Monitoring system design based on *Kingview* sewage treatment

ABSTRACT:

Aims: The aims of this paper is to design a monitoring system for wastewater disposal.

Study design: The study design is to design a monitoring system and perform simulation analysis based on Kingview software.

Place and Duration of Study: The place and duration of study are North China University of Water Resources and Electric power and one month respectively.

Methodology: The methodology used is computer simulation technology.

Results: The result of the experiment is to monitor the sewage disposal process through the developed monitoring system.

Conclusion: The conclusion is that the monitoring system can achieve dynamic control of the sewage disposal process.

Keyword: Kingview; sewage disposal; monitoring system; Programmable Logic Controller

1 Introduction

Whether it is in rivers, lakes, seas or country ditches, water pollution threatens the physical and mental health of human beings with its unpredictable existence and destroys the earth [1]. Water is the carrier of life. If the carrier is damaged, the human beings living on it will be punished or even seriously injured. Domestic sewage is subject to environmental pollution, and its degree of damage can seriously damage human physical and mental health and the ecology of nature [2]. The main pollutants in domestic sewage are organic pollutants, biological pollutants, nitrogen, phosphorus compounds and other harmful substances. If it is discharged into non-polluted water without treatment, it will make the receiving water worse and even make the water body eutrophic, which will cause the spread of water disease while causing biological death of the water body, thereby destroying the ecological environment and affecting people's health. Therefore, the treatment of water pollution is extremely urgent. At present, developed countries have achieved the effect of tertiary sewage purification. China started to learn sewage treatment technology recently, so that we are still behind the technology and equipment of developed countries.

Automatic control of sewage treatment has great advantages in efficiency, capacity and cost, which can save costs in a wide range. China's sewage treatment automation technology has been nearly 30 years old and 1980-1989 was a period of rapid development. Among them, the large-scale sewage treatment plant built in 1984 used domestically produced equipment and the construction of the sewage plant accelerated China. The development of sewage treatment has made China's sewage treatment technology scale and industrialized. After that, many sewage plants have been built. By the end of 2005, the efficiency of sewage treatment had been greatly improved, reaching 50%, which is a great progress and development. In foreign countries, the automatic control of sewage treatment is much earlier than that of China. The reason is that developed countries can integrate automatic control technology into network and information technology. It develops rapidly in network communication and field bus, such as applying Supervisory Control And Data

Acquisition (SCADA) technology and Distributed Control System (DCS) to sewage treatment. In addition, developed countries attach importance to the research of Programmable Logic Controller (PLC), and have developed control units with reasonable price and small intelligence at different times, such as *Mitsubishi's FX2N* series, *Omron's Ω* series, *Mitsubishi K* series and so on. Western countries have realized simple control of the system very early. By simplifying the complicated program, the user can easily master its operation method instead of the cumbersome manual operation. The degree of automation has risen by a certain height. For example, in order to evaluate the possible environmental, economic and technical performances of different systems properly, Kacprzak et al (2017) proposed a number of selected decision-making tools, namely Waste Disposal End Criteria and Life Cycle Assessment [3]. Therefore, in the sense of circular economy "from waste to resources", some basic criteria for optimal selection were proposed to make people recognize the importance of sludge as a valuable substance and the potential dangers associated with the application of these strategies. Lee et al (2018) [4] studied biological Smooth Trans Focus (STF) using the anaerobic-anoxic-aerobic (A2O), sequence batch reactor (SBR), and the Media processes to determine the efficiency of these treatments and the traces released by each process. The relevant quantities of plastics have been verified by experiments to be more than 98%. Benvenuti et al (2018) used an artificial floating wetlands of large plant hyphae [5]. During 12 months, the average removal of organic matter was evaluated by chemical oxygen demand (COD), 5-day biochemical oxygen demand (BOD5) and by total suspended solids (TSS) analysis and a removal efficiency of 55, 56 and 78% was, respectively, obtained. For nutrients, total Kjeldahl nitrogen (TKN) was reduced in 41% and total phosphorus, in 37%. The floating mats supported satisfactorily the macrophytes. This floating arrangement was applied as a single step on the sewage treatment. It is an effective alternative in Brazilian sewage treatment systems, where wetlands are normally used as a polishing step. The evaluation of parameters in the treatment system may give useful information in order to improve the removal efficiency and increase the quality of the water bodies.

