Implementation of Desalination Sewage Treatment Based on PLC Automatic Control System

M. Y. Li[†*] & S. A. Ouattara[‡]

[†]Engineering institute, Xi'an International University, Xi'an 710000, China

[‡]Thoracic Surgery Department, Hospital of Mali, Bamako, Mali

ABSTRACT: The shortage of water resources and pollution has become the major problems affecting people's production and life, and the increasing emissions and low efficiency of sewage treatment the contradiction between the contradiction of water resource in China is becoming more and more obvious. In this situation, how to design a control effect of the sewage treatment system and improve the efficiency of wastewater treatment depending on the current urgently needs to solve the problem. This paper introduces the basic process of sewage treatment and processes. And in view of the present systematic problems in sewage treatment of our country, using advanced control technology, design a wastewater treatment system based on PLC control. So as to realize the automatic control of sewage treatment system. Using this technique for sewage treatment system, not only can enhance the stability of the system, but also can reduce the labor intensity of workers. So as to improve the production efficiency.

KEYWORDS: Sewage treatment; PLC; Control system; Fault diagnosis.

INTRODUCTION

Water is the source of life, is a necessary condition for existence and economic development. But our country's water resources situation is not optimistic. Per capita water resources is one of the indicators measuring national available water resources, water resources in China, 2.8 trillion cubic meters, per capita accounts for a quarter of the world per capita is only as one of the 13 country which are lack of water. Not only that, China's total water resources is on the decline, with the Yangtze river as an example, since the 1950 s, more than 20 rivers Yangtze river shrank by 37.1% on average. And what is more worrying, in the case of lack of water resources, its quality is declining, the increasing of wastewater discharge and lower than the world level of sewage treatment technology lead to water shortages, the adverse effects on the social impact, brings to the national economy is bigger loss.

Water shortage has become one of the important factors that restrict the economic and social sustainable development. The performance of the water resources contradictions of our country is increasingly obvious: on the one hand, rapid industrialization led to a sharp increase of water demand and the contradiction between the limited water reserves; On the other hand is increasing wastewater emissions and the contradiction between the low sewage treatment. The contradiction of water resources has become the bottleneck of restricting the sustainable economic development, so the wastewater treatment and water recycling has become a reality in the society pay more and more attention to the problem, the ultimate goal of wastewater treatment has been from sewage discharging standard for water reuse. Sewage treatment can not only make the wastewater reused, and in the process of sewage treatment can produce renewable energy, the energy can be applied to production, can improve the quality of water supply at the same time, improve the economic benefit. The shortage of water resources and water pollution, which not only affects People's Daily life, but also for our country's economic construction and development. With the requirements of energy conservation and emissions reduction and environmental protection, not only embodies the necessity and urgency of the sewage treatment, but also puts forward the mode of sewage treatment process and higher requirements. The wastewater treatment system based on PLC control, can realize to the sewage purification treatment, not only can achieve the purpose of protecting the environment, save water, but also reduce the cost, improve the environment in industrial wastewater treatment. And it is of great significance to maintain the rapid development of economy.

INTRODUCE OF SEWAGE TREATMENT SYSTEM

Commonly Used Water Treatment Technology

Sewage treatment has been widely used in construction, industry, energy, environmental protection and other fields. It is to make the sewage reaches a water drainage or use again water quality requirements. And the purification of a process, this paper involves the wastewater treatment is mainly to industrial wastewater treatment. Industrial

wastewater treatment according to the action principle, there are four main processing method. They are the physical method, chemical method, physical and chemical method and biological method. The highest of the four methods, utilization of biological method, due to the complexity of wastewater treatment process, a method often can't meet the needs of the sewage treatment. So in the process will also be a physical method and chemical method. Its commonly used process has the following five:

The traditional activated sludge process. Also known as activated sludge process, this method is often used in activated sludge wastewater biological treatment system, is a more traditional way. It is a key component of the aeration pond and sedimentation tank, process flow diagram is shown in Figure 1. This method is the main mechanism of the microbial metabolism, tank capacity is small, low cost nature, and by microbial metabolism and reproduction, can effectively reduce the content of organic matter in wastewater. But this method cannot be ignored also has disadvantages: aeration tank water organic load cannot too high, so need to aeration tank has a larger volume, leading to higher cost of construction. Running effect depends on the feed water quality, water quantity changing.
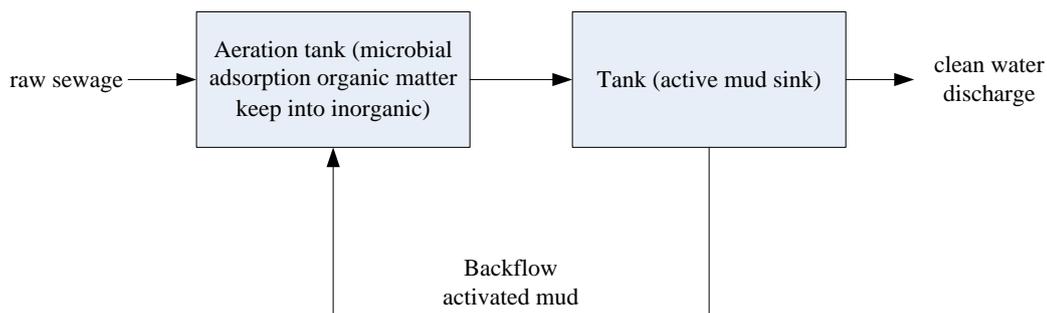

Figure 1. Traditional activated sludge process flow chart.

A/O method. Also known as the anaerobic aerobic process method. A refers to the anaerobic part, O refers to aerobic section, the method is based on the development of the first approach, the removal of organic matter, sewage can effectively remove nitrogen and phosphorus in sewage, as compared with activated sludge treatment process, can significantly improve the utilization rate of wastewater. The flow chart shown in Figure 2. The technological process is simple, in the reaction to form the inner loop of denitrifying and nitrifying, can effective nitrogen in sewage. But this system to manage the demand is higher.
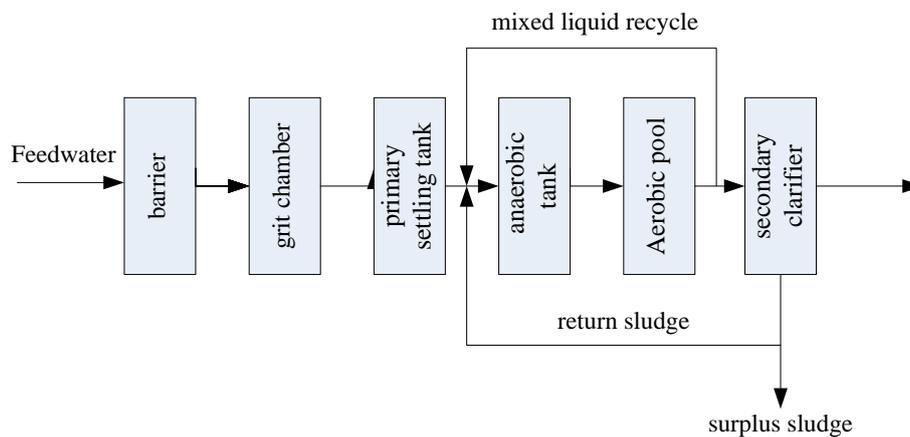

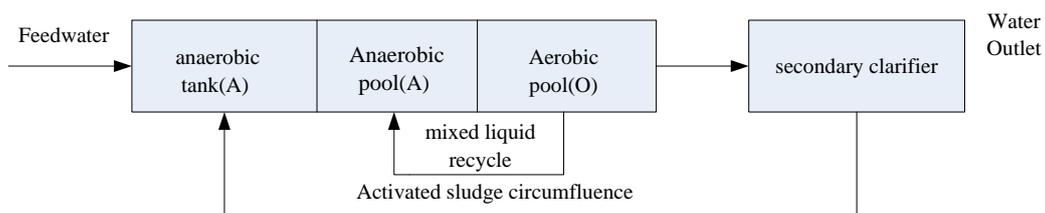**Figure 2.** A/O process flow diagram.

