

Design and Implementation of Sewage Treatment Control System

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Abstract. The performance of the sewage treatment as one of the important equipments in ships has a direct impact on the entire power installation and ship performance. The performance of the sewage treatment is a kind of Ship antipollution devices which can treat sewage such as bath water, hygienic-water and cooking water. In this way, it could make the wastewater reach the discharge standard. This paper describes the optimized design of the new disposal equipment of domestic sewage. In the further research of liquid level control and automatic control program, it posed the new disposal equipment of domestic sewage which takes SIEMENS S7-200 as the control core, integrated liquid level difference sensor, engine room extended alarm combination of monitoring and alarm means, and used PROFIBUS-DP network to achieve real-time communication between modules combined with existing equipment. The experiments show that the performance is steady, and the operation control is more easy and simple, so it reaches the expected purpose .

Keywords: Ship, Sewage treatment plant, Automatic control, PLC.

Introduction

Ship sewage treatment plant is a kind of environmental protection equipment, mainly to make sewage runoff conform to international standards. By this way it can reduce the pollution of marine environments. Ship domestic sewage treatment plant. With the development of maritime transport, marine pollution from ships is also increasing. Every country is fully aware of precautionary measures they have to take to prevent marine pollution.

At present, most sewage treatment control system of the ship, adopt conventional means of relay controlling, inspected artificially the survey found. But this control mode has poor reliability and it is easy to appear abnormal situation. The emergence of these fault situations not only can cause of marine pollution, may also make the ship to stranded when being examined, and cause economic loss. In order to solve the problems of the low speed and poor reliability in traditional relay controlling, a ship's sewage treatment system based on PLC is proposed.

Design Principle

Marine sewage treatment plant is composed of Pretreatment chamber, Aeration chamber, Settling chamber and clear water chamber. Pretreatment chamber equips with a smash pump, Aeration is a tank where microorganism decompose organism in waste water. Aeration chamber contains aeration fan.

Equipping with high temperature protection, liquid level alarm, air pressure alarm, high and low level control, automatic dosage control and emission control of system for the purpose of automatic control and alarm and protection of the processing equipment.

First, domestic sewage passes through a pretreatment chamber to remove large materials like tree limbs, trash and leaves and smash small materials; the crushing sewage run into aeration chamber with sufficient oxygen provided by the aeration fan. In this high oxygen environment, active bacterium be able to decompose the organic compound in wastewater. The treatment sewage then led into settling chamber; The clear liquid is finally led into clear water chamber, chlorine could kill bacteria in this tank. And automatic coagulant addition system can adjust doses in real time by the discharge pump running time. The resulting harmless liquid is drained onboard by discharge pump.

During the entire rendering process, Smash pump automatic control process of the phenomenon such as jam problem, it will stop pump running by temperature control protection; When the high and low level control system malfunction caused water chamber high relief, the system will send out alarm, and extend to the cabin circuit alarm system.

Automatic Control Ssystem Hardware

Automatic control system includes Main control module , visualization Operation module, liquid level module operation, Sewage treatment module and alarm module, Figure 1 as follow.

