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Treatment of Hospital and Biomedical Waste Effluent Using HUASB Reactor

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ABSTRACT: The Most of Hospitals are making a surgical treatments having a lot of medical waste it contains large volumes of water in their surgical operations. But during this process the water gets contaminated. This implies the need for waste water treatment before discharge. Waste treatment refers to the activities required to ensure that waste has the least practicable impact on the environment. Improvement in determining the effects of medical waste discharges have led to the passage of stringent environmental laws, which defined the degree of treatment necessary to protect water quality. In this present study enhanced the reactor designed and different parameter. The anaerobic treatment is considered one of the most efficient methods for treating several types of effluents. This is due to its scope for treating high rate of simply biodegradable matters and wastewater. The up flow anaerobic sludge blanket (UASB) technology was considered as the most popular method in which the highest rate of organic materials can be removed. Nonetheless, the long start up interval of UASB reactor requires more understanding of the biological process inside the reactor. During this study, which lasted for 50 days, two distinct phases were carried out according to the ambient temperature. The temperature of the waste water entering the reactor was naturally ranged from 26^0c to 30^o c and no heat exchanger was used. From this experimental work enhanced for treatment efficiency of effluent by varying the different parameters like hydraulic retention time and various organic loading rates. On the basis of the results in optimal hydraulic retention time and organic loading rate BOD, COD and TSS was removed respectively.

KEYWORDS: Anaerobic process, HUASB Reactor, Ambient temperature, Hydraulic retention time (HRT), Organic loading rate (OLR), Methane.

1 INTRODUCTION

The modified up flow anaerobic sludge bed (UASB) technique developed by industrial technology research institute (ITRI) has been applied to industrial waste water treatment. 25 full scale treatment plants and more than 50 modified UASB reactors have been installed for industrial waste water purification including food processing, brewery, distillery, pulp and paper textile, chemical and petro chemical industries. Anaerobic processes characterized by its low production of sludge, and its generation of energy comparing with the aerobic treatment. The development of use of anaerobic waste water treatment had been started in Netherlands, whereby the UASB system was firstly used on treatment of beverage industry, distilleries and fermentation industries, food and paper industries.

Waste treatment refers to the activities required to ensure that waste has the least practicable impact on the environment. In many countries various from of waste treatment are required by law. In surgical treatments large amount of water is used. But during this process the water gets contaminated. Hospital waste have maximum amount of BOD, COD, Turbidity, PH, Toxic metal. This implies the need for waste water treatment before discharge. Improvement in determining the effects of biomedical waste discharges have led to the passage of stringent environmental laws, which defined the degree of treatment necessary to protect water quality. In this present study enhanced the reactor designed and different parameter.

Recently, the use of aerobic technology has been expanded, where it comprised the treatment of chemical and petrochemical industry effluents, and the UASB concept is also considered more than suitable for the domestic waste water treatment especially in warm climates in tropical countries. Tropical, over the last decades, up flow anaerobic sludge blanket (UASB) technology has been commonly used, due to its all- round performance for high-low organic content waste water treatment. The operational parameters that are specially mentioned in literature have been controlled the process. The high rate reactor was widely used for the treatment of several types of waste water in up flow anaerobic sludge blanket reactors developed by Lettinga (2001). The up flow anaerobic hybrid reactors (UAHR) configuration has combined the advantages of both UASB and up flow anaerobic filters(UAF) while minimizing their limitations and the reactor is efficient in the treatment of dilute to high strength waste water at high organic loading rates and short HRT. Anaerobic digestion has been applied with different degrees of success to the treatment of liquid and solid wastes from the tannery waste. YanfangNIU and Xingyuan MA et al., had published experimental result as the maximum removal rate of COD is 91.6%, The macromolecule organic compounds are degraded into the small molecular organic acid by the acidate bacteria firstly, among which acetic acid is the most and then the small molecular organic acids are degraded into CH_4 and CO_2 by the methanogenus, realizing the transformation from waste to resource. Gangesh Kumar and asaudhan et al., has focused on the design analysis indicates that the design of the sewage treatment plant is adequate and appropriate. According to the standard design considerations the design criteria has been found complying.