With the wide application of DCS in industrial control, more and more configuration tools are used to develop control system application software. Any automatic system is composed of objects and automatic devices. As people pay more attention to the level of automation, traditional application software has been unable to keep pace with the development of automation, and can not meet the needs of industrial control [6]. When developing the system application software, the change of its control object will lead to the modification of the source program and extend the development cycle. It is difficult for the new programmer to modify the source program designed by the original programmer. The fast changing PC technology and control technology have changed the original status quo with the emergence of Configuration software, so that users do not need to change the complex source code. Due to the configuration software enables the control engineers who have not mastered the rich computer expertise to easily master the use of methods in the case of lack of operational experience, it saves a lot of tedious programming work for industrial control and improves the development efficiency of automatic control. In addition to being applied in small industrial control systems, configuration software is also the main part of developing human-machine interface and monitoring system in large SCADA systems [7].

2 Basic methods of sewage treatment

The method of sewage treatment needs to consider the quality of the sewage and the standard of discharge. Whether the treatment cost is in line with the local development level and whether the recovery can meet its economic value, etc., in order to determine the treatment method applicable to a certain area. So determining a suitable process is not blindly following the trend. Sewage treatment can be classified according to treatment method and degree.

2.1 Classification by processing method

Different types of hazardous substances correspond to different types of sewage and different types of sewage correspond to different countermeasures. According to water treatment measures, sewage treatment methods can be divided into three categories. Among the three treatment methods, physical action is the core principle of physical measures. Since sewage contains many floating wastes and pollutants on the surface, the physical action is to separate it from sewage. Physical processing methods generally include the following: gravity center, gravity separation method and screening throttling method [8]. Chemical treatment can produce neutralization, REDOX and other chemical reactions on the basis of adding chemicals. In addition, it can also carried out using mass transfer effects, such as adsorption and membrane treatment technology. It is a treatment measure which converts harmful substances into substances that do no harm to people on the basis of chemical reactions and mass transfer. Biological treatment is advocated and used in the development of modern society widely. It uses the metabolism of microorganisms to convert soluble or insoluble organic matter in sewage into non-threatening substances. There are many types of microorganisms but the individuals are so small that they cannot be recognized by the naked eye, and can rapidly multiply during growth [9-11]. Only by understanding and mastering the different characteristics of different microorganisms can we cultivate microorganisms in the sewage treatment process to obtain better purification of sewage.

3 Overview of configuration software

Configuration is any combination of modules. The main characteristics of general configuration software are:

(a) Continuity and extensibility.

For applications developed with general configuration software when the site (including hardware equipment or system structure) or user requirements change, it is easy to update and upgrade the software without many modifications.

(b) Encapsulation.

The functions that can be completed by the configuration software are packaged in a user-friendly way. For the user, a complicated project can be completed without much programming language technology (or even programming technology).

(c) Universality.

According to the actual situation of the project, each user can use the Input/Output (I/O) driver of the underlying equipment (PLC, smart meter, intelligent module, board, inverter, etc.) provided by the general configuration software, open database and screen production tools. Completing an animated, real-time data processing, historical data and curve coexistence, with multimedia and networking capabilities is not limited by the industry. The earliest general configuration software developed is the configuration software under DOS environment, which is characterized by simple man-machine interface (MMI), gallery, drawing toolbox and other basic functions.

With the continuous development of PC, more advanced configuration software from abroad has been developed, including *iFix* by GE Fanuc, *InTouch* by Wonderware, *WinCC* by Siemens and *Web Access* software by BroadWin [12-13]. As the market demand for configuration software becomes more and more urgent, domestic configuration software also has the bud of gradual development, such as *powercontrol*, Kunlun tongtai *MCGS* and *Kingview* series of control technology and so on. The Kingview 6.53 developed by Asia Control Technology Company is adopted in this design.

