

## Technical Communication of Automation Control System in Water Treatment Plant

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**ABSTRACT:** This paper presents technical communication of automation industry which describes the technical issues of automation control system in operation development, improving management level and high efficiency process in water treatment system. Today's water treatment plants are applied for water conservancy projects, emerged by the technology of automation control system is to ensure safe, continues, high quality water supply to municipal and for multi-purpose usage. Along with automation technology, computer technology, network communication development, advanced water treatment monitoring system is realized in Nantong pengyao water purification plant. The Nantong pengyao water purification plant has an important beneficial industry relationship to People's Republic of China improving living status and environment condition mainly expounds the water supply, to build well-off society, comparatively improving the labor production growth & level of implementation of targets as well as high water quality requirements. In this paper, it develops the task and tells the technical solutions of water treatment plant which has been centralized in fully automated operation in some developed industries since many years. And also append short description of its current practices such as networking, and real-time monitoring control, composition & structure, process flow and automatic process control which are performed in water treatment plants to achieve high efficiency in quality of productivity.

**KEYWORDS:** Automation Control, Water Treatment System, Computer Technology, Networking, Monitoring Control, Nantong Pengyao Water Purification Plant.

### 1 INTRODUCTION

The population of China is gradually growing fast since the world has been entered in 21st century [1]. At the same time, there is large demand of water is required in large magnitude, which has become one of the main contradictions of sustainable urban development. Urban water system is vital infrastructure and widely distributed in Chinese society [2]. At present with the automation technology, mode of utilizing PLC to carried out automatic control and upper computer to monitor and set the parameters is normally adopted in water/water waste Treatment system [3]. Typically, a PLC coordinates all functions of an outstation including monitoring and control and supervision the acquisition of measurement data, pre-processing and filtering network. Therefore it checks for function, status and limits, calculation of control action,

temporary data storage and receives and reporting from and to the central station [4]. Basing on Nantong Water Purification plant, this paper mainly introduces the structure and function of control system. An automation system, commonly referred to as a Process Control System or Supervisory Control and Data Acquisition (SCADA) System, is critical to the efficient operation, safe and reliable of so many industrial processes. Process Control System (PCS) is used widely in manufacturing operations and in various infrastructure subsidiaries [5]. Commonly process control needs sensors and analyzers for continues on-line implementation [6]. Many recent years the technology of water treatment system is localized by control automation system for multi-purpose usage. This paper describe the technical communication of automation control system including network and computer monitoring system of water treatment plant and also append short communication of networking, monitoring & control of process flow of Nantong pengyao water purification plant. Nantong pengyao water purification plant working behavior & control treatment system has placed as typical same as highlighted in this paper. Therefore, this paper intends the innovation research work associated with Nantong pengyao water purification plant and develops the task on technical communications of its composition & structure and process control of automation system.

## 2 OVER VIEW OF WATER TREATMENT PLANT

The water treatment system is mainly composed of water source intake system (water intake pumping station), feed water treatment system (water purification plant), water supply pipe network (including pipe network and booster pump station), drainage pipe network, wastewater treatment system (sewage treatment plant) and discharge and reuse system, etc.

A set of water treatment system is adapted with different process flow which depends on the quality of water sources; target purpose of water is industrial, commercial utilization and domestic usage. The selected flow basically includes three parts of treatment: pretreatment system, terminal processing system and micro processing system. The water treatment system basically is used to treat municipal and industrial waste water, clean water for beverage manufacture & food, water for city water supply, beer deistic fermentation and water for boiler, drainage system, high pure water for electronic & electrical industry or relative industry, water for large hospital service, injection and pharmaceutical industry, and propose river water desalination system. Polluted water needs to be dully treated to minimize its negative effects on public environment and unsuitable for drinking, recreation, agriculture and industry [7].



**Fig. 1. Water Treatment System for Multi purpose Uage Manufacturing by Guangzhou Tech-Long Packaging Machinery Co., Ltd, China.**

## 3 SYSTEMS OF WATER TREATMENT & CONTROL OBJECT

Almost few years back water/ waste water treatment plants have been commuted into control system since after automation system; commonly referred to as a Process Control System is introduced [1],[5]. The computer automation Control system of water treatment is applied to city water purification plant, sewage plant and other water conservancy projects. The system mainly includes network communication system, computer monitoring system and video image monitoring system of water purification plant (sewage plant).