Sunny Aiyuk and Philip Odonkor et al (2010) UASB process for the direct treatment of domestic sewage was effective in producing effluents with somewhat low amounts of organic matter, but not sufficient for efficient recycling/reuse. There were serious limitations inherent within the system: inefficiency in removing nutrients, and difficulties in removing suspended solids, leading to rapid rise in sludge bed height and frequent sludge removal. The high rate of sludge production, due to the accumulation of SS, was certainly a disadvantage, as sludge handling in full-scale installations can be expensive. E.Ravendranath and Chitra kalyanaraman et al (2010) this study shows high up flow anaerobic sludge blanket reactor was studied for different operating and design parameters are hydraulic retention time (HRT), organic loading rate (OLR) for treatment characteristics of leather effluent. Lu wang and Xingyuan Ma have been investigated for number of reported on the bio conversion of biomass by different investigators For example; the anaerobic digestion of solid refuses like municipal solid wastes.

1.1 Bio-Medical Waste

Bio-medical wastes are defined as waste that is generated during the diagnosis, treatment or immunization of human beings or animals, or in research activities thereto, or in Animal the production of biological1. Animal waste: Carcasses, body parts, etc. that have been inoculated with microorganisms infectious to humans. Human blood and blood products: Waste blood and materials containing free-flowing blood. Cultures and stocks: Culture dishes, blood specimen tubes, devices used to Transfer, inoculate, and mix cultures that are infectious to humans. Pathological waste: Tissue coming from biopsies, surgery, obstetrical procedures or autopsies. Sharps waste: All hypodermic needles, syringes & tubing with needles attached, scalpel blades and lancets. Respiratory isolation waste: waste contaminated with blood or other potentially infectious bodily fluids from humans isolated for disease spread by respiratory or droplet transmission.

1.2 Chemicals are used as biomedical

- 0.2% phenol
- Chlorine
- Iodine
- Boric acid
- Bithion
- Chloroxylenon (Dettol)
- 60-90% ethanol
- Chlorohexidine gluconate
- Mercurochrome.

Table 1. Pharmaceuticals industry waste water characteristics

S No	Parameters	Standard Effluent
1	BOD	900-4000PPM
2	COD	2000-6000PPM
3	PH	1.5-6.0
4	TSS	500-2000PPM
5	TDS	1350-7250PPM
6	OILS % GREASE	35-2000PPM

1.3 EFFECTS OF BIOMEDICAL WASTE

- Tropical disease
- Skin disease
- Malariya
- HIV
- Jaundice
- Enviromental effect

These kinds of problems consider that HUASB Reactor can be designed in the treatment of Medical waste, Pharmaceutical waste, Biomedical and Hospital waste effluent. The several favorable characteristics of anaerobic processes, such as low cost, operational simplicity, low bio solid production and considerable biogas production, together with suitable environmental conditions are contributed to highlight anaerobic systems for the treatment of tannery waste in small communities of tropical regions. Although different types of anaerobic treatment system have been applied to a great variety of industrial and biomedical wastes, so far the anaerobic treatment concept is rarely used for tannery waste. To compare the different anaerobic treatment systems, the UASB concept looks the most attractive option for tannery waste treatment. The present work evaluates an important design parameter for a UASB reactor that is hydraulic retention time (HRT). The performance of UASB reactor was assessed by applying various HRTs. From this experimental work enhanced for treatment efficiency of biomedical and hospital waste effluent by varying the different parameters like hydraulic retention time and various organic loading rates. On the basis of the results in optimal hydraulic retention time and organic loading rate BOD, COD and TSS was removed respectively.