Figure 3. A2/O process flow diagram.

The A2/O process. For biological gentrification and phosphorus removal methods, in terms of nitrogen and phosphorus, widely used for the process. A2 is one of the A representative Anaerobic (Anaerobic), another A representative Anoxic (hypoxia); O stands for (aerobic), process flow as shown in Figure 3. A2 / O is a kind of anaerobic - anaerobic - aerobic process in industrial wastewater treatment. The method of nitrogen removal effect is good, suitable for nitrogen removal with the requirements of the industrial wastewater treatment.

AB. The method of adsorption biodegradation method. For high concentration of industrial wastewater treatment, this method has a high energy saving efficiency, higher applicability. But this method in high load period is given priority to with biological flocculation adsorption, sludge in reaction process is more. So we need add to the high load period of reactants in the processing, thus increasing the cost of sewage treatment.

SBR method. SBR method is from active sludge method, also called sequencing batch type activated sludge process. Reaction principle of the method and the traditional activated sludge process are basically the same, different only operation mode.

Sewage Treatment System

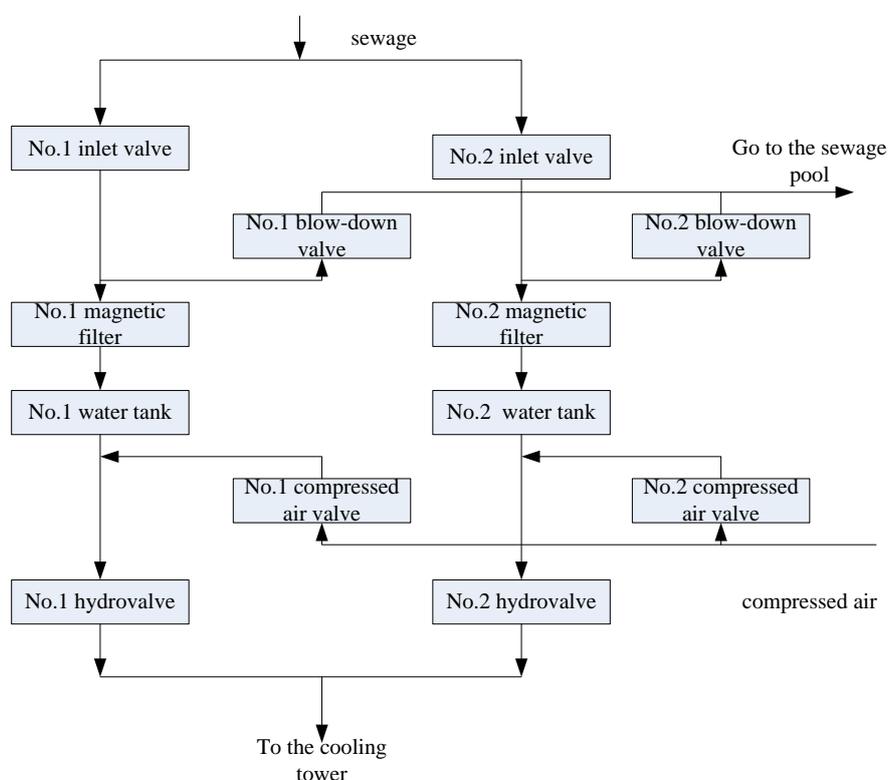In this paper, the wastewater treatment system process flow is shown in Figure 4.

Figure 4. sewage treatment system schematic diagram.

The process flow of the sewage treatment system is divided into two working procedure, filtering process and backwashing process respectively.