The network communication system is used to transmit data of all subsystems. The computer monitoring system is in charge of data acquisition and real-time control & adjustment of all pumping houses, dosing and chlorination, filter, clean-water reservoir and other subsystems of the whole plant. The video image monitoring system is applied to realize the remote

image monitoring of all pumping houses, dosing rooms, filters and other key parts of the whole plant. The automatic control system of water treatment is used for the purpose of realizing the full-automatic control of water purification plant and sewage plant, achieving unattended operation and improving management level and efficiency. The city water-purification plant is mainly composed of water intake pumping room, dosing and chlorination, filter, clean-water reservoir, water supply (booster) pumping room and other subsystems. The control object of water plant automation system refers to the electromechanical devices in each subsystem.

**4 COMPOSITION & STRUCTURE OF SYSTEM**

With layered and distributed structure, the system is mainly composed of upper computer & local control unit (LCU) and Automation element. It can be longitudinally divided into master station of control layer (upper computer) and LCU.

1) Upper computer system: mainly include host computer, operator workstation, data server, communication server, network communication and other functional nodes and is composed of software and hardware devices.

Hardware: IPC, server, workstation, network device and printer, etc.

Software: configuration software

Overseas: InTouch, iFix, WebAccess, Citect and Wincc, etc.

Domestic: Kingview, NC2000, EC2000 and H9000, etc

2) LCU: base of data acquisition and control of system; usually composed of PLC, touch screen and auxiliary devices.

Applied PLC mainly includes:

Schneider: Quantum, Premium, M340 [8]

Siemens: S7-400, S7-300, S7-200 [9]

GE: 9070 (PAC RX7i), 9030 (PAC RX3i), VersaMax [10]

AB: ControlLogix, CompactLogix, FlexLogix, MicroLogix [11]

NARI: MB80, MB40, MB20 [12]

3) Automation element

Mainly include: water/liquid level gauge, chlorine-leakage alarm detector and pressure sensor, etc.

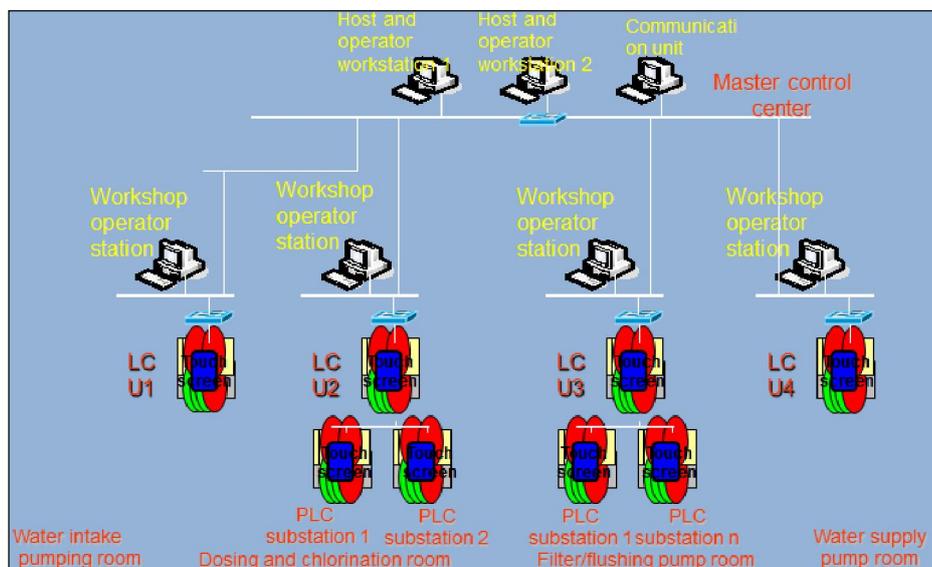


Fig. 2. Composition & structure of system of water Treatment plant

## 5 WATER PURIFICATION PLANT : CURRENT PRACTICE

### 5.1 SYSTEM FUNCTION

- Realize data acquisition and processing of all systems and devices of whole station;
- Realize accident analysis and processing of whole station, such as safety operation monitoring, event alarm, trend analysis and SOE and so on.
- Realize the time synchronization of automatic control system and GPS.
- Realize the independent control and full-automatic control and regulation of all pump houses, dosing, chlorination, filters and other subsystems of whole plant.
- Realize statistics and recording of operation parameters and production management.
- Realize communication with other systems and superior dispatching.
- Realize self-diagnosis and redundancy switching of system.
- Realize WEB release and browse.
- Realize ON-CALL and other alarm functions