2 EXPERIMENTAL SETUP AND PROCEDURE

2.1 UASB REACTOR

Up flow anaerobic sludge blanket (UASB) technology, normally referred to as UASB reactor, is a form of anaerobic digester that is used in the treatment of waste water. The UASB reactor is a methanogen (methane producing) digester that evolved from the anaerobic clarigester. A similar but variant technology to UASB is the expanded granular sludge bed (EGSB). A diagrammatic comparison of different anaerobic digester can be found here. UASB uses an anaerobic process whilst forming a blanket of granular sludge with suspense in the tank. Waste water flows upwards through the blanket and is processed (degraded) by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket begins to reach maturity at around 3months. Small sludge granules begin to form whose surface area is covered in aggregations of bacteria. Eventually the aggregates form into dense compact biofilms referred to as “granules”. Bio gas with a high concentration of methane is produced as a byproduct. The heat produced as a byproduct of electricity generation can be reused to heat the digestion tank. Sugars dissolved in the liquid waste stream can be converted in to gas quickly in the liquid phase which can exit the system is less than a day. Up flow anaerobic sludge blanket (UASB) technology, normally referred to as UASB reactor, is a form of anaerobic digester that is used in the treatment of wastewater. The UASB reactor is a methanogenic (methane-Producing) digester that evolved from the anaerobic digester. A similar but variant technology to UASB is the expanded granular sludge bed (EGSB) digester. A diagrammatic comparison of different anaerobic digesters can be found here.

Table 2. Construction details

S.No	Particulars	Specification
1	Material of construction	Glass
2	Inner diameter	6.5cm
3	Height	65cm
4	Packing material	Foam
5	Packing height	26cm

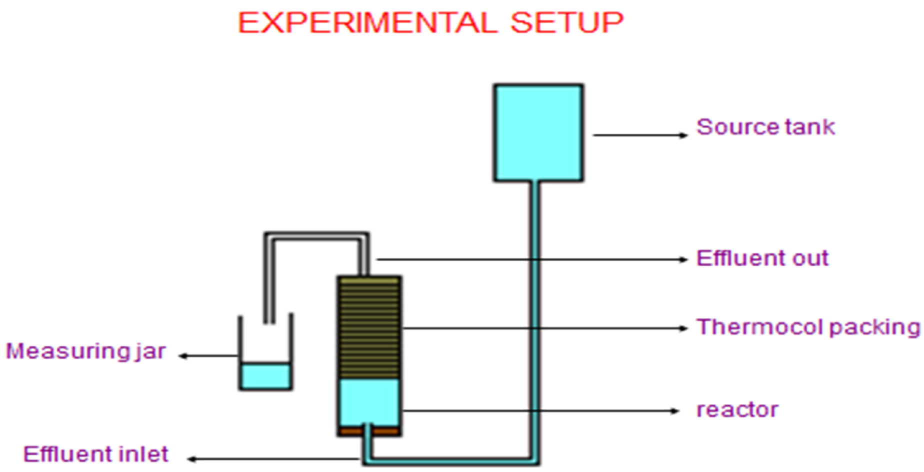

Fig. 1. Experimental Setup Of HUASB Reactor Design

The main components of the HUASB are,

- Inlet and outlet distribution system
- Sampling port
- Packing media

UASB uses an anaerobic process whilst forming a blanket of granular sludge which suspends in the tank. Wastewater flows upwards through the blanket and is processed (degraded) by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket design to reach maturity at around 3 months and Small sludge granules begin to form whose surface area is covered in aggregations of bacteria. In the absence of any support matrix, the flow conditions create a selective environment in which only those microorganisms, capable of attaching to each other, survive and proliferate. Eventually the aggregates form into dense compact biofilms referred to as “granules”. A picture of anaerobic sludge granules can be found here.

