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Research Article

Design of Automatic Liquid Mixing Device Based on PLC

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Abstract: According to the technological requirements of the control system, the Siemens S7200PLC can operate the valve by liquid level sensor data, and complete automatically the liquid mixing in this liquid hybrid control system. It can undertake the single cycle or more cycle work, has the power memory function, and continue to work after the reset. Conditions monitor through the configuration interface has an application in industrial liquid mixture stirring device, and the realization of mixing process has realized automatic control, which can provide the strong guarantee for high mixer, mixing device of the smooth and orderly and accurate work.
Keywords: PLC; mixing device of automatic liquid; configuration.

INTRODUCTION

Two kinds of traditional liquid mixing device using artificial control or relay control system, there are more problems such as connections for many electrical appliances, poor reliability, and low degree of automation [1]. PLC has the characteristics of miniaturization, high speed, high performance, programmable controller instruction is rich, can meet various output and input expansion equipments, it has the rich special extension equipment, one of the analog input equipment and communications equipment is necessary for the system, it can be easily connected to the internet communication [2]. PLC automatic liquid hybrid control system was inputed a set of parameters to realize the automatic control by the sensor, Start automatically after a cycle of work done, and circulation.

Control requirements and the initial state

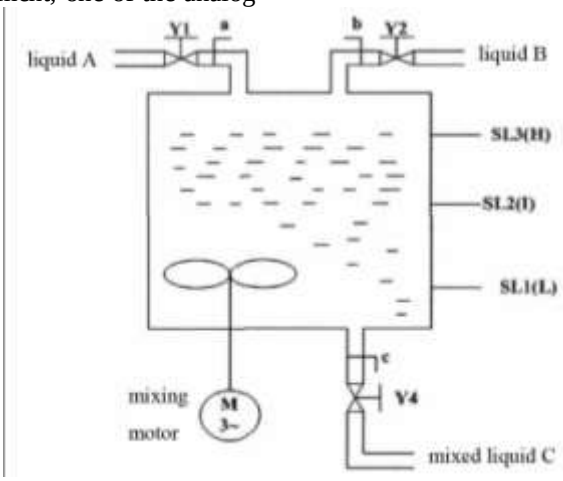

Fig. 1: The schematic diagram of system

Figure 1 is the system working schematic diagram, SL1 (L), SL2 (I), SL3 (H) of figure are three liquid level sensor, liquid submerged when switched on the liquid valve Y1, Y2 control liquid A and B respectively to come in, the liquid valve Y4 controls mixed liquid C go out a, b, c represent respectively three flow meters, forming two monitoring pipe for liquid into and a monitoring pipeline for liquid out traffic. This design is for two kinds of liquid mixing control, control requirements and the initial state is as follows:

Initial state: open electromagnetic valve Y4, shut down automatically after delaying 10 s.

Start operation: press the start button SB1, liquid device began to work with the following order:

(1) Open hydraulic solenoid valve Y1, liquid A flow into the tank, liquid level rise.
(2) When reach the SL1, liquid valve Y1 close, liquid A stop inflows, at the same time open the liquid valve Y2, liquid B flow into the container.
(3) When arrived at SL2, liquid valve Y2 close, liquid B stop inflows, mixing motor start to work at the same time.
(4) After mixing motor timing for 10 s forward stirring and 10 s reverse stirring, stop stirring, Y4 open at the same time, began to flow liquid out, liquid level began to drop.
(5) When the liquid level drops to SL1 (L), start to record time, close solenoid valve Y4 after 10 seconds, automatically start the next cycle.

Stop operation: when working, if press the stop button SB2, after delay 3 s equipment stop working.

Warning: when the liquid inside the tank reaches the highest level SL3, exceed this level, the system will alarm, and stop working, and timing of 10 s.

THE DESIGN OF THE SYSTEM

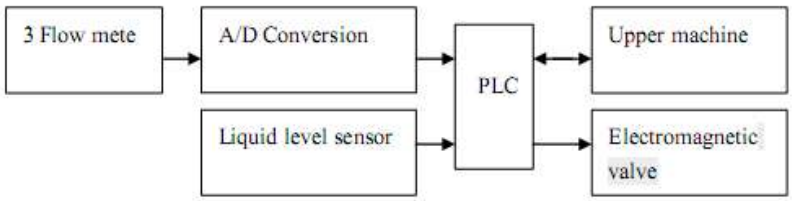

Fig. 2: Block diagram of control system

Control system block diagram as shown in figure 2, three pipe flow meter acquisition of analog, collected and transmitted to the AD conversion module, then converts the digital signal, Three level sensor output amount of liquid according to the measured water level situation, PLC control of two-way signal processing, the switch of electric valve, and blender, at the same time, all the data are transmitted to the PC monitor.

LIQUID AUTOMATIC MIXING SYSTEM HARDWARE CIRCUIT DESIGN

Component selection

Automatic liquid mixing device component selection as shown in table 1.