### 5.2 CONTROL MODE

#### a) Remote automatic control

The master control center and workshop remotely switch on/off, shut down, and set objective or objective flow for devices of each subsystem through man-machine interface of computer.

#### b) Local automatic control

The operator locally switches on/off, shut down or set objective flow for devices of each subsystem through man-machine interface (touch screen) on LCU.

#### c) Local manual control

In case of emergency or maintenance, the operator locally switches on/off and shuts down water plant through button and handle on LCU.

#### d) PLC automatic control

PLC automatically starts the control flow of each system according to acquired signal status to ensure the normal operation of system, which is the main functional operation mode of water plant.

### 5.3 SYSTEM FEATURE

Have complete network structure and support multiple networking modes, such as single computer with single network, single computer with dual network, dual computer with dual network and distributed IO and so on; Support real cross-platform and adopt full-open and distributed design; Have perfect PLC communication protocol with sorted storage of data, improving the correctness and reliability of communication; Have abundant external communication interface to meet the access of different intelligent devices of pump station; Have reliable sequence control flow, ensuring the safety and correctness of automatic control; Support SOE, which understands the action time and sequence of field devices, for convenience of accident analysis; Make full use of advanced automatic control technology and computer network and communication technology and adopt layered and distributed network structure;

Today, digital Programmable Logic Controller (PLC) is largely replaced analogue controllers [4]. PLC automatically starts the control flow of each system according to acquired signal status to ensure the normal operation of system, which is the main functional operation mode of water plant. Follow the principle "centralized management, distributed control and data sharing"; Have a dynamic and vivid man-machine interface and analog simulation of the physical environment; realize the full-automation control of all processes; realize the automatic statistics of device operation time and troubleshooting to help operation management.