In the filtering process, open the inlet valve and outlet valve, sewage, flows through the electric magnetic filter coil, the impurity in the sewage is adsorbed on the magnet of the magnetic filter, purifying water by water valve flow out. Two units of the filtering process, can be done at the same time, also can run independently. Magnetic filter water after a period of time, the magnet has been adsorbed on a considerable amount of sewage impurity, at this time must be cleaning the impurities, the process for backwashing process. During the process need to cut off the power supply of magnetic filter, close the inlet valve and outlet valve, open the drain valve and compressed air valve at the same time, the compressed air will push the water into the magnetic filter, can wash away impurities on the magnet, and the process of sewage into the sewage pool, waiting for the secondary processing. Unlike filtering process and backwashing process at the same time can only have a set of unit operation, when the unit 1 backwashing, if unit 2 also need backwashing, the unit 2 wait 1 after backwashing is allowed to enter backwashing process. When two units need to enter the backwashing process at the same time, the unit 1 priority backwashing. In the system, need to be on

the road of the unit is installed, differential pressure gauge, when instrument signal that differential pressure high, the system will immediately stop the filtering process, and automatically enable the backwashing process. It can ensure the safe operation of the filter hydraulic skill. At the same time, we use PLC control, receiving set external components connected to the signal, once the control display signal is abnormal, the system will immediately stop work, waiting for repair. This increases the reliability of the system.

Control Form

When it is just the introduction of sewage treatment technology in our country, using the control system for relay - contactor control. But with the development of industrial technology, sewage emissions increased as well as a variety of impurities in wastewater. In the past already can't meet the needs of the sewage treatment system control method, so the control before the system begins to be phased out. Now high utilization of the control system can be divided into the following three categories:

Distributed control system, the system is known as the DCS system, the domestic it distributed control system, it is a computer system, by a computer, signal processing and control technology and communication network technology. The system will be on-site control stations, through the network communication system, control station, cabinets, etc, and provide open data interface, so as to realize the functions of decentralized control and centralized operation, can disperse risk of the system, and improve the security of the system.PLC system from the 1960 s, by the United States is a programmable logic controller. It has replaced the traditional relay control device. The wastewater treatment system based on PLC system, not only can complete the basic requirements for control system, but also can through the network connection to process real-time monitoring. The system programming is convenient, short development cycle, easy to maintain, and can be connected to the Internet, convenient to upgrade. In general, strong commonality, easy to operate, the system control function and extension ability is stronger. Fieldbus control system is a real-time network control system based on fieldbus, it can be in accordance with the standard communication protocol, control through automation, field control unit and the interconnection of intelligent instruments, so as to realize between equipment, equipment, and computer data transmission and exchange. The system comprehensive cost and installation cost a lot less than other control system, with high cost performance, and can use the Internet in the process of using rich resources, not only can real-time transmission, and different product can interconnect.

Functional Requirements

Design sewage treatment system is designed to make discharge sewage after treatment, the output can be used again, water quality so as to realize the purification of wastewater. For a long time, with the continuous development of sewage disposal technology, the development of China's sewage treatment in a new phase, but the sewage treatment technology still can't keep up with the needs of the development of the city. There is still a problem of wastewater treatment rate is low and low operation rate. Along with the rapid development of economy, to solve these problems is imminent, based on the above problems, the comparison of the three listed control form, add PLC in sewage treatment system of the core controller is relatively convenient and feasible, not only can achieve effective reuse of sewage, also can effectively save costs.

Wastewater treatment system based on PLC can put the design process easier, and can realize more features. These capabilities include the system of real-time monitoring, also has a simple and easy operation interface, convenient for the user to control the PLC system. Wastewater treatment system based on PLC can realize the signal input and output signal of the control.

System to control the signal input of the main performance in the detection of signal input, detection can be divided into four parts. One button input detection for manual control. Liquid level difference input test is used to start and stop the sewage disposal machine. Liquid level height input detection; Oxygen input detection is to maintain of dissolved oxygen content in water, this part of the detection is accomplished by controlling the speed signal of the aerator. PLC to its control is accomplished by the readings of the dissolved oxygen meter feedback. The first three input signal detection are the digital quantity input, input and oxygen content detection for analog input.

