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The Control System Design for a Central Purifying Water Treatment in Hospital

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The process flows of a central purifying water treatment system in hospital is introduced. The system structure control flow charts using King view and S7-200 siemens programmable controller is given. The hardware configuration of control system is described. The monitoring panel of the configuration software is given. The application results show this system can meet the requirement for design.

1. Introduction

Hospital water quality directly related to the general medical patient's life health, the requirements for water quality are extremely strict in the process of medicine and surgery. Meanwhile, In order to adapt to the improvement of hospital hardware facilities and equipment for water quality request enhancement, the original scattered, small-scale single department using water processors have obvious disadvantages for poor water quality and difficult management.
The central purifying water treatment system in hospital is a central water making and high quality water supply system instead of the original water processor by single department in hospital. It has the characteristics such as energy saving, consumption reduction, high automation degree, low cost. This paper mainly introduces the control plan of a purifying water treatment system in some state-level hospital.

2. The process flow

Usually the following department should set pure water points in hospital: operating room, center of loading, ward laboratory, wash the infant room, ICU, hemodialysis room, outpatient clinical laboratory , dispensing center, outpatient stomatological department, important equipment water (such as linear accelerator) and part of the place such as drinking water points. This system design four road pure water pipes output in view of some state-level hospital's specific situation, they is respectively: the clinical pathology and pathology department, the water supply center and dental department, the surgery, speculum and obstetrical department, drinking water. But because of pure water of hemodialysis chamber, in addition to set a higher request more advanced pure water processor, this paper does not involve. The process flow of this system as shown in figure 1.
Purifying water treatment mainly adopts membrane processing, in this process the pretreatment general should be before membrane treatmen, the post-processing is after processing. The system uses the membrane processing technology for reverse osmosis (RO), the pretreatment generally uses filtration and soften, the post-processing with disinfecting.
The purpose of pretreatment is removing the substance in water easy causing subsequent filtration membrane jams and scaling, protecting filtration membrane from being polluted, and prolonging the service life of filtration membrane.
Tap water after the original water tank, the water displacement gas ran out from internally, the water sediment precipitation down, to avoid the damage of booster pump impeller, and avoid unexpected shutdown of the impact of system, made the head of the whole system reached need values.
Many media filters also called mechanical filter, medium can be quartz sand, hollow fiber or specific filter etc. Its main function is to remove 30um ~ 50um above the impurities. In this filter design with recoil device, the

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recoil can be manually or automatically regularly, the intercept impurity is rinsed clean most, this can prolong the service life of filter.

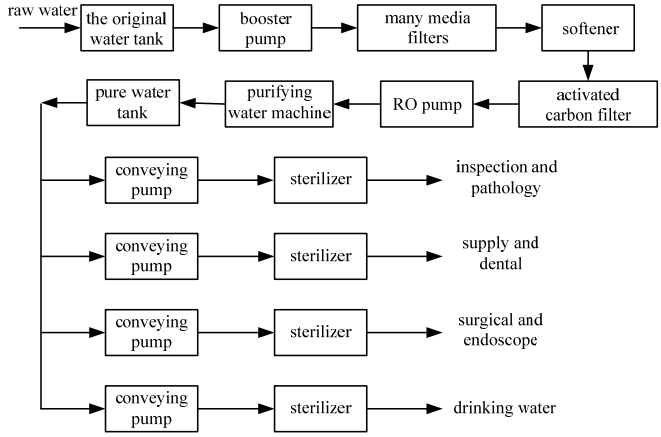

Figure 1: The central purifying water treatment system process flow diagram

The softener is mainly to fill the calcium and magnesium plasma exchange, water can be greatly reduced the hardness. The softener may through sodium chloride to regenerate.

Activated carbon filter can remove the water by adsorption effect of organic materials, at the same time through charcoal with chlorine catalytic reaction can be in water chloric purify, it makes the organic film from oxidative and prolong the service life of membrane.

Reverse osmosis membrane (RO) is mainly the desalination and residual organic matter. Reverse osmosis is using polymer selective pervaporation membranes, in the reverse osmosis driven, pure water from membrane side is pushed to the other side, but inorganic salt, sugar, bacteria, viruses, pigment, heat-trapping source etc all impurities are trapped in wastewater side, so as to achieve the purpose of purified water desalination.

The purpose of post-treatment technology is to make sure the processing standards of water does not occur secondary pollution pure through water tank and conveying pipe valves, so in four ways of pipes installed on each a sterilizer.