2.2 Sludge

The sludge granules have many advantages over conventional sludge flocs are dense compact bio-film, High settle ability, High mechanical strength, Balanced microbial community, High methanogic activity, Resistance to toxic shock, Biogas with a high concentration of methane is produced as a by-product, and this may be captured and used as an energy source, to generate electricity for export and to cover its own running power. The technology needs constant monitoring when put into use to ensure that the sludge is maintained, and not washed out (there by losing the effect). The heat produced as a by-product of electricity generation can be refused to heat the digestion tanks. The blanketing of the sludge enables a dual solid and hydraulic (liquid) retention time in the digesters. Solids requiring a high degree of digestion can remain in the reactors for periods up to 90 day. Sugars dissolved in the liquid waste stream can be converted into gas quickly in the liquid phase which can exit the system in less than a day.

The sludge granules have many advantages over conventional sludge flood.

- Dense compact bio-film
- High settle ability
- High mechanical strength
- Balanced microbial community
- High ethnologic activity
- Resistance to toxic shock

2.3 Sampling And Analysis

The reactor is fixed and the set up was done as per the plan. This is followed by the loading of waste water for the formation of sludge blanket. The waste is prepared by mixing poultry waste and cow dung in equal proportions with water. The reactor is left undisturbed for the function of the sludge and growth of anaerobic microorganisms on the foam packing provided at the top portion of the reactor. After two months it is observed that the reactor is at the start up stage. Now the reactor can be loaded with tannery waste for treatment. Effluent from the tanning industry has been collected. The effluent was analyzed to found various parameters like COD, pH, turbidity, TDS and amount of chromium. The initial values were found to be as follows;

COD = 2000-4000ppm, Tss =500-2000ppm, TDS = 1350-7250ppm

pH = 1.5-6 and BOD = 900-4000ppm

For experimental convenience the effluent is diluted with water. The samples after dilution, has the following values for different parameters. The COD value is found to be 448 mg/l. Then it would be difficult for the microorganisms to grow. The values of turbidity and TDS are found to be 1438 and 1752 respectively. The diluted effluent is then reached in the HUASB for different flow rates. The sample is analyzed at the end of each 7^{th} day. The experiment is repeated for another flow rate of the effluent. This procedure is repeated for 10 different flow rates and the results are tabulated.

3 Results and Discussions

The experiment shows there is considerable reduction in the amount of chromium. The reactor also shows effective reduction in the values of COD, TDS, pH and turbidity. It is noted that the reactor is more effective at very low flow rates.

3.1 Potentials For Improvement

The tannery waste contains heavy metals and toxic metals in it. The treatment in the HUASB is showing considerable reduction. This is due to the bio sorption of these elements by the anaerobic microorganisms. By inoculating some other anaerobic microorganisms which can be brown in the HUASB reactor there is a great chance of reducing the amount of harmful metals like chromium, copper, calcium, zinc etc., this can be increased the quality of the treated biomedical waste to further extent.

3.2 Measurement Of TDS

The two principal methods of measuring total dissolved solids are gravimetry and conductivity. Gravimetric methods are the most accurate and involve evaporating the liquid solvent and measuring the mass of residues left. This method is generally the best, although it is time-consuming. If inorganic salts comprise the great majority of TDS, gravimetric methods are appropriate. Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water. Ions from the dissolved solids in water create the ability for that water to conduct an electrical, which can be measured using a conventional conductivity meter or TDS meter. When correlated with laboratory TDS measurements, conductivity provides an approximate value for the TDS concentration, usually to within ten-percent accuracy.

3.3 Organic Loading Rate

In wastewater treatment, the rate of introduction organic compounds is defined as organic loading rate. The organic loading rate can be calculated as follows.

$$\text{Organic loading rate} = \frac{\text{Design flow x COD/day}}{\text{Volume}}$$

When input COD <5000 mg/l using the method based on OLR is not effective in operation process because the granular sludge will be hardly formed.

$$\text{Hydraulic retention time} = \frac{\text{Volume of Reactor}}{\text{Influent flow rate}}$$

The volume of UASB reactor V = Q × HRT

The area of the UASB reactor A = V/Q

Table 3. Experimental results

S.No	Flow rate (L/day)	HRT (day)	Up flow velocity (m/day)	OLR (mgCOD/L.day)
1	1	2.157	0.301	242.93
2	0.9	2.397	0.271	218.637
3	0.8	2.696	0.241	194.344
4	0.7	3.081	0.211	170.051
5	0.6	3.595	0.181	145.758
6	0.5	4.314	0.151	121.465
7	0.4	5.392	0.12	97.172

The minimum flow rate is enhanced for higher microbial growth and reduced for Biological oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Turbidity, chromium and High rate of production of methane gas. The treatment efficiency of high up flow anaerobic sludge blanket reactor is dependent on the flow rate.

