer of 2011. This survey allows for the isolation of answers and the possibility to compare and contrast the data with similar surveys used by the author in several informal settlements in other countries. The survey covered a wide range of socio-cultural aspects related with the dwellings, including both material realities of Ger district housings as well as such intangibles such as the expectations of Ger district residents. From the four districts selected for this research, two are on the outskirts of the city (Beix, Uliastai) and two are in vicinity of the city center, (Zuun, Ayushin).

Written surveys were not arduous to administer because Mongolia has a literacy rate of 98.5%. This impressive rate for a developing country allowed the researchers to prepare a written questionnaire in the Mongolian language to be answered by the householders. The rate of success recollecting the questionnaires was about 98%. The householders were always ready

to help researchers answering the questions and collaborating with this research (Fig. 3).

Fig. 3. The response of the inhabitants in answering the survey was very positive. From 116 householders visited, only two were unable to do the survey in the subsequent two hours.

4 RESULTS

For this paper only some of the thirty-three questions are analyzed. Future analysis of the data will complement this research.

4.1 PERCENTAGE OF HOUSEHOLDERS WITH A FIX DOMICILE THE FIRST TIME

Approximately 48% of the Ger district householders were living as nomads in the countryside before moving to their present domicile. In other words, for half of the families, this is the first time they have lived in a permanent place. (Table 2) Therefore half of the selected householders did not live in the selected neighborhood or in any other city before moving to the capital. It is appropriate to conclude that a country that once was a nomadic rural society is transforming to a highly urbanized society.

Table 2. Percentage of householders that use to be nomad

Householder was a nomad before moving to the present location?	%
Yes	48
No	52

4.2 LAND TENURE

It is widely known that land tenure must be a right of every citizen [22]. It is also an important factor to improve the quality of the self-built dwellings of low-income inhabitants, even when there is a perception of land tenure [23]. The land tenure situation in Mongolia is completely different from any other developing country. As explained, since antiquity, Mongolia has been a pastoral society. Traditionally the land is a position of the state for the common use of their inhabitants. Since 2002, every Mongolian citizen is entitled to a free piece of land one time in his or her lifetime. In some circumstances, the assigned land can be sold. This is obviously a completely different situation compared to other developing countries.

An impressive 79% of the householders that are part of this study are owners of the piece of land where they live (Table 3). This is especially outstanding when considering that most of the Ger district inhabitants are typically new arrivals. Dwellings built on invaded lands in the Ger districts of this research represent less than 9% of the householders. This situation is very different compared to other developing countries, where usually self-built informal neighborhoods and slums are originally built on invaded land, except in some countries such as India. In Mongolia, the dimension of the free plot

of land for every citizen depends on the location, which is a driver of the market price. In the outskirts of Ulaanbaatar the dimension of the allowed free piece of land will be much smaller than that of the more rural countryside area. In this survey, only 21 percent of householders do not have land tenure. Some of the householder may have a property in a different area of the country.

Table 3. Dwelling land tenure status

Land tenure of the dwelling	**%**
Own land, the householder has documents	79
Rented land	12
Invaded land or free use	9

4.3 ROOMS PER DWELLING

The number of rooms per dwellings in the high-density informal settlements is an important fact to measure the inhabitant's well being. In the selected neighborhoods, 50% of the householders live in a dwelling of one room, which coincides with the number of householders living in individual ger structures. The number of dwellings with two rooms is 23% and the proportion of dwellings with three or more rooms is only 12% (Table 4).

Table 4. Number of rooms per dwelling

Number of rooms per dwelling(s) (except kitchen and restroom)	%
One	50
two	23
three	15
Four	8
Five or More	4

4.4 NUMBER OF INHABITANTS PER DWELLING

The percentage of inhabitants per dwelling is show in table 5. About 70% of the dwellings in this research are occupied by three to five people. As explained before, half of the dwellings are single ger structures. The dimensions of traditional ger are between 16 to 23 square meters, depending on the radius of the surrounding lattice wall. In the countryside gers are erected in open areas and nomads spend most of the time outside maintaining their livestock. In the urban areas of Ulaanbaatar, gers are located in small plots, where districts and density are incrementally divided. This fact, together with the lack of sanitary services, explains the challenges related with living in an urban ger.

Table 5. Number of rooms per dwelling

Number of inhabitants per dwelling	%
One	3
two	6
three	22
Four	23
Five	25
Six	7
Seven or more	14

4.5 DWELLING MAIN STRUCTURAL MATERIAL

As previously explained, the 50% of householders living in a one room dwelling only have a ger tent, the rest were able to build permanent dwellings. Table 6 shows the main structural material used to build the dwellings. A part of the 50% prevalence of ger, bricks houses are 21% and log or wood houses are 21% (Table 8). Many of the permanent dwellings are still under construction. About fifteen percent of the householders who participated in this research still have a ger as a secondary housing structure; or as in the case of some large families, there are two or more ger forming a family compound.