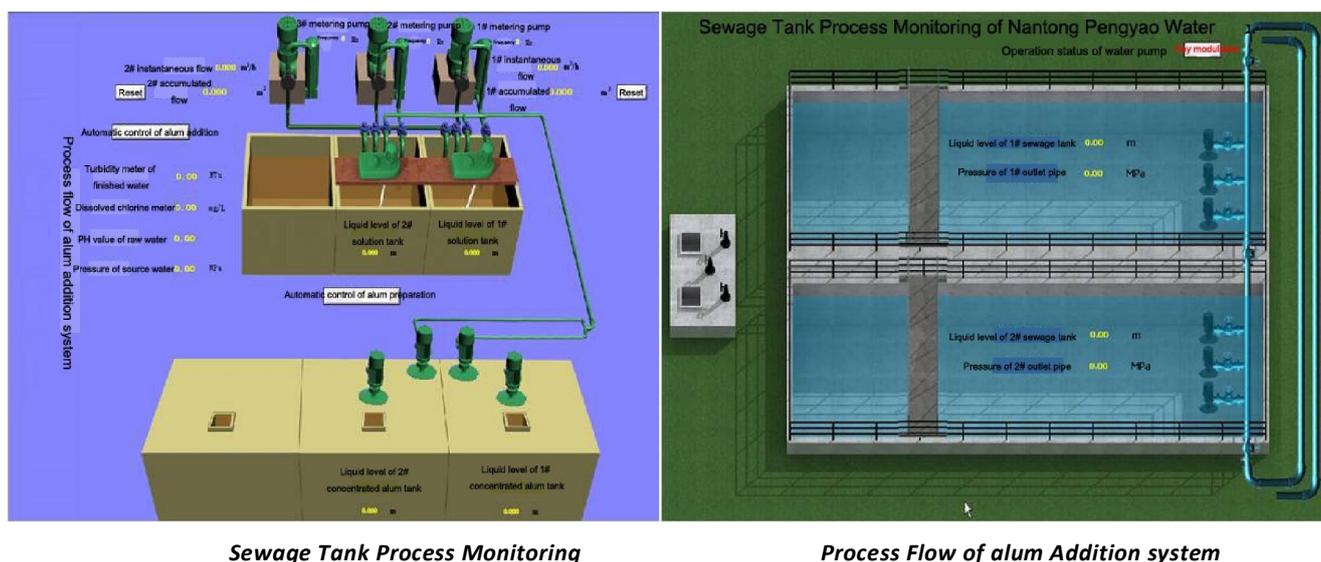


Fig. 3. Nantong Pengyao Water Purification Plant system featured monitoring by Nantong Pengyao Water Supply Co., Ltd

## 6 KEY TECHNIQUE- AUTOMATIC PROCESS CONTROL

The main device of water intake pumping house is source pump with control principle as follows: ensure the operation of one source water pump and automatically start or stop the pump according to finished water flow and water level of clean-water reservoir.

### a) Control of dosing and chlorination

PLC sets and controls the operation frequency of frequency converter with flow proportional control ring according to detected turbidity and flow of source water and then carries out fine adjustment of converter operation frequency with composite control ring as per the detected water turbidity after reaction and sedimentation.

### b) Control of V-shaped filter

Automatic control of constant water level filtering: PLC ceaselessly adjusts the opening of discharge regulating valve according to detected water level of filter to keep stable water level in filter grating, to ensure that the filtering is carried out with constant water level.

c) Control of filter automatic backwash: The filtering time reaches to setting filtering period; or water head loss of filter reaches to presetting value; or mandatory backwash order is received. It mainly includes three stages: air washing, air-water mixed washing and water washing.

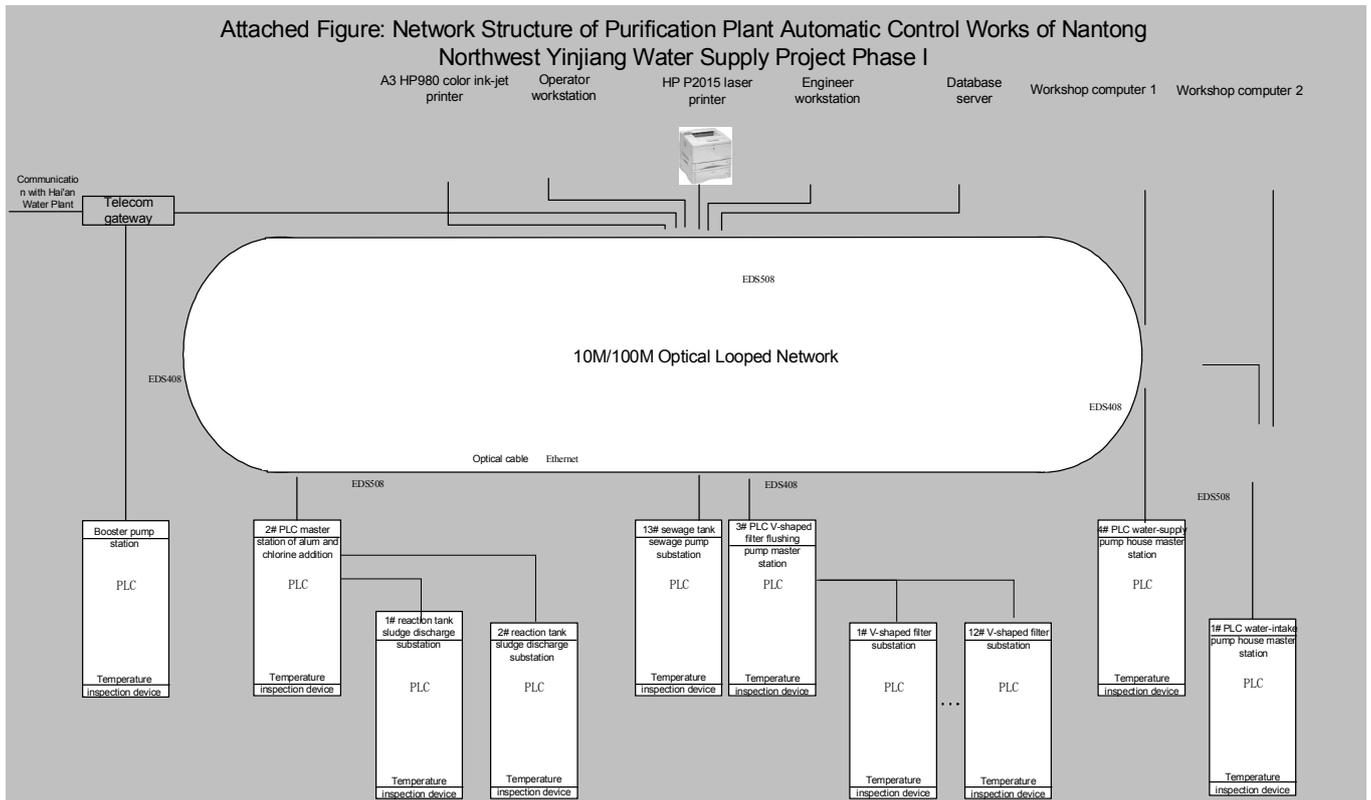
### d) Control of water supply pump house