Table 4. Experimental results for removal efficiency of HUASB Reactor

S.No	Flow rate (L/Day)	Removal Efficiency (%)		
		COD	Turbidity	TDS
1	1	79.96	90.19	69.98
2	0.9	74.61	88.82	69.06
3	0.8	72.9	86.27	67.16
4	0.7	70.22	85.49	64.8
5	0.6	67.55	83.92	62.25
6	0.5	64.31	80.58	60.22
7	0.4	60.87	79.02	57.86

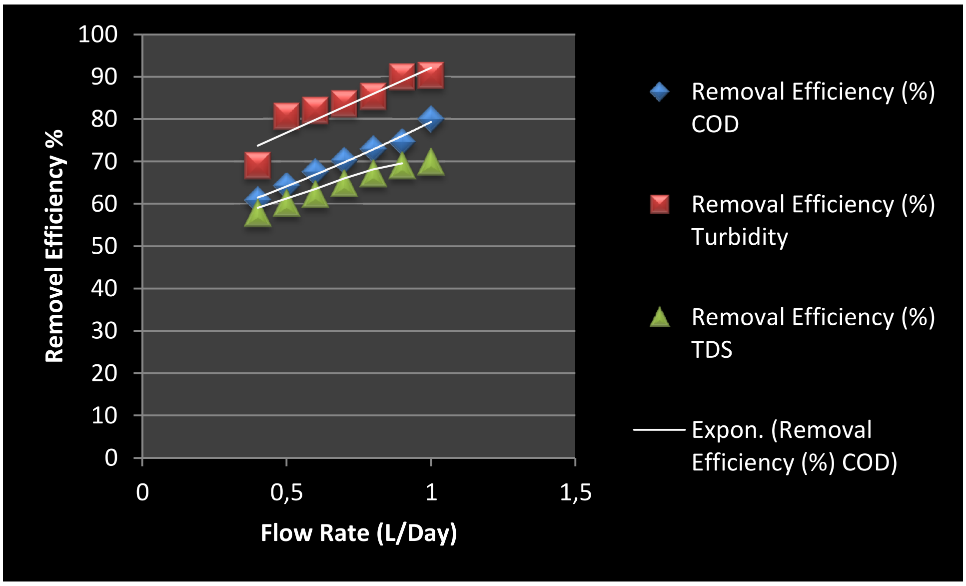

Fig. 2. Experimental Results for Efficiency of HUASB Reactor

4 CONCLUSION

In the high up flow anaerobic sludge blanket reactor was studied for different operating and design parameters are hydraulic retention time (HRT), organic loading rate (OLR) for treatment characteristics of biomedical waste effluent. In our study is observed that the untreated biomedical effluent have harmful effects on the environment. So we have to consider from this treatment process. It will have reduce the environmental effect and Study the characteristics of Biomedical effluent. Detailed literature survey suggests that the HUASB reactor is suitable to treat the leather effluent. Mainly from this study focused on BOD, COD, Turbidity, TDS, PH and Chromium reduction. In this study observed as PH is maintained at a range of 8 – 9, it will promote microbial growth. The maximum COD removal of 81% is obtained in the HUASB reactor at an OLR range of 50 – 60 mg COD/l day. The maximum Turbidity removal of 73% is obtained at an OLR range of 70 – 80 mg COD/l day. From this study concluded that maintain the minimum flow rate and using of different backing materials. Detailed survey suggested that the HUASB reactor is suitable to treat the biomedical waste effluent.

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