Table 6. Dwelling Main Structural Material

Main structure material of the dwelling	%
Traditional ger structure	50
Bricks	21
Concrete	7
Log Wood / wood	21
Steel or metal	0
Other	2

4.6 WHO BUILT THE DWELLING

Usually, most of the dwellings in informal settlements of African and Latin American cities are self-built on invaded land. In several Asian countries, landlords renting shacks is a very common practice. In Mongolian Ger districts, according with this survey, there are a high percentage of self-built dwellings. Of the surveyed dwellings 81% have been built by the householders themselves, or with the assistance of friends (Table 7). This is to be expected as fifty percent of the housing plots have as a main dwelling a traditional ger that can be assembled in a few hours. However, most of the permanent dwellings, those made out of wood or bricks, are self-built with only 6% of the dwellings having been built by housing specialists. These dwellings are mostly legal dwellings built by the speculative private market or renters of the land that own their own mobile ger.

Table 7. Main builder of the dwellings

Who was the main builder of the dwelling?	%
The owner or family owners	70
Owner together with friends or other external family members	11
Owner and building specialists	6
Building specialist	6
No owner participation including houses built by specialist.	7

4.7 SANITARY SERVICES

In Mongolia there are public and private apartments complexes, some of which are within Ger districts. These structures are connected to urban services, including, running water, heating and sewerage. A traditional Mongolian ger does not have plumbing or sanitation services, which is one of the reasons why a high percentage of Mongolians living in ger would prefer to move to an apartment. Living without sanitary services is acceptable when living as a nomad, but in a cramp urban neighborhood it is not.

Dwelling sanitary services provided on Table 8 shows the percentage of dwellings with sanitary services. Some ger householders in Ulaanbaatar dug latrines on their plots. This can be problematic because such waste disposal is not adequate in high-density areas leading to soil and water pollution. Only 13% of the households participating in this study are connected to sewers where about 36% do share latrine with other families. The dwellings connected to sewers are almost always made

of permanent materials. The situation of services in Ulaanbaatar's Ger districts is worrisome, as it will contribute to health problems and environmental risks.

Table 8. Sanitary Services

Percentage of dwelling with sanitary services	%
Service with sewerage.	13
Services without sewerage	42
Services Shared with other families	36
No services in the area	9

4.8 A Dedicated Space to Prepare Food

In developing countries the availability of kitchens in dwellings, located in informal settlements, is measure of level of hygiene. In rural Mongolia the kitchen is located in the center of the ger and during the winter it is used as a source of heat. In the selected urban Ger district only 20% of the householders surveyed have a dedicated space for food preparation. (Table 9). Because ger do not have restrooms the issue with a room dedicated to cooking is not as a great of a concern as in informal settlements in other parts of the world.

Table 9. Dwellings with a reserved space to prepare foods

There is a kitchen or room reserved to prepare the food	%
Yes	27
No	73

4.9 Energy Source For Heating

In Ger districts of Ulaanbaatar there is a significant pollution issue. Most inhabitants use the same type of traditional heating stove that burn large amounts of wood or coal and produces a high quantity of smoke and pollutants. As explained, this in not of consequence when the gers are located in the countryside, however high-density urban settlements are really are of concern. The householders responding to this survey, as most inhabitants in Mongolia, use multiple energy types. (Table 10). For heating 87% use coal and 69% use wood. Only 21% use electricity. This is why, in winter, the capital has high levels of smog. The government has been promoting a new type of stove that limits pollution production and is energy efficient.

Table 10. Energy source for heating

What type of energy sources do you use for heating?	%
Coal	87
Wood	69
Electricity	21
Gas/Petrol	1
Other	2

4.10 Energy Source For Cooking

The same stove used for heating is also used for cooking in the traditional ger during the winter. The questionnaire was conducted during the summer when some of the food is cooked outdoors or using electricity. Coal is utilized by 44% the

householders to cook (Table 11). The difference between the percentage of coal used for cooking and the percentage used for heating is due to coal being a long burning fuel. This characteristic allows for the householders to get uninterrupted sleep during the cold evenings. Wood is used by 61% of the householders and but the most popular, in summer, is electricity which is used by 67% of the householders. As previously referenced, most inhabitants of Mongolia use multiple types of energy sources for cooking and heating.

