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Based on Siemens S7-300 Plc and Wincc Flexible High Pressure Foaming Machine Control

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Abstract: This study proposes a control method with high precision for high pressure foaming machine based on Siemens products. Aiming at the headrest foaming machine operation characteristics and production requirements, the system uses the Siemens S7-300 as the main body, making full use of its modular structure, short cycle, high processing speed, command powerful and so on. The innovation of this system is to develop a variety of formulations and operating modes, using the PID control system to ensure the accuracy and quality products, using Siemens WINCC flexible software to design a human-computer interface and realize the system automatic control and visibility. The overall system running rate is the ms level.It may make the product of precision control in the +/-0.5% or less.

Key words: A variety of formula, STEP 7, WINCC flexible, high precision

INTRODUCTION

Siemens S7-300 PLC is medium size of control system with practical distributed structure and interface network capacity. It can support a variety of network protocol (such as PROFIBUS, MPI agreement and industrial Ethernet protocol) and provide SETP7 programming software, which fully meets the PLC control system and ensures reliable (Liao, 2005; Ma, 2004), efficient and accurate.

Along with the visual technology, liquid crystal technology, field bus of booming development, man-machine interface is widely used in real life. The system uses the MP277, 10.4 inch localization operation screen, while set many process data such as display mechanical injection time, test time, pressure time to realize the automatic control system of real-time monitoring.

In this study, we propose an automatic flow adjustment algorithm. The upper computer software and lower computer control software are combined into a complete system with MPI interface. Operating personnel in advance on the upper set total flow and total weight and scale numerical. When we selected one of the formulas, lower computer immediately calculated flow theory and read metering pump feedback value and compared real-time correction and finally it achieved dynamic balance. In this way not only to ensure the operation of the system is efficient in data communication, but also can realize the real-time dynamic monitoring system. Relatively pure manual operation control, it can greatly improve the speed and accuracy.

SYSTEM DESIGN

Configuration

System configuration: Field equipment, control cabinet and PLC system adopts hierarchical control way, between PLC and PC through a standardized MPI interface for programming and data communication. PLC transmits the equipment real-time state to an upper computer, accepts and executes real-time control instruction of the upper computer and at the same time, PLC through the control relay, contactor and electrical components to realize the control of the equipment (Xue, 2011; Xu, 2011).

PLC configuration: The project adopt the Siemens company produces the series S7-300 PLC, with module points high density, superior performance, compact structure, high performance/price ratio, loading and unloading convenience etc.

CPU module: Choose CPU313C-2 DP, integrated a MPI, DP interface.

Digital input module: Choose SM321, a total of 3 blocks (2 blocks of 32 points input, 1 piece of 16 point input), used for receiving the various switch quantity signal.

Digital output module: Choose SM322, a total of 2 blocks (1 block of 16 points output, 1 block of 32 points output), used for PLC output from the various control instruction and alarm signal.

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Analog input module: Choose SM331, a total of 1 block (8 channels 12 points), will the flow, pressure, temperature sensor of the analog signal into digital quantity signal.

Analog output module: Choose SM322, a total of 1 block (2 channels 12 points), will be processed through PLC control signal into analog signal output, which is mainly used to control frequency converter equipment.

Other configuration: Converters use the series of Siemens MP277, the rest of the components such as buttons, lamp, contactors, relays, protection switch choose Schneider products.

Software design

Software design of PC control: PC interface software runs under the Windows XP environment and uses of configuration software WINCC flexible provide driver for data communication through the MPI interface and S7-300, including data acquisition and transmit data/instruction. This way makes communicationprogram and configuration software constitute a complete system and ensures the efficient operation system. Through the man-machine interface, we can realize the whole system dynamic monitoring management, fault alarm and notes etc., (Shi and Cai, 2011; Luo, 2010; Liu *et al*., 2009).

- Monitoring menu (Fig. 1). It mainly used for monitoring the currently selected formula number, P/I material mixing ratio, P/I real-time circulating pressure and flow rate
- Raw material parameter Settings screen (Fig. 2). Here it mainly include raw material level range and limit value, pressure range and limit value, liquid level correction and temperature correction, the biggest supplementary food time and so on
- Formula parameters Settings screen (Fig. 3). It mainly casting full flow, pouring gross weight, raw material ratio, time correction parameters and pulse equivalent
- Time parameter Settings screen (Fig. 4). Action is a regulation of the parts of the field devices action time, basically have built pressure time, dwell time and cycle pause time, low cycle time, high pressure cycle time and so on

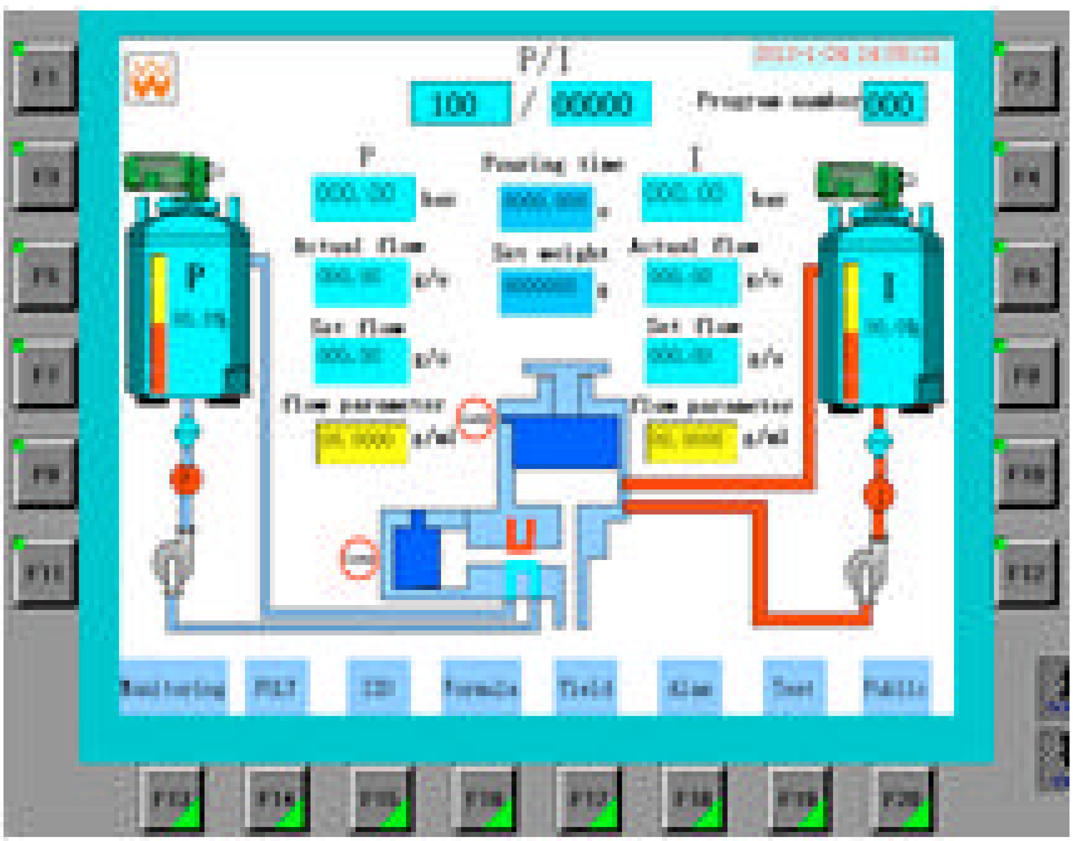

Fig. 1: Monitoring picture

