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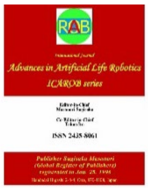

Research Article

An Automatic Water Supply System Based on KingView and PLC

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ABSTRACT

The existing water supply system has poor water supply quality and low level of automatic control. Therefore, this paper designed an automatic water supply system based on Siemens PLC and the software of KingView . The pressure sensor in the water supply pipeline is used to detect the pressure of the pipeline, and the liquid level sensor monitors the liquid level in the tank. The sensor transmits the data to the PLC, and the PLC issues the control instruction after the computation processing. The KingView can realize real-time monitoring and fault alarm. The system can not only avoid the problem of large fluctuation of water pressure, reduce the failure rate of water supply equipment, but also realize the automatic control of water supply system.

1. Introduction

With the continuous development of China's urbanization process, the pressure on the urban water supply system is increasing. In old urban communities, the regional water supply is basically achieved by the municipal pipe network through secondary artificial pressurization, water towers and high-level pools.

However, these water supply methods have serious imbalances between water pressure and water consumption. In addition, the existing water supply system has a low level of automation, and the work of system pipe network pressure monitoring and system troubleshooting are all finished manually. This greatly reduces the operating safety of the operator. And when the water supply pressure changes greatly at different times, it can only be adjusted manually. Thus this adjustment method cannot satisfy the demand for water supply [1].

Based on the above discussion, the software of KingView is used to design the upper computer of the water supply system and connect it with the lower computer Siemens PLC to stress the design of automatic constant pressure water supply system. Finally, the system realizes the constant pressure water supply, remote monitoring and remote operation of the water supply system.

2. The Hardware Structure

The core task of this system design is to remotely monitor and operate the water supply system through the host computer. The PLC is used to make the frequency converter implement cyclic control of multiple pumps [2]. The whole hardware system is composed of a liquid level sensor, three water pumps, a pressure sensor, a frequency converter and PLC.

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2.1. *SIMATIC S7-300 PLC*

The lower computer is the SIMATIC S7-300 PLC and it has good versatility. This PLC has the advantages of easy realization of distributed configuration, modularization, low user difficulty in mastering, and no exhaust fan structure. It is very suitable for the small-scale control [3].

This system controls the frequency converter through PLC, and the different working states of the three pumps can be controlled, which are the function of the start, stop and frequency conversion of the pump. The SIMATIC S7-300 PLC is shown in Fig.1.

Fig.1. SIMATIC S7-300 PLC

The automatic water supply system has a medium amount of program and does not occupy much storage space. And the computing speed, communication resources and programming resources required by the system are not too much. But this design needs to be connected with the scene through the field bus, so the PROFIBUS DP is adopt. We chooses the CPU model of 315-2DP in SIMATIC S7-300 PLC. The 315-2DP used in this design is shown in Fig.2.This CPU has the following characteristics:

- 48 KB working memory.
- 0.3 ms/1000 instructions.
- MPI + DP connection.

Fig.2. The 315-2DP CPU

2.2. *Frequency converter*

This design uses the MicroMaster430 series inverters, which are particularly suitable for driving water pumps and fans. The model used is 6SE6430-2UD27-5CA0. The power of this type of inverter is 7.5~250KW. It is controlled by a microprocessor and has high functional diversity. Its power output device uses IGBT which has high flexibility and reliability.

The following functions can be realized: bypass function, multi-pump switching, energy-saving operation, manual/automatic switching, broken belt and water shortage detection, etc [4]. The inverter terminal interface is shown in Fig.3.

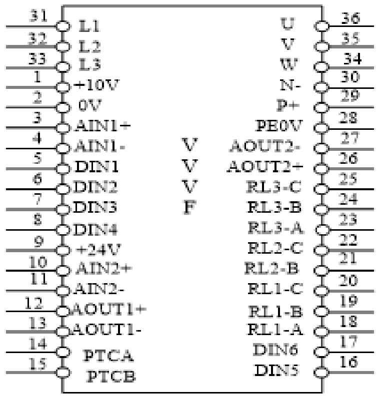

Fig.3. Inverter terminal interface

2.3. *Sensor module*

In this system design, MC20B economical pressure sensor and MC20C drop-in liquid level sensor are used.

The MC20B economical pressure sensor selected in this design can modify the range and zero point according to the needs on site. And it has high anti-interference and overload performance, and is not prone to failure.

The MC20C drop-in liquid level sensor uses an isolated diffused silicon sensor to convert the hydrostatic pressure into an electrical signal. After temperature compensation and linear correction, it is converted into the standard electrical signal output. It has high sensitivity, stable performance and wide measurement range. The liquid level sensor has the following characteristics:

- Measuring range: 0.3M~200M.
- Working temperature: -20 ºC ~ 80 ºC.
- Output signal: 4mA~20mA.

3. System programming

This design consists of the PLC programming and configuration simulation design. The combination of these two programs can well reflect the control process of the system.

3.1. *PLC programming*

This design uses the STEP7 programming software for PLC programming. The method is the logic algebra design. It is to edit the PLC ladder diagram program according to the simplified logical expression [5].

In this design, the PLC program needs to realize the following control actions. (1) start and stop the automatic water supply system. (2) when the frequency of the frequency converter reaches the upper limit, the water pump is switched between frequency conversion and industrial frequency. (3) when the pressure fluctuation of the pipeline is small, the water pump shall be alternated periodically. (4) by detecting the liquid level, the system can be stopped when the water supply level is too low.

PLC programming is modular. The main program OB1 is composed of seven functions or function blocks. Make the main program simple and visual for easy troubleshooting.