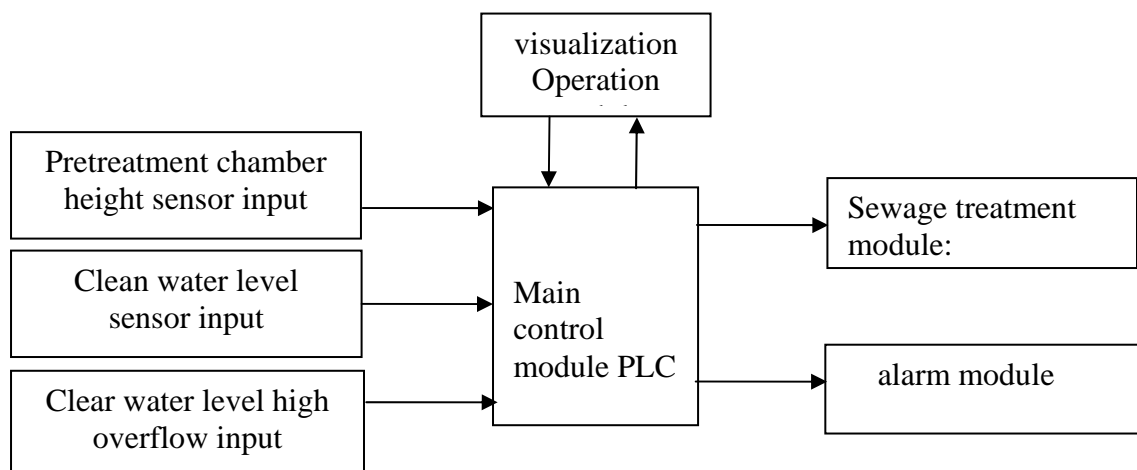


Figure 1 Automatic control system diagram

Control module hardware

Control module hardware consists of Siemens s7-200 PLC. According to requirement of the I/O points, we choose CPU226 model that is twenty-four input and sixteen output. The application of PLC in the achievement of sewage treatment control can simplify the hardware circuit of the system and obtain more reliable work. Control module could promote the orderly operation of the work, such as controlling Smash pump, discharge pump to operate in an automatic mode. Meanwhile, PLC and other peripherals communicate with each other by module EM277. It has been widely used in the large equipment of business. It has been widely in the machinery.

Level module module

The operation control of the smash pump and the discharge pump is based on the detection of the liquid level of the pretreatment chamber and the clean water chamber.

In this system, the liquid level sensor is selected, the model of which is YW-67-1A type liquid level difference sensor, and the UQK-03 liquid level switch. Liquid level difference sensors are installed on the top of the pretreatment room and the clean room, through which the signals are input into the PLC controller for analysis and calculation to control the operation of the smash pump and the discharge pump and the liquid level within the set range.

The liquid level switch is installed at 2cm of the overflow port in the clean room. When the sensor fails, the liquid level switch with output signal to PLC, and then extended alarm by PLC will be sent to the engine room, Warning duty personnel to deal with that.

Visualization operation module

Using the touch screen to control, monitoring, operate and adjust parameter during the entire process.

Touch screen selection model: Kunlun Tongtai TPC7062Ti MCGS, Cortex-A8 CPU, 7 inch four wire resistance type embedded integrated touch screen with powerful displaying and data processing functions.

The module includes: The display module can monitor the working state in real time, liquid level of pretreatment and clean room; Input operation is mainly composed of input buttons and input information dialog box which can be used to adjust the input control and parameters of the device instruction. Figure 2 as follow.