3. The hardware design of control system

According to the pure water treatment process requirement, system is mainly for sequence control and process control. PLC was used to realize to start and stop the components such as the original water pump, many media filters, softener, activated carbon filter, sterilizer, reverse osmosis membrane RO, water making machine, pure water tank, each output purified water piping , and association control between various equipment. Liquid level, flow, conductivity, the resistance parameters are collected, according to requirement of process of pure water treatment system each unit is sequence controlled. And the units are adjusted sequentially when the water quality appear unexpected circumstances, so as to control the whole preparation of the operation of the system and the water quality.

This system is divided into the upper computer and lower level computer: the upper computer is composed by Siemens touch screen MP277, Siemens S7-200 series programmable controller was used to lower level computer, its model is CPU 226 CN, In addition, an 8 input/8 output module EM223CN and two 4 input analog input module EM231 be expanded according to system requirements. PLC communicates with touch screen by MPI interface, realizing real-time signal acquisition and monitoring and control for the whole process operation.

The control system structure is shown in figure 2.

This system has 13 various types of pump, is respectively:

① 3 sets raw water booster pump: two running and a back-up, 3×380V, 4.6KW.

② 2 sets RO pump: a running at the same time, 3×380V, 11KW.

③ 2 sets conveying pump for Inspection and pathology department: a running and a back-up, 3×380V, 0.82KW.

④ 2 sets conveying pump for supply and dental department, a running and a back-up, 3×380V, 1.35KW.

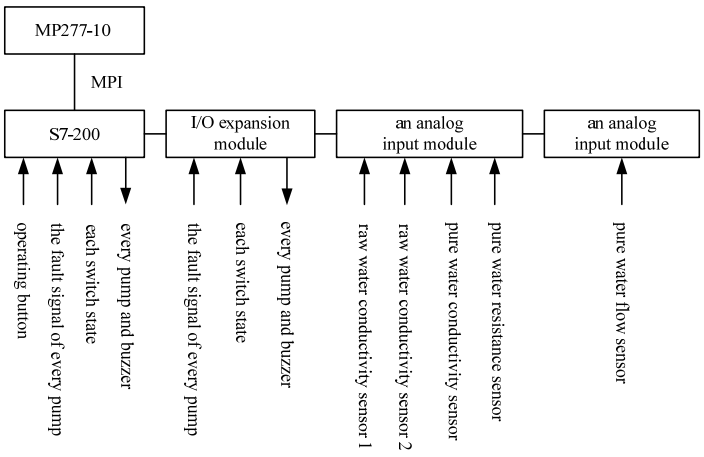

Figure 2: Purifying water treatment control system structure diagram

⑤ 2 sets conveying pump for surgical and endoscope and obstetrical department: a running and a back-up, 3×380V, 2.23KW.
⑥ 2 sets conveying pump for drinking water: a running and a back-up, 3×380V, 0.54KW.
Various types of sensors in this system has nine, them is respectively:
① High and low level switches in the original water tank: 2
② Raw water conductivity sensor: 2
③ Pure water conductivity sensor: 1
④ Pure water resistance sensor: 1
⑤ Pure water flow sensor transmitter: 1
⑥ High and low level switches in pure water tank: 2 (Every have high, medium and low three gears)
The 4 sterilizers and 4 metering pumps are arranged in the 4 road output pipe of the system respectively.
① A sterilizer in the clinical pathology and pathology department（220V，0.2KW）
② A sterilizer in the water supply center and dental department（220V，0.2KW）
③ A sterilizer in the surgery , speculum and obstetrical department（220V，0.2KW）
④ A drinking water sterilizer（220V，0.2KW）
⑤ A single-phase metering pump（220V，0.2KW）

4. The design of the PC monitor screen

The kingview software this system using is the configuration software developmented from Beijing yakong automation software Technology Company Limited. It consists of engineering manager (King View), project browser (touch explorer), the pictures development system (touch make), the pictures operation system (touch View) and information window. The system design of the monitor screen is introduced below.

4.1 The main screen design

The system boot and after a short system startup and self-examination time, the initial screen will present in MP277 touch screen. It mainly display system name, date, time and operation password input and other relevant information; After inputting a password, the main screen of the system is entered, as shown in figure 3. The main screen display system technological process and the pump running state and fault information with animation way. Using the touch key on the bottom of the screen can switch to other picture. While on the other picture, click monitoring button to return to the main screen.
When raw water can't supply and the original water tank is in a low level, the pump are pretreatment stop running, "The original tank low level" red font scintillation alarm below in the graphic the original water tank. When raw water supply returned to normal, alarm disappear.
When pure water tank low level, the system alarm. "Ultra-low liquid level of the pure water tank" red font scintillation alarm above on the pure water tank, as shown in figure 3, and delay stop pure water transportation.