Table 11. Energy source for cooking

What type(s) of energy sources do you use for cooking?	%
Coal	44
Wood	61
Electricity	67
Gas/Petrol	14
Other	1

4.11 MONGOLIAN HOUSING PREFERENCES

A key fact to understand the future of Ger districts in Ulaanbaatar is related to how permanent or provisional are traditional Ger districts. The first point is the will of the inhabitants to move from the neighborhood. When asking if the householder wants to move from a Ger district, about half of them answered positively [21]. That means many of them are not satisfied with living in their current circumstances. This number is quite high when compared with most of the neighborhoods around the world where the author has been doing research. The main reason why the householders want to move is because they live in a felt tent or because the location is bad. Some of the Ger districts householders want to move even if they live in an adequate dwelling of wood or brick.

As explained, Mongolia housing preferences are different to most countries and surprising at least, It is said that well-off people live in apartments and low-income live in houses. Taking into account that most of Ulaanbaatar apartments are decrepit, old soviet-style social housing, it seems housing preferences in Mongolia are unlike any other in the world. (Fig. 4 and Fig. 5)

Fig. 4. View of residential blocks at Bichel, the project displaced at least five hundred families living in the place, additionaly few of those families were later awarded apartments [13]

Fig. 5. A wall of Soviets style residential blocks in Ulaanbaatar

The respondents also may prefer to live in apartments because, as explained, in Mongolia an apartment is a symbol of status since well-off people live in apartments and the rest of the population live in houses or ger. Also, apartments in Mongolia are relatively expensive, even the public housing building under state socialism have premium prices. Some Mongolians believe they can elevate their economic prospects effortlessly with the rise of property markets.

5 CONCLUSIONS

Nomadic people of Mongolia have been traditionally respectful to nature and sustainability. In a country with a growing economy, new concerns have been emerging in the most recent years. The first part of this paper is a condensed version of particulars about the Mongolian economy that explains urban migration; however the reality is more complex. One of the main challenges is the general vulnerability of the country produced by the rapid increase of livestock, the mining exploitation, the climatic changes and the uncertainty of food availability. Reducing the vulnerability of the country is one of the first steps towards achieving a sustainable development. There is no doubt Mongolia is facing one of the most impressive urban population growths, as reflected in its new informal settlements or Ger districts, in cities such as Ulaanbaatar.

The conditions and nature of slums and self-built informal settlements of Ulaanbaatar are very different compared with other developing countries. In many countries informal settlements are part of an invasion of public and private property land. In Mongolia, all inhabitants have the possibility to receive free land from the government; tenure not of issue. Usually migrants move to Ulaanbaatar with their belongings including the felt tents or ger. The second difference is the type of housing since they do not build a shack of recycled material upon arriving to the city as is the norm in many other developing countries. Advantageous in a cold climate, the traditional Mongolian ger dwelling which is a product of a hundred years of cultural knowledge is well suited. However, as previously explained, a high concentration of ger is inadequate due to the lack of sanitary services in the traditional dwelling. Among the differences and challenges, the provisional nature of the ger is contradictory to permanent urban housing.

One of the most dangerous consequences of such rapid development could be ecological damage. Ulaanbaatar is a very polluted city during the winter. The demand of resources by Mongolian cities could damage not only the environment, but also cultural treasures as the popularity of the traditional vernacular architecture of the country wanes.

As explained by Miller [13]: The potential to transform the Ger districts into not only inhabitable space, but into a desirable place, for the majority of its residents does not necessarily lay in the demolition and replacement of tracts. Investment by the municipality in infrastructural improvements and services is an oft-cited need for these areas.

This research is the first part of this study that will continue in the future. This research is composed of a small amount of data recollected in a limited number of communities. The author believes permanent dwellings will substitute ger structures and this survey confirms that assertion. Almost 50% of the householders replaced their ger by building a permanent residence using concrete, wood or bricks. The survey shows that many of the householders would prefer to move out of their dwellings. However, residents may want to stay after the dwellings are improved and services installed. Many of the dwellings built during socialist time are showing their age. Cold winters and poor construction have contributed to making some of those buildings undesirable lodging. In time, as with slums in many other countries, Ger districts will improve. As the

GIP level of the country is quickly augmenting the government of Mongolia and investors are getting serious about the exploitation of the rich mineral resources of the country. The modern exploration of mineral resources has just scratched the surface and, as many people have suggested, Mongolia may become the next Dubai; for good and for bad.

The lack of a tax in some ger areas is one of the economical difficulties of the government to accomplish improvement. An economical boom in Mongolia can improve the conditions in the Ger districts.

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