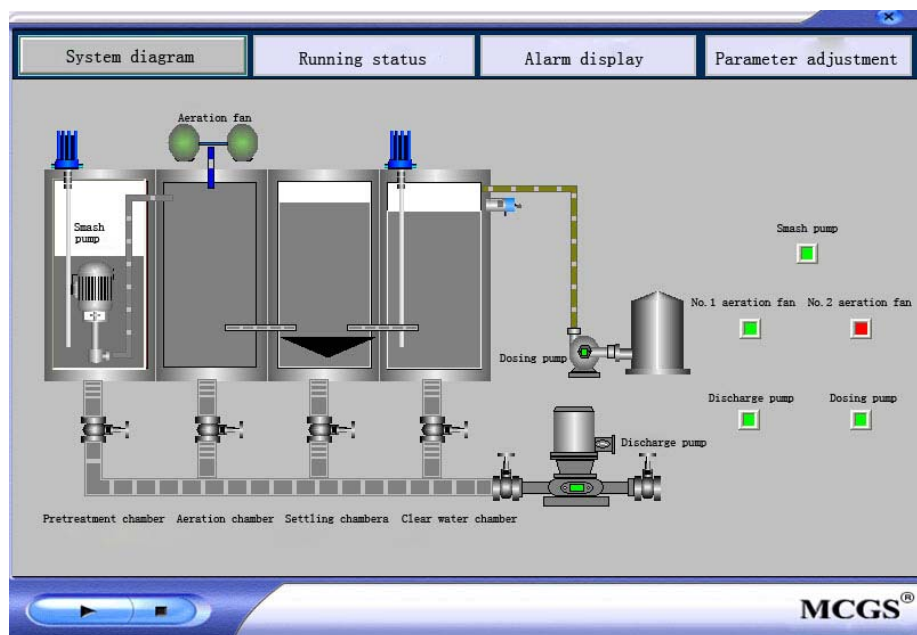


Figure 2 Touch screen

Sewage treatment module

The sewage treatment module is composed of a smash pump control system, an aeration fan control system, an dosing pump control system and an discharge pump control system.

Among them, the model ICWFI2 is chosen for the smash pump, the start and stop is controlled by the liquid level sensor in the pretreatment chamber, and the pump fault alarm is provided; Aeration fan selection model CYBW25 equipped with two units, each other standby, can be manually and automatically controlled which is also equipped with pressure alarm. Dosing pump KS803 discharges the drug according to the discharge of the pump; Discharging pump 25GW5 - 15, starts and stops by the clear water level sensor control.

Alarm module

The alarm module controls the whole system, sound timely alarm, which can be displayed on the touch screen details, and can be extended to the cabin alarm, the engineer can give timely judgment, analysis and treatment of fault to protect the equipment.

Software Design

PLC I/O resource allocation

According to the functional requirements of the system, the configuration of the PLC I/O is as follows.

(See Table 1 and Table 2)

Digital input part

Table 1 Digital input address assignment

Input address	input device	Input address	input device
I0.0	Emergency stop	I0.6	Manual mode No.2 aeration fan start
I0.1	Manual mode	I0.7	Manual mode dosing pump start
I0.2	Automatic mode	I1.0	Manual mode discharge pump start
I0.3	Automatic start confirmation	I1.1	Pretreatment chamber liquid level sensor
I0.4	Manual mode smash pump start	I1.2	Clear Water chamber level sensor
I0.5	Manual mode No.1 aeration fan start	I1.3	Clear Water chamber overflow liquid level switch

Digital output part

Table 2 Digital output address assignment

output address	input device	output address	input device
Q0.0	Smash pump contactor	Q0.5	smash pump alarm
Q0.1	No.1 aeration fan contactor	Q0.6	pressure alarm
Q0.2	No.2 aeration fan contactor	Q0.7	Clear water chamber overflow alarm
Q0.3	Dosing pump contactor	Q1.0	Engine room extension alarm
Q0.4	Discharge pump contactor		

PLC hardware connection

Hardware connection diagram of automatic control system for domestic sewage treatment plant is shown in Figure 3