The main device of water intake pumping house is water pump with control principle as follow: at least ensure the operation of one water pump and automatically start or stop the pump according to factory water flow and discharge pressure.

## 7 TYPICAL PROJECT- NANTONG PENGYAO WATER PURIFICATION PLANT

In order to increase the efficiency and stable water quality, Water supply companies are gradually changing to an advance centralized, fully automated operation [13],[14].The increasing demand of water treatment plants to require more efficient use of water resources, both in urban and rural environment [15]. The Nantong Pengyao project was aimed to develop the conceptual design of an effective and economically responsible water purification plant for the municipality of Nantong [16]. The project of Nantong Pengyao Water Purification Plant is located in the west area of Nantong regional water-supply planning. It water-supply scope includes Rugao, Hai'an and partial regions of Tongzhou. The project is composed of water intake works, water purification plant, water transmission main pipe and booster pump station with total design scale of 0.6 million m<sup>3</sup>/h. The production network for phase I automation control system of water purification plant is composed of centralized control center, local control center, PLC master station and PLC substation. The communication network between

centralized control center, local control center and PLC master station adopts Ethernet (TCP/IP protocol). The control network among master station and substation of filter are used DH485 network for communication. Meanwhile, connect all supervisory computers of water purification plant and each functional department together to form intranet, which then connects with production network through Ethernet switch.



**Fig. 4. Network Structure of Purification Plant Automatic Control works of Nantong Northwest Yinjiang water supply Project Phase I**

The backbone of whole network is loop optical topological structure (10/100M self-adaptation) to realize data and resources sharing of all devices in same network. The signal transmission between water intake pumping station, booster pump station and water purification plant is realized through optical cable, to establish network connection on same logic, which carries out real-time transmission of control information and other data. The system is used to monitor the status and parameters of water intake pumping station, alum preparation, alum addition, chlorination, sludge disposal of sedimentation basin, V-shaped filter, sludge tank, second-order pump station and other devices and automatically control all processes. The main advantage of the project is the plant capability of being remotely controlled via a complex data communication network over the internet so it's easy control & maintain [17].

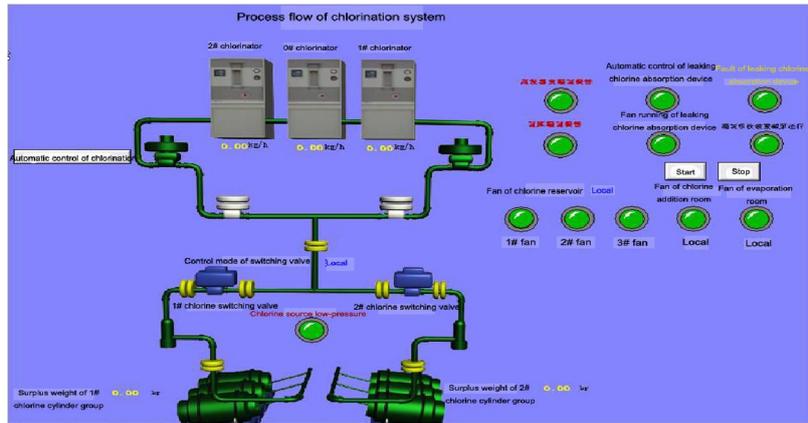


Fig. 5. Process Flow of Chlorination System of Nantong Pengyao Water Purification Plant