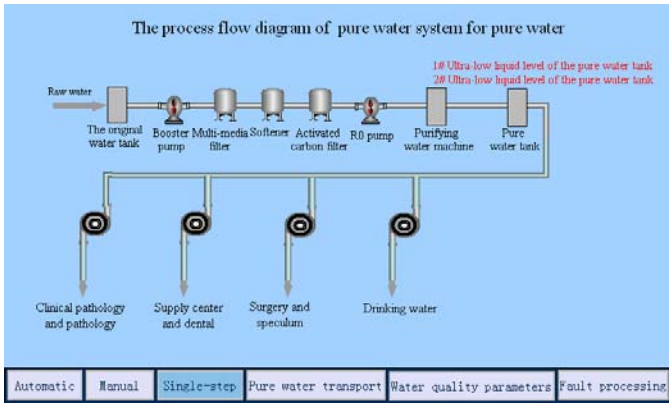

Figure 3: The process flow diagram main screen

4.2 Operation work station picture

Click the automatic button below screen of the figure 3 and enter the operation work station picture, as shown in figure 4. Operation work station is used to control operation mode of the start and stop of system automatically. Each pump corresponding circle surface show the current state, green for running state, red for stop position, yellow for fault condition. In the graph, the startup delay is the interval time that the booster pump and RO pump are starting at the beginning of the water system; the stop delay is the interval time that RO pump and the booster pump are stopping at the end of the water system.

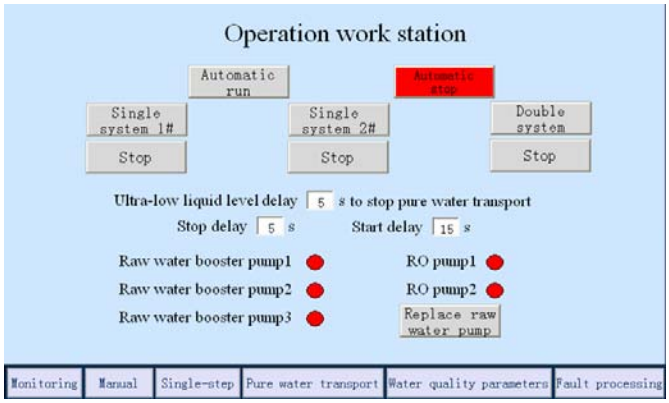

Figure 4: Operation work station picture

4.3 Manual work station picture

Click the manual button on any screen and enter the manual work station, as shown in figure 5. Each pump corresponding circle surface show the current state, green for running state, red for stop position, yellow for fault condition. After the completion of the manual operation must be returned to be automatic running state: click the manual stop button on the manual work station, and then click the automatic operation key.

4.4 Single step operation picture

Single step operation used to recoil, regeneration, disinfection, rinsing maintenance operation such as in the control system, as shown in figure 6. Recoil: the reverse flushing of various pretreatment container; Regeneration: the packing activation inside SF filter; Disinfection: the disinfection of the pretreatment system; Cleaning: To add cleaning agent in the water, cleaning pretreatment equipment. Rinsing: when regeneration, disinfection, cleaning operation is completed, the pretreatment equipment must rinsed with water to achieve the effect of rinsing before purifying water.