Table 1: Component selection on mixing device of automatic liquid

Necessary component	Parameter requirements	Component selection
PLC	Reasonable structure, appropriate function, unified model, whether online programming, environmental adaptability of PLC, PLC capacity	Siemens S7_200
AD conversion module	Number of analog input and output signals, input range, resolution, etc. [3]	EM231
Flow meter	The performance of the flow meter, fluid properties, installation , etc	LS-LWGY-C
Liquid level sensor	Work pressure 2.5 Mpa; Working temperature up to 125 ℃;Contact life 1 million times; Switch voltage 24 VDC; Switch current 0.5 A [4]	LSF-2.5 type sensor
Solenoid valve Controlling the liquid input	Medium temperature limit of 150℃/ environmental temperature -20 to 60℃;Using voltage DC24V, AC: 50 Hz, 220 v / 60 Hz; Power 2.5 Kw; mode of operation: normally closed, Electricity open, Power is closed response quickly, high frequency	VF4-25 type solenoid valve
Solenoid valve Controlling the liquid output	Valve body material is ABS, has the very strong corrosion resistance; The use of voltage DC：24V，AC：220V 50Hz/60Hz；power：5Kw	AVF-40 type
Motor	Power, types, methods, voltage and speed, etc. [5]	Y90S-6/0.75KW
Contactor	Contactor action is flexible, convenient manual inspection, compact structure design, can prevent the dust and debris into the contactor, ambient temperature meet the requirements, can be within the scope of the 9 ~ 38 a general, reliable operation low dissipation factor, high mechanical strength	CJX1-9,220V type contactor
The circuit breaker	Ac 50 Hz, rated voltage 380 V, rated current 63 A, distribution circuit(rated short circuit breaking capacity no more than 6000 A)	Small three-level circuit breakers DZ47-63

PLC I/O point distribution

According to the liquid hybrid control system requirements, a total of five digital input and six digital output, the CPU model can choose S7-200 PLC CPU224 (the unit has 14 digital input and 10 digital output).Because the system need to display the number of filling, output up to 1600, you can use the four BCD digital display tube with decoding circuit show that filling production, so it also requires 16 points digital output. It Can use two digital output extension module EM233 (DC24V) or the use of a digital quantity input/output mixed extension module EM233 (DI16 / DO16 * DC24V) [6].

The I/O distribution of input and output devices used by this system is shown in table 2.

Table 2: Input and output devices of the I/O allocation table

Input relay	Input devices	Input relay	Input devices
I1.0	SB1（start switch）	Q0.0	KM1（motor forward contactor）
I1.1	SB2（stop switch）	Q0.1	KM2（motor reversing contactor）
I1.2	SL1（low liquid level sensor）	Q0.2	YV1（liquid electromagnetic valve Y1）
I1.3	SL2（middle Liquid level sensor）	Q0.3	YV2（liquid electromagnetic valve Y2）
I1.4	SL3（High liquid level sensor）	Q0.4	YV3（liquid electromagnetic valve Y4）
		Q0.5	(alarm)

Hardware circuit diagram

1. Motor main circuit diagram

In the design of mixed liquid mixing start up by motor M. With short circuit protection, overload protection etc, short circuit protection implemented by FU fuse protection, overload protection realize its protection function by FR thermal relay. The start-up procedure is QS closure, when KM1 normally open contact closure, motor M positive rotation. When KM2 normally open contact closure, motor M reverse rotation. In the main circuit protection device selection is CJX1-9220 V contactor, DZ47-63 series miniature circuit breaker, JR16B - 60/3 type thermal relay and model 6/0.75 Y90S - KW motor. The main circuit is shown in figure 3.