- The program in function FC1 is used to process the input analog quantity.
- The program in function FC2 is used for boot initialization.
- The program in function FC3 is the start-up program of the water pump motor.
- The program in function FC4 is the switch between frequency conversion and industrial frequency of the water pump motor.
- The program in function FC5 is an alarm program.
- The program in function FC6 is used to process the output analog quantity.
- The program in function FC7 is a water pump alternate working program.

The main program OB1 is shown in Fig.4.

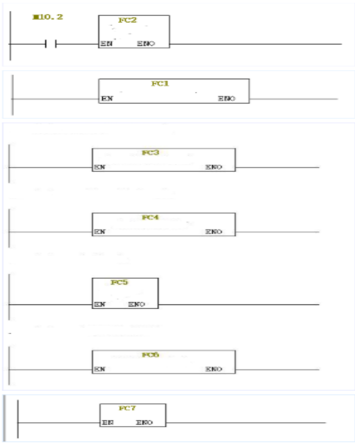

Fig.4. Main program OB1

3.2. *Configuration simulation design*

The design of the configuration screen of the upper computer system uses the KingView software produced by Beijing Yakong Company [6]. The software is widely used in the current industrial field, and it has various functions such as process control design, field control, and resource management. It can collect various information flows in the system to optimize the management process.

The configuration screen designed by this system covers the main screen, real-time curve, alarm screen, historical data report, historical curve and real-time data report. In the main configuration screen, the operator can start, stop and emergency stop the system. And it can adjust the pressure of the pipe network. At the same time, it can monitor the running status of the water pump, the liquid level of the pool and the pressure of the outlet pipe network. From the home page, pump failure tests can be performed or other monitoring screens can be accessed via the page toggle button. The main configuration screen is shown in Fig.5.

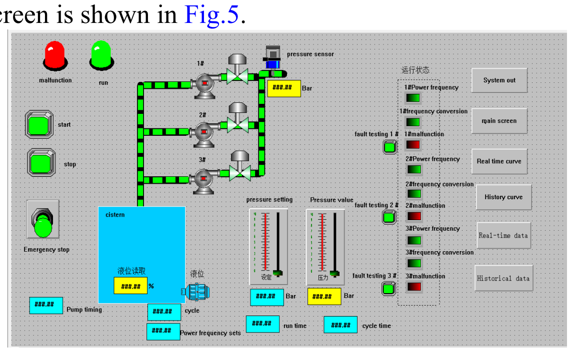

Fig.5. Main screen

4. System Simulation

After the system design is completed, it can be simulated on the Kingview software.

Based on the main screen of the system, the parameter control and real-time monitoring of the automatic water supply system can be realized. In the real-time curve interface, the operator can intuitively monitor the pipe network pressure and pool water level in the system through real-time changes in the curve. At the same time, real-time data will be recorded into a report.

It can be seen in the real-time curve simulation image that by changing the water supply pressure setting value, the system will automatically adjust the actual water supply pressure to match the standard value. The real-time curve is shown in Fig.6.

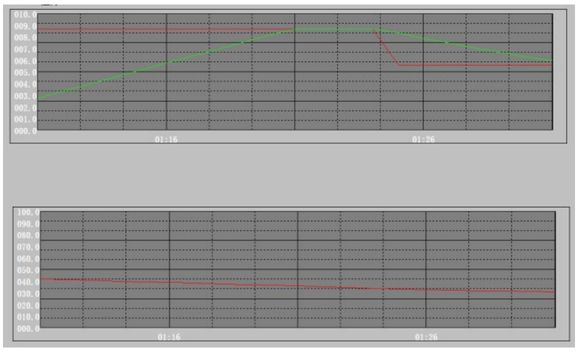

Fig.6. Real-time curve

In the historical curve interface, the operator can intuitively monitor the changes of the pipe network pressure and the water level of the pool from the historical time, which is shown in Fig.7. At the same time, the historical data is recorded in the data report to facilitate the inquiry of the historical dynamics of the system.

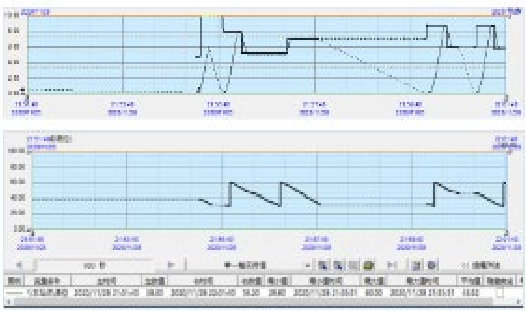

Fig.7. Historical curve

5. Conclusion

This design uses the KingView software combined with PLC and frequency converter to form an automatic water supply control system, so as to replace the previous valve control and manual water supply system.

It is ensured that the pressure of the water supply pipe network will not drop during the time when the residents have more water. It also ensures that when the residential water is low, there will be no impact on the components of the entire system due to excessive pressure on the pipe network. It greatly slows down the aging of the water supply system components and extends the service life of the system.

The automatic water supply system in this design monitors the running status of the lower computer and the water pump through the upper computer. It can read the real-time data and historical data of the automatic water supply system, and it also can monitor the changes in the operation of the water pump and the occurrence of system failures when the pressure of the water supply system fluctuates. The combination of KingView and PLC in this design makes the system program simple, integrated and highly transplantable

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Authors Introduction

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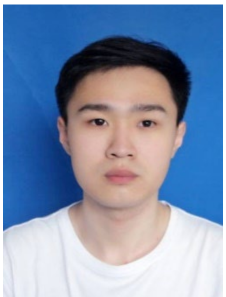

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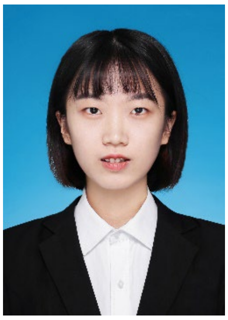

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