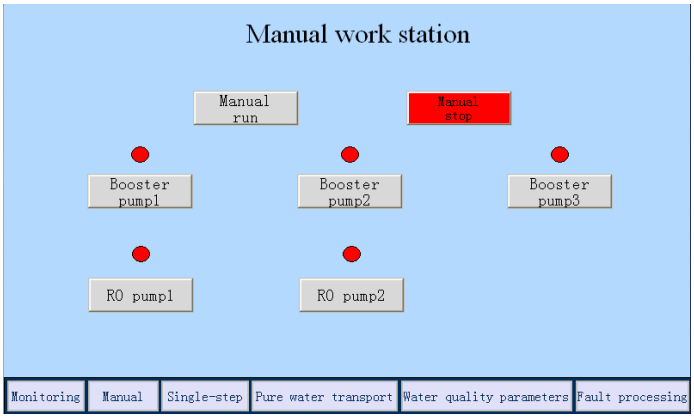

Figure 5: Manual work station picture

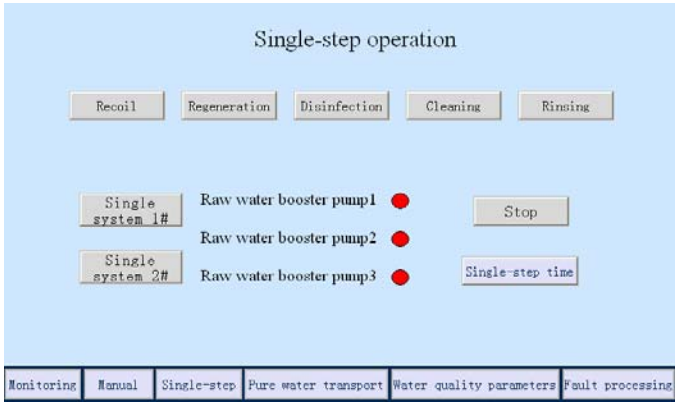

Figure 6: Single step operation picture

4.5 Pure water pump control picture

Click the "pure water transport" button below any screen and enter the pure water transport picture, as shown in figure 7. This picture control the operation of the pump and shows the state of the pump.

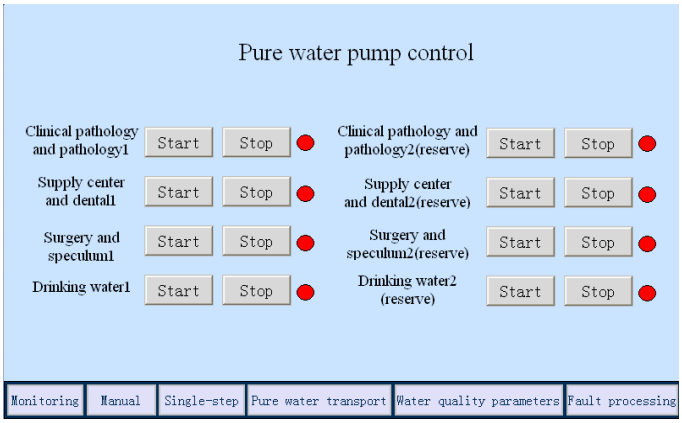

Figure 7: Pure water pump control screen

4.6 Water quality parameter monitoring picture

Click the "water quality parameters" button on any of the bottom of the screen and enter water quality parameter display screen, as shown in figure 8. It can directly show the system running situation and water quality changes. When the pure water conductivity exceeds a set value or pure water resistivity actual value is smaller than set value, the system will automatically alarm and delay shutdown.

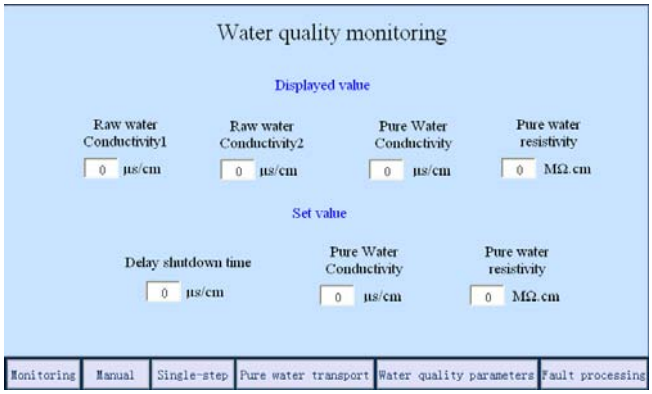

Figure 8: Water quality parameter monitoring picture

4.7 Fault processing picture

When the equipment fails, the device icon shows yellow alarm. When the equipment fault was ruled out, the equipment must be manual reset and put into use again.

5. Conclusions

Through the use of Siemens PLC and touch screen control system, which greatly improves the degree of the system equipment automation, reduce the equipment maintenance cost, ensure the continuous production of qualified pure water, meet the requirements of hospital on the central pure water, ensure the normal operation of the hospital departments. Through the use of a year, the system conform to the expected design requirements.

This system has been put into practical operation. Since the system has been put into operation, the control system operation is stable and reliable, the equipment is in good working, the use and maintenance is simple and convenient. All indexes meet the design requirements, the workload of operators the intensity of labor is greatly reduced, the utilization rate of the equipment and energy is improved. The pure water indicators meet the design requirements, at the same time this system save energy, reduce energy consumption, it is the affirmation of the user.

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