System to control the output signal of the control performance of digital output and analog output. Control all kinds of instruments and equipment, the former is the main control contactor in these instruments and equipment, including the start and stop of instruments and equipment. Analog output is mainly implemented by controlling the aerator inverter, the ultimate goal is to control the oxygen content in water, the PLC to its control performance in controlling the output frequency of frequency converter, thus the speed for effective control of the aerator, ultimately to achieve control of the analog output.

SEWAGE TREATMENT SYSTEM DESIGN

Hardware Configuration

Sewage treatment system hardware configuration includes the selection of PLC and the choice of differential pressure gauge. When choosing PLC controller, not only to select the CPU model, to choose their corresponding extension module models.

First is the selection of PLC controller, when choosing the controller, you can refer to the following list of unit 1 I/o address allocation Table 1. For sewage treatment system working principle of the two sets of basic same, table, comparing to the sewage treatment system can be drawn from the input points and output points, and then choose higher than the total points of controller and the extension module. The table shows the input and output points of 18 points and 16 points respectively, so when choosing the CPU model, we choose the Siemens S7-200 series CPU224 programmable controller, the controller input and output points of 22 points and 18 points respectively. For the normal operation of the PLC controller, the extension of the corresponding module we choose is Siemens series with digital quantity EM223 extension module.

Table 1. Input or output address allocation table.

Programming components	I/O terminal	Circuit component	Use
Input Relay	I0.0	SB1	No. 1 water purifiers start button
	I0.1	SB2	No. 1 water purifier stop button
	I0.2	YJ1	No.1 water purifiers, differential pressure gauge high differential pressure switch signal
	I0.3	SB3	system abrupt stop button
	I0.4	YA1	The auxiliary contact of magnetic filter for fault diagnosis of YA1
	I0.5	YA2	The auxiliary contact of water valve, used for YA2 fault diagnosis
	I0.6	YA3	Inlet valve of the auxiliary contact for YA3 fault diagnosis
	I0.7	YA4	Drain valve of the auxiliary contact for YA4 diagnosis
	I1.0	YA5	Compressed air valve auxiliary contact for fault diagnosis of YA5
Output Relay	Q0.0	YA1	No.1 the magnetic filter coils
	Q0.1	YA2	No.1 The water inlet valve coil
	Q0.2	YA3	No.1 The water drain valve coil
	Q0.3	YA4	No.1 Drain valve coil
	Q0.4	YA5	No.1 Compressed air valve coil
	Q0.5	HA	Backwashing bell
	Q0.6	HL1	Trouble lamp
	Q0.7	HA1	The fault alarm

After that, select PLC controller select differential detection instrument. Installation differential pressure test instrument in the sewage treatment system is necessary, not installed the sewage treatment system of differential pressure gauge can not effectively control the filter process, when filtering process problems in, can't find problems and solve problems quickly, and there is the possibility of damage to the instrument, the reason is not hard to understand, in this paper, we have mentioned before, when magnetic filter entry and exit pressure difference is too high, should immediately stop the filtering process, but if there is no pressure differential detection instrument, so the differential display not to come out, problems arise not immediately stop the filtering process. Differential pressure measuring instrument not only can detect the magnetic filter exit and entry of differential pressure, and still can output differential pressure signal effectively. In this system, we choose the Photogenic gauge dwyer 3000 imr series in the United States.

The Software Configuration

Ladder diagram is obtained by sequential function chart can quickly and should pay attention to the aspects of content:

First of all, to clearly identify the other PLC programming device address, so no need to list. Second, the open and close valves and magnetic filter to delay order in action, so that we can avoid the impact of the system process switching. Through differential pressure testing instrument of magnetic filter is the differential protection, when magnetic filter entry and exit of differential pressure is greater than the set pressure difference. So an immediate end to the filtering process, in order to the backwashing process.