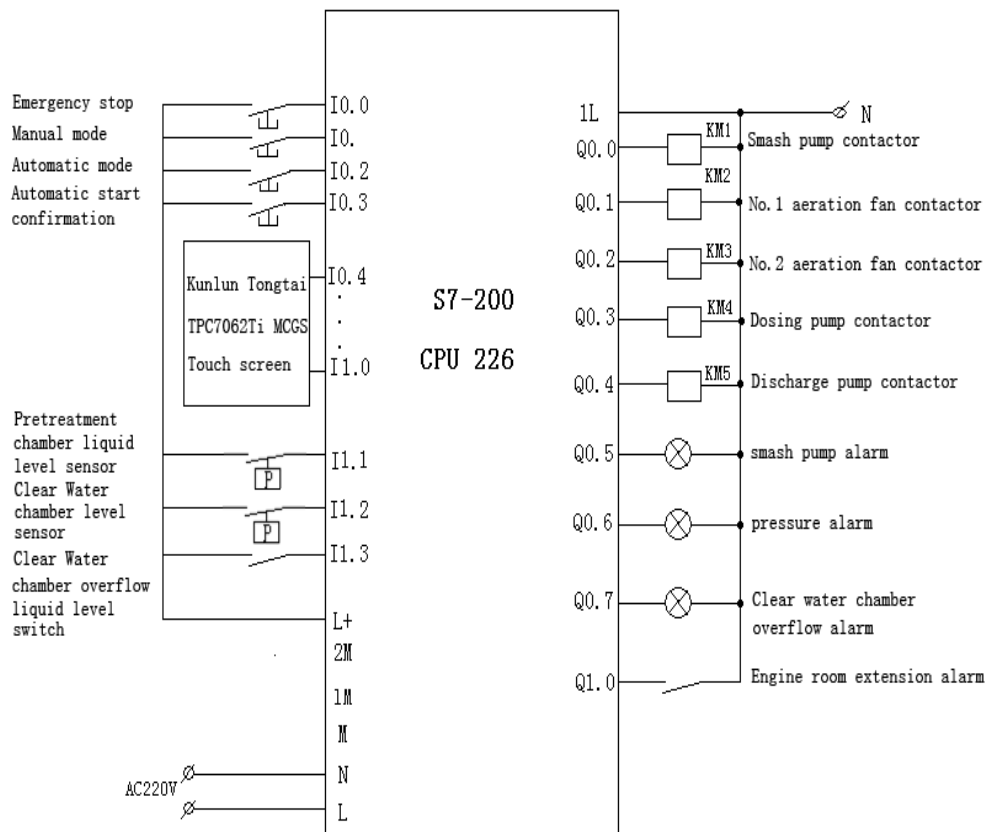


Figure 3 Hardware connection diagram of automatic control system for sewage treatment plant
Software implementation of each functional module

This system mainly uses STEP7-Micro/WIN32 as the programming software, According to the function of the system to carry out the modular programming, Information exchanging between modules through the network, After the completion of the program, It will be tested by SIEMENS simulation software and then the hardware test. According to the requirements of ship operation, the equipment can be controlled manually or automatically.9:26 2017-4-11This system mainly uses STEP7-Micro/WIN32 as the programming software, According to the function of the system to carry out the modular programming, Information exchanging between modules through the network, After the completion of the program, It will be tested by SIEMENS simulation software and then the hardware test. According to the requirements of ship operation, the equipment can be controlled manually or automatically.

Manual mode

Manual control is mainly used in the initial use of equipment ang during the process of maintenance. In this mode, each device is run separately and can be used for detection and adjustment of each device (See Figure 4).

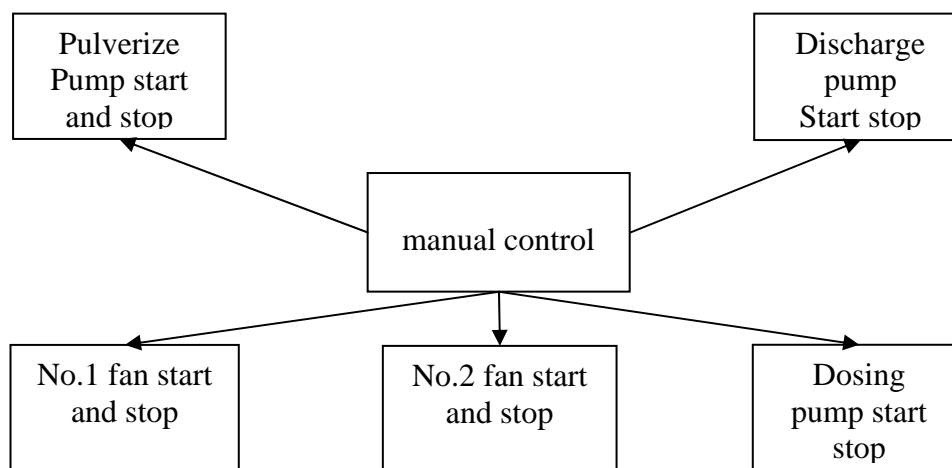


Figure 4 System diagram of manual operation mode

Automatic mode

When the system is in automatic control mode, the system power is supplied, the automatic start confirmation is pressed, the system will start to work. The work includes the following aspects:

The liquid level sensor in the pretreatment chamber determines the liquid level, which is higher than the highest liquid level value, and the PLC control of the smash pump will start.

When the pretreatment chamber level sensor determines the liquid level is lower than the lowest level, the PLC control of the smash pump will stop.

No.1 aeration fan accepts PLC signal to automatically start, after the operation for 24h and automatically change to No.2 aeration fan.

Clear water chamber level sensor determines the liquid level, higher than the highest level value, PLC control discharge pump will start.

The liquid level that is determined by the water chamber level sensor is lower than the lowest level, PLC control discharge pump stop.

PLC monitors the running time of the pump and controls the work of the dosing pump.

System programming is not performed in sequence, Therefore, the actual work process is not in accordance with the order of the Sequential control mode, But in accordance with the PLC sensor to detect the state of real-time parallel start (See Figure 5).

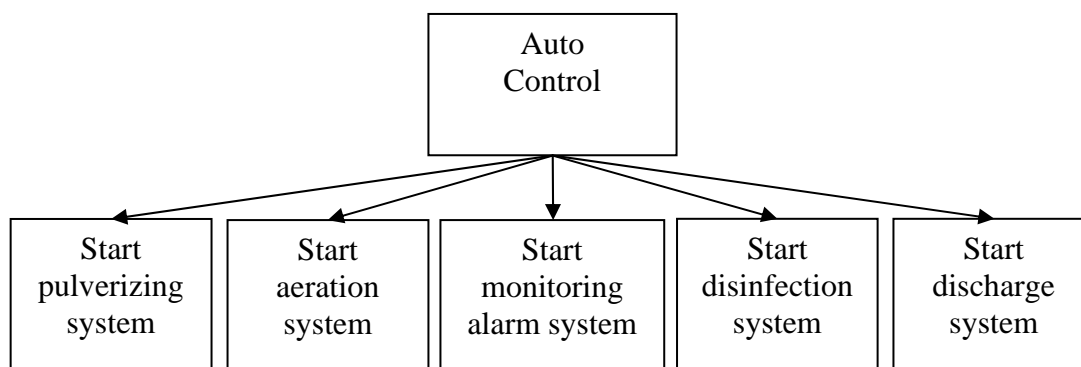


Figure 5 System diagram of automatic operation mode

Test Result

Through the simulation of the hardware, check the program ,which is correct,by using of SIEMENS PLC S7-200 simulation software.

Connect the hardware and control the equipment manually and automatically through the PLC control system. After power up, select the manual control mode, which can realize the control of various pumps. When selecting automatic control mode, PLC detects the value of analysis and judgment by the sensor , you can achieve the automatic control of the pump start and stop and alarm monitoring.

Conclusion

This design takes SIEMENS S7-200 as the control core, Integration of liquid level difference sensor, engine room extension alarm combination of monitoring and alarm means, Using PROFIBUS-DP network to achieve real-time communication between modules, The utility model has the advantages of stable working state, visual operation, saving control elements, improvement of the quality of the production process monitoring, and the establishment of a plurality of alarms to protect the system.

Through debugging and trial operation, The automatic control system meets the design requirements. This equipment is used for more than 6000 hours in the actual operation of more than 4 ships in a Shipping company, Cumulative sewage of treatment is more than 2500m³ and save working time for 460 hours, which has the features of labor saving ,reliable operation, free of malfunction ,and meet the sewage discharging requirements.

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