Kingview series products account for the largest proportion in the domestic configuration software. Among which kingview 6.53 in the series products increases the capacity of Kingview and the advantages of large data storage meet the demanding requirements of some customers on the capacity. It has been able to connect thousands of industrial control equipment, including PLC, board card, frequency converter, etc. In addition, Kingview 6.53 adds many communication modes for users to select and users can choose different communication modes according to different situations, including serial communication, field bus, etc. Therefore, Kingview software can well meet the requirements of automatic monitoring of sewage treatment monitoring system.

4 Configuration monitoring system design

The use of Kingview software to build a new project is the only way to complete the design of the monitoring system. The process mainly includes device driver selection definition, variable definition, graphical interface creation, programming animation connection and running debugging [14]. These steps are not sequential, but you can configure one process while the other is in progress.

4.1 Connect external equipment PLC

After opening the Kingview software, it is necessary to establish a project named "sewage treatment monitoring system", open the project and configure the COM terminal in the project browser. Click "COM" on the left and create a new one. Because the PLC of mitsubishi series is used in this design, FX series subordinated to mitsubishi is selected. However, when debugging the configuration screen, it is not connected to the PLC. In order to facilitate debugging, the analog device can be used first and the COM port of the sub-control simulation PLC can be used. Device selection is shown in Figs.1 and 2:

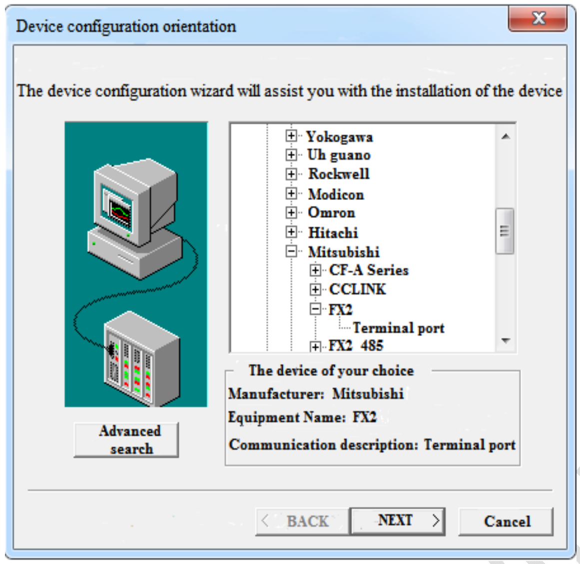


Fig.1 Device configuration wizard diagram

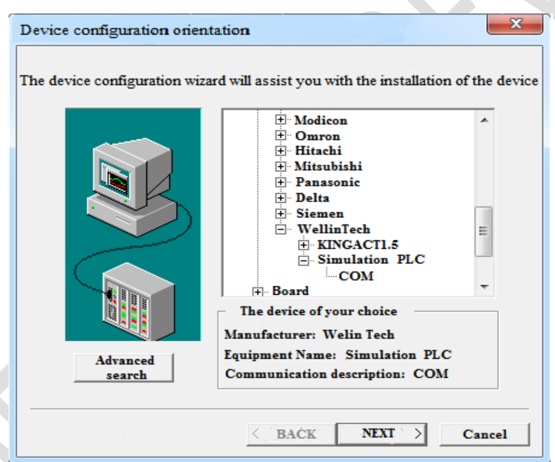


Fig. 2 Debug device connection wizard

4.2 Defined variable

In order to reflect the properties of the controlled object with data, it is necessary to create a real-time database in the configuration king. Variables in the real-time database can reflect the properties of the object and achieve the purpose of control [15], such as liquid level, temperature and so on. In addition, it can also set variables representing operators in the configuration king, similar to valves, switches and so on.

If a variable is newly created in the data dictionary, a dialog box will appear for the corresponding setting, such as the level of the sump, which is set as I/O integer. Register as INCREA incremented by 1 and the read/write attribute as read/write. In addition, the alarm function of the level can be set to give an alarm when the upper and lower limits are reached. According to experience, the liquid level height is set to 68cm and the remaining variables are shown in Figs. 3 and 4.