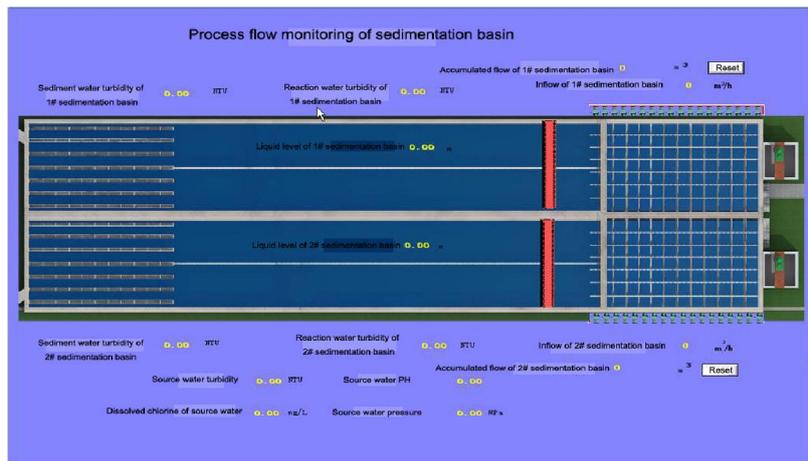


Fig. 6. Process Flow Monitoring of Sedimentation of Nantong Pengyao Water Purification Plant

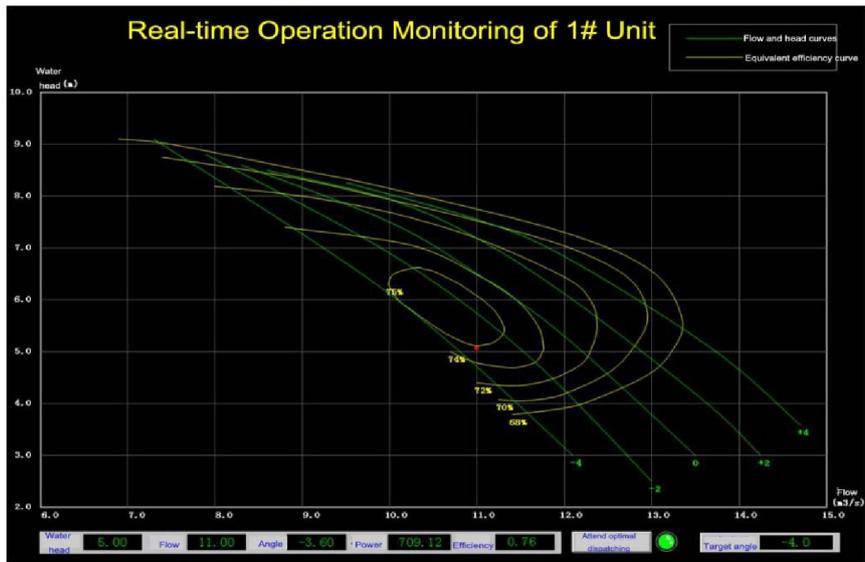


Fig. 7. Performance Calculated of Real-Time operation Monitoring Phase-1

## 8 CONCLUSION

The increasing demand of automatic control system has taken up great achievements in polluted environment to resolve the issue for high quality of water supply, drinking, sewerage network (water waste treatment plants), drainage pipe network, discharge and reuse system. Therefore, Water resources are explored widely and research & development is implemented fast and secure in all over the world [18]. This study established on technical communication of automation system in water treatment plants. Technical levels of control system in water/water waste treatment are helped to improve their productivity, flexibility and reliability. The same work is done in this paper which introduces the technical work in approaches and benefits of the industries [19]-[20]. Nantong Pengyao Water Purification Plant as water supply planning project which produces the environmental, social and economic impacts as benefit to Rugao, Hai'an and partial regions of Tongzhou. Therefore this paper is also highlighted by the performance of production network and Process flow of Nantong Pengyao Water Purification Plant as a reference [21].

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