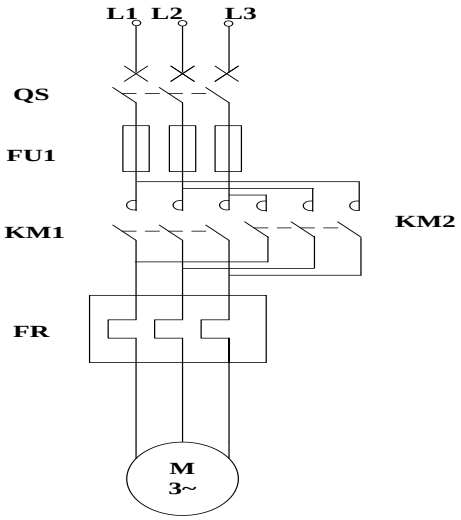

Fig. 3: The main circuit

2. I/ O wiring diagram of PLC

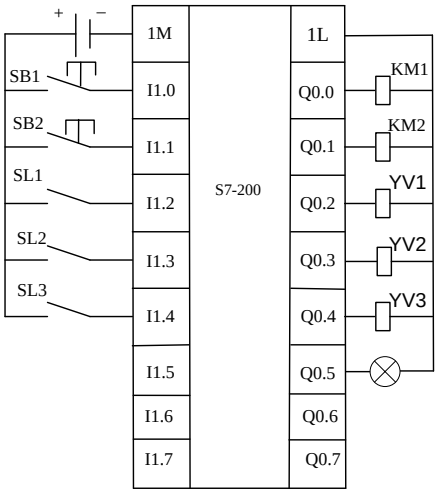

Fig. 4: I/O wiring diagram of PLC

3. Wiring diagram of AD module

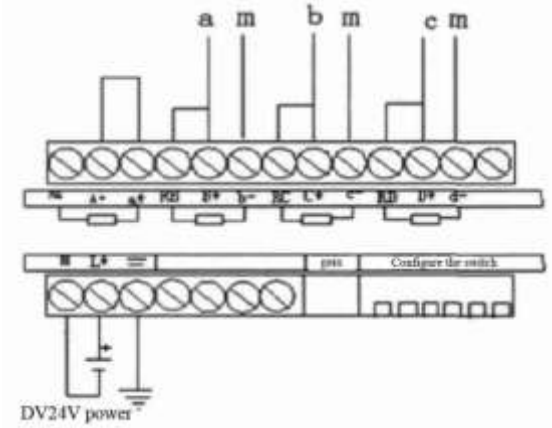

Fig. 5: Wiring diagram of AD module

AD module EM231 is mainly used for extension S7200PLC analog measurement capability, this system is mainly to complete analog signal acquisition of three level sensor a, b, c, and convert them to digital quantity, through the bus interface connected to the PLC.

THE SOFTWARE DESIGN OF LIQUID AUTOMATIC MIXING SYSTEM

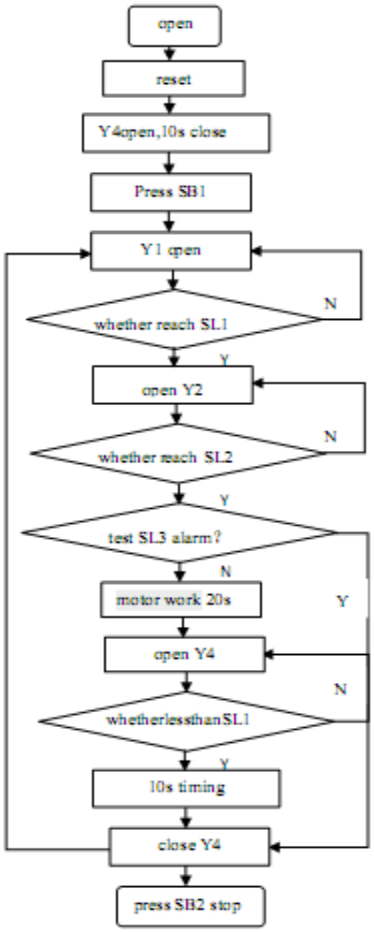

Fig. 6: Flow chart of program

THE MAN-MACHINE INTERFACE DESIGN

Monitoring software systems used in the Beijing sun way company Force Control 6.1 configuration software, it is an integrated man-machine interface (HIM) system developed by Beijing sun way technology co., LTD., Compared with the force control early product, Force Control 6.1 products produced a huge leap in data processing performance, ability to answer wrong, interface container report forms etc.

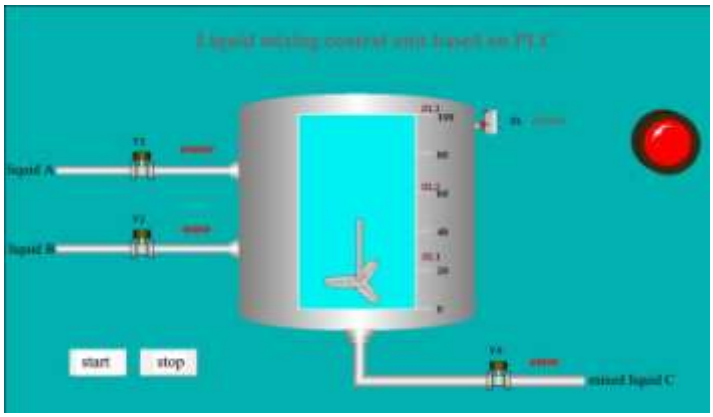

Fig. 7: Configuration diagram

There are liquid tank electromagnetic valve, level gauge, pipelines, mixer and alarm indicator light in configuration figure 7, when click the start button the Y1 valves open, liquid A flow into it, when reached level SL1, close Y1, Y2 open at the same time, liquid B flow into it. When reach level SL2, Y2 shut, motor rotation began to stir, Y4 open after a certain time, began to discharge liquid. System began to alarm when liquid level reached SL3, alarm indicator lights flashing, System stop working after 10 s.

CONCLUSION

Using Siemens S7200 programmable controller for a variety of liquid mixing state can realize automatic control, realize accurate control requirements in the mixing process, improve the stability of liquid mixture ratio, stable operation and high degree of automation, and shows that liquid water mixed state through the configuration interface, when the liquid level overrun, alarm display, it is suitable for industrial production needs.

ACKNOWLEDGEMENT

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