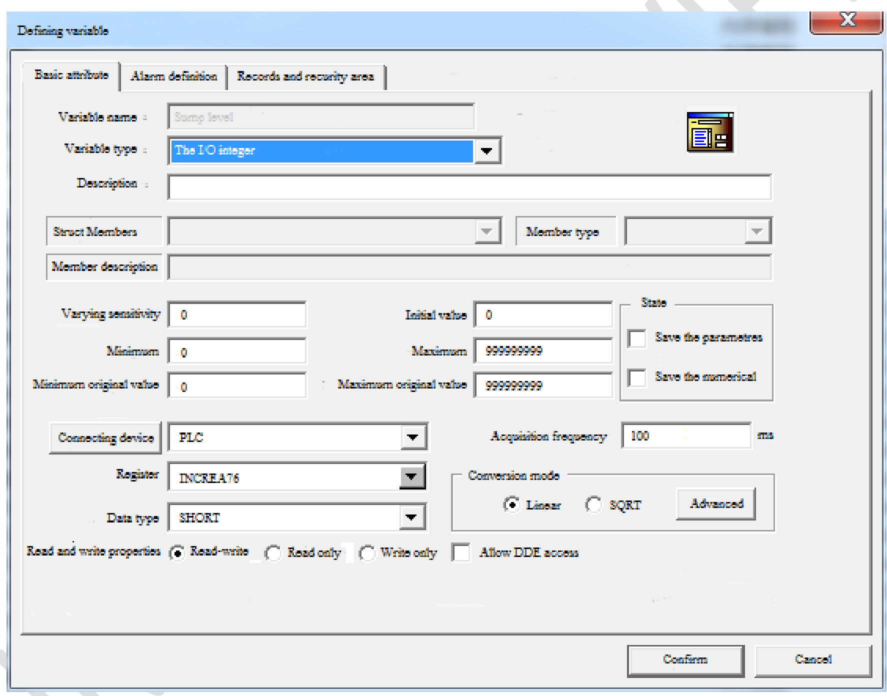


Fig.3 Variables define basic attributes

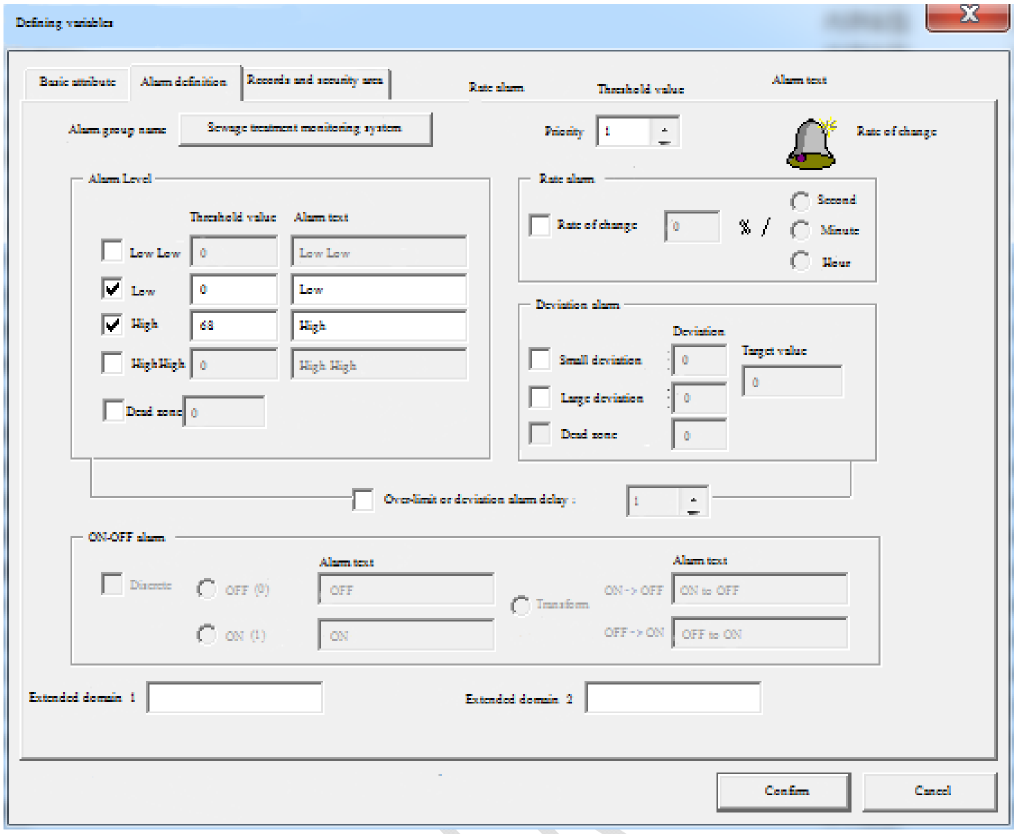


Fig.4 Variable definition alarm definition

4.3 Design monitoring screen

The monitoring screen mainly consists of three parts: the user login interface, the main screen of the process and the sub-screen. The login interface is set to ensure the security of the interface. Users can enter the system only after the password of the relevant person is logged in. The main screen is the plane dynamic diagram of sewage treatment process, including such processes as grille, collecting pool, SBR pool and reclaimed water reuse, etc. The administrator can view the total dynamic of sewage treatment in this screen after obtaining the permission. The split screen is mainly composed of grille, collecting pool, SBR pool, blower room, trend curve and how to change the treated water into the middle water.