Again, when entering the backwashing process, also mentioned above. If the two sets of units need to enter the backwashing process at the same time, the unit 1 of executive power, this is because the sequence function unit 2 shown in the figure 0.1 seconds delay. But if one unit first entered the backwashing process, so have to wait for another unit, because there is a clear display in the sequential function chart, two groups of backwashing process interlock function of the unit.

Finally, pay particular attention to the fault diagnosis of subroutines. In the sewage treatment system, relative to the software, more prone to failure usually for external devices, these devices main function for the output signal. If cannot be handled in a timely manner the problems these output components, easy to cause the system work properly or even damage the system. So to design fault diagnosis of a subroutine, to ensure that the external main output device fails, the system outage and sounded the alarm. Were designed in this paper, the sewage treatment system eight subroutine of fault diagnosis, the fault diagnosis algorithm are similar, and fault diagnosis subroutine 1. For example, the ladder diagram as shown in Figure 5, detailed explanation is in the filtering process, if the inlet valve and outlet valve is not opened, magnetic filter without electricity or compressed air valve, drain valve and shows as an open, was diagnosed with defective, system alarm and immediately stop waiting for inspection.
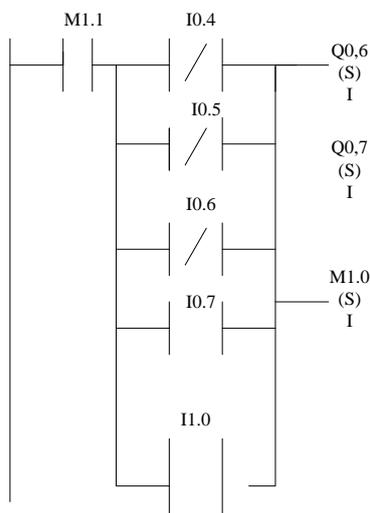

Figure 5. Subroutine 1 ladder diagram of fault diagnosis.

DEBUGGING AND RUNNING

After completion of the sewage treatment system design, installation, must carry on the system debugging and commissioning, to discover and solve the problems.

The first is the debugging of hardware, according to the instructions to the hardware wiring connected. In the process of debugging to check whether the power supply is normal, then check that the equipment of electrical control whether normal, whether can normal opening and closing of valves, also check the instrument and control system is normal. Test results show that the hardware functions are normal.

Followed by the software debugging, in software debugging, to run in the PLC programmed program debugging, to run for each subroutine, look to whether can get a result, the running and compared the results are consistent with the expected results, whether the corresponding function cannot achieve. In addition, in software debugging, can also according to the function points module debugging, commissioning after completion of each module, overall debugging together again.

For the wastewater treatment system debugging results show that the hardware configuration is normal, not only can meet the needs of the operation, but also can bring into play the function of PLC control. Each module program in debug also can realize the corresponding function of the control. Basically reached the function of the sewage

treatment system design.

CONCLUSION

This paper expounds the technological process of sewage treatment, control system and hardware and software configuration, realize the sewage treatment system based on PLC automatic control. The differential pressure gauge is added in the hardware design, can guarantee the normal operation of the filtering process; Adopted in the software design of structured programming method, and the sequence function diagram of the control system is presented.

Due to the sewage treatment system used PLC as the controller, so not only its structure more simple, and high reliability, system design since the diagnostic program, make the system a certain self-diagnosis function, the system out of order, alarm and stop immediately, reduce the possibility of damage to the machine, but also can guarantee the system work stable and reliable. And after backwashing process using the delay and interlock algorithm, effectively solve the competition problem in two groups of units in the washing process.

Wastewater treatment system based on PLC controller, simple to use, easy maintenance, has a broad prospect of promotion. But in order to realize intelligent sewage, optimization operation processing system, it is a long road back. This requires further study of principle of sewage treatment, and keep learning the advanced technology, constantly improve the level of process control, thus promote the realization of energy saving and emission reduction.

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