(1) Login interface design: the login interface ensures the security of other interfaces. Only when the user clicks the user to log in and the password is correct, the user has the right to enter the system to observe and monitor the system. The following Fig. 5 is the login interface.

Fig.5 Login interface

(2)Main screen design: In the main screen, plane dynamic graph is processed, and there are two keys: logout and screen switch. Logout is the key for users to log out. When the key is pressed, the page will return to the login interface. Screen switch is a menu-type button. When pressing the button, the name of each sub-screen will appear below and users can choose one to enter. Fig. 6 shows the main design drawing:

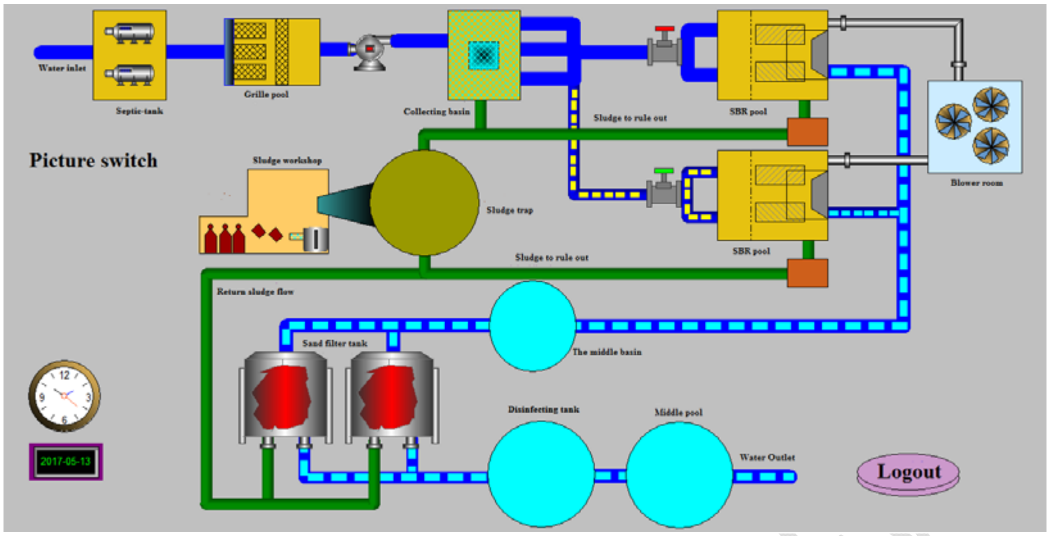


Fig.6 Main screen of the system

(3)Split screen design: it is mainly composed of grille, collecting pool, SBR pool, blower room and trend curve et al.

A、Grilles, Sinks

In this design, the grille tank and the collecting tank are combined. The inlet pump is used as the connecting medium and the sewage flows into the collecting tank through the pump between the grille decontamination machine and the collecting tank. The screen of grille and collecting pool is shown in Fig. 7:

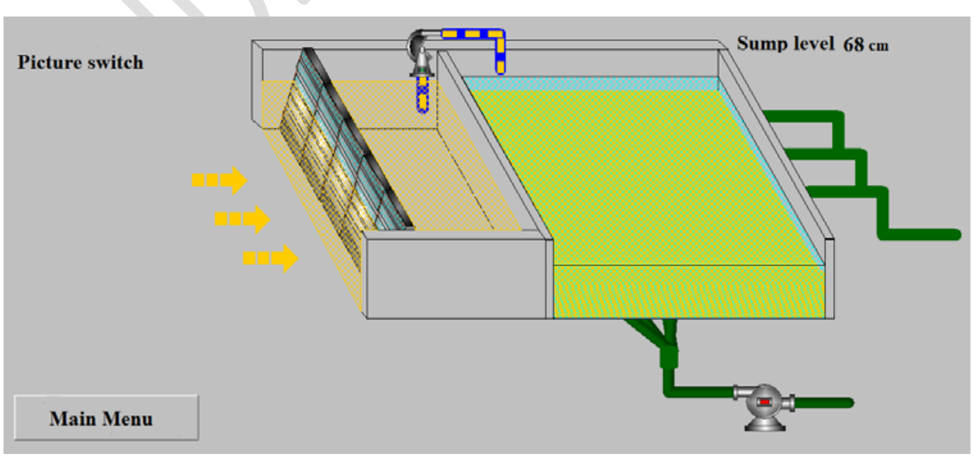


Fig.7 Grilles, Sinks

B、SBR pool

SBR pool is the core part of sewage treatment. When the water inlet valve is opened, the sewage needs to go through the processes of water inflow, reaction, precipitation and drainage in SBR pool to achieve the effect of water purification. It is equipped with aerator, water decanter and other equipment to help complete the treatment process. The SBR pool screen is shown in Fig.8:

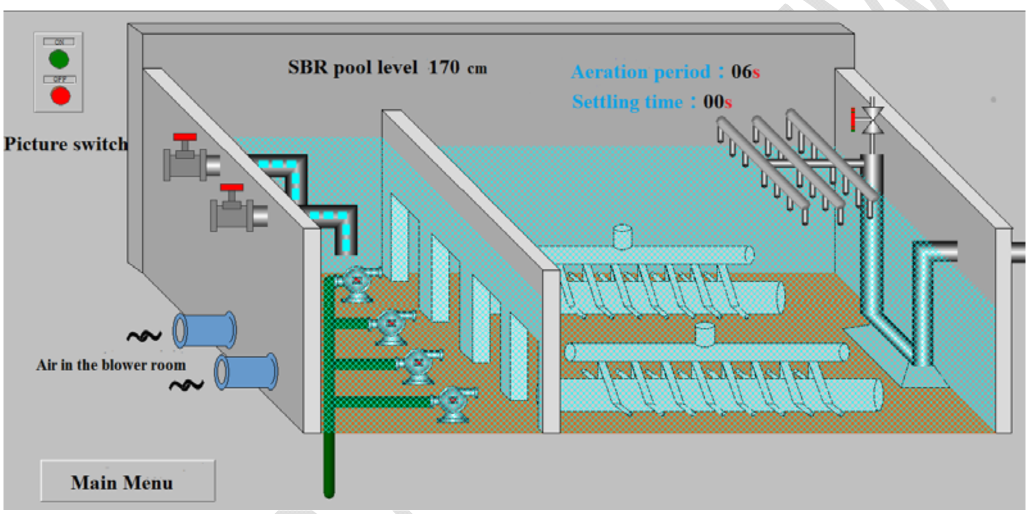


Fig.8 SBR pool

C、Blower room

There are 3 roots blowers in the blower room, among which the third one is used as an emergency standby. The role of the blower is to provide air for the reaction pool and allow the sewage to be fully aerated. Before the liquid level of the SBR tank rises to the upper limit, the Roots vent valve of the blower room is opened, and when the liquid level of the SBR pool rises to the programmed upper limit, the water is no longer discharged into the pool. At this point, the roots blower is turned on, the roots vent valve is closed and the fan is turned off when the aeration time is reached. Then the vent valve is opened again and turned off after a while. Among them, the opening and closing degree of fan outlet valve are controlled by the total amount of DO in water. The picture of blower room is shown in Fig.9:

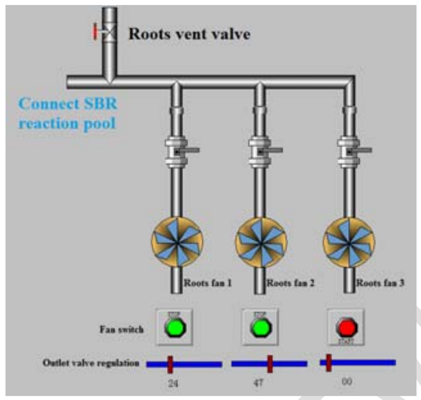


Fig. 9 Blower room

D、Real-time trend curve

The real-time trend curve is a synchronous record of the addition and subtraction of variables and time changes during the process, allowing operators to observe changes in the water level in the pool. The real-time trend curve is shown in Fig.10:

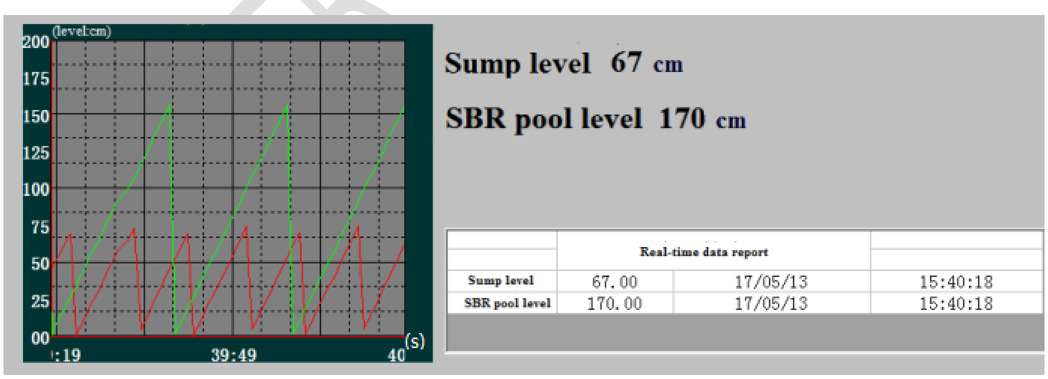
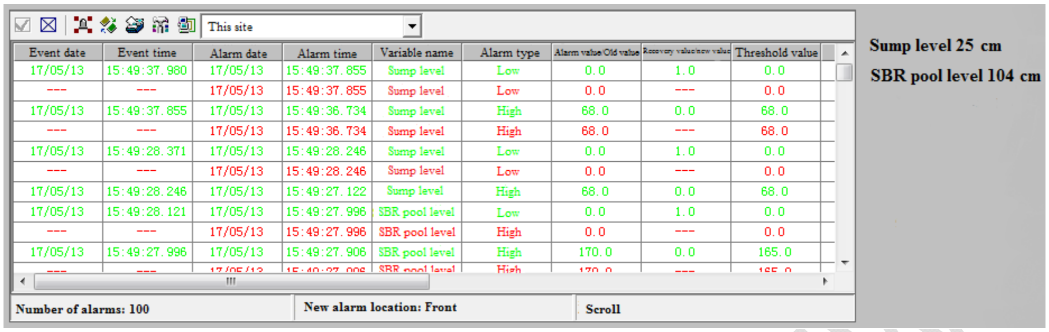


Fig.10 Real-time trend curve

E、Alarms and events

This screen will reach the alarm state according to the upper and lower limits set by variables. For example, when the level of the collecting tank is higher than 68cm (the previous setting has been set), the alarm state will reach and the event will be recorded in the table. The alarm and event screen is shown in Fig.11:



Event date	Event time	Alarm date	Alarm time	Variable name	Alarm type	Alarm value/Old value	Recovery value/new value	Threshold value
17/05/13	15:49:37.980	17/05/13	15:49:37.855	Sump level	Low	0.0	1.0	0.0
---	---	17/05/13	15:49:37.855	Sump level	Low	0.0	---	0.0
17/05/13	15:49:37.855	17/05/13	15:49:36.734	Sump level	High	68.0	0.0	68.0
---	---	17/05/13	15:49:36.734	Sump level	High	68.0	---	68.0
17/05/13	15:49:28.371	17/05/13	15:49:28.246	Sump level	Low	0.0	1.0	0.0
---	---	17/05/13	15:49:28.246	Sump level	Low	0.0	---	0.0
17/05/13	15:49:28.246	17/05/13	15:49:27.122	Sump level	High	68.0	0.0	68.0
17/05/13	15:49:28.121	17/05/13	15:49:27.996	SBR pool level	Low	0.0	1.0	0.0
---	---	17/05/13	15:49:27.996	SBR pool level	High	0.0	---	0.0
17/05/13	15:49:27.996	17/05/13	15:49:27.906	SBR pool level	High	170.0	0.0	165.0

Fig.11 Alarm and event screen

F、Reuse of recycled water

The water reuse system advocates the concept of reducing water use, reducing energy consumption and strengthening pollution control. Therefore, when designing the system, various advanced and integrated technologies were used to respond to the concepts advocated by the system. The water filtration system consists of filtration and disinfection parts. The filtration part uses a sand filter tank containing manganese sand and anthracite coal, which can remove iron ions and solid colloidal particles in the water. The water passing through the sand filter tank is added to the disinfection tank for dosing and disinfection to reach the standard of effluent. The reclaimed water reuse system is shown in Fig.12:

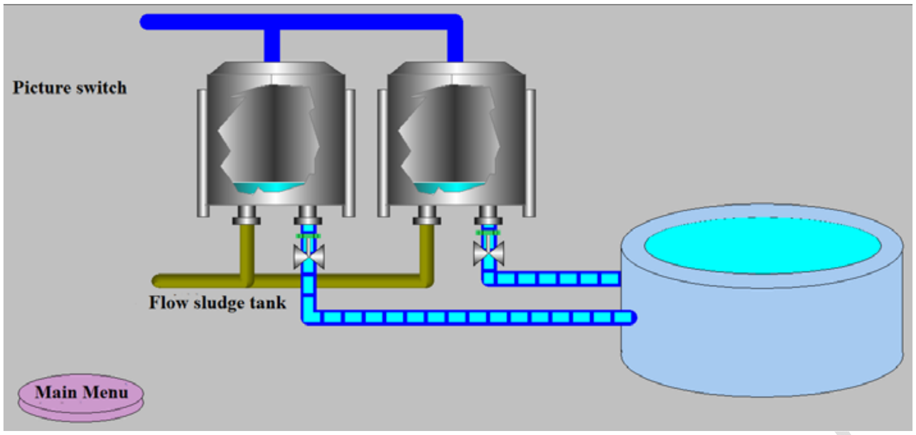


Fig.12 Water reuse system

5 Conclusion

In this work, a PLC-based sewage treatment system was designed in the previous work. Although the system is a complete sewage treatment process, it does not realize the real simulation process. Therefore, this paper designed a sewage treatment monitoring system based on Kingview.

This paper mainly designed the screen of the upper computer monitoring system, which realizes the operator's understanding and mastery of the current operating status of the sewage treatment, so that the user can adjust the corresponding data according to the problems found. In addition, it is also possible to generate an alarm for the corresponding overrun problem and collect and record the change data generated by the variable. In this system, the staff can understand the progress and status of the sewage treatment, the changes and trends of the parameters in real time, and optimize and improve the sewage treatment process in time to achieve real simulation results. Therefore, by using Kingview software to complete the drawing of the monitoring system screen, the basic requirements and expected results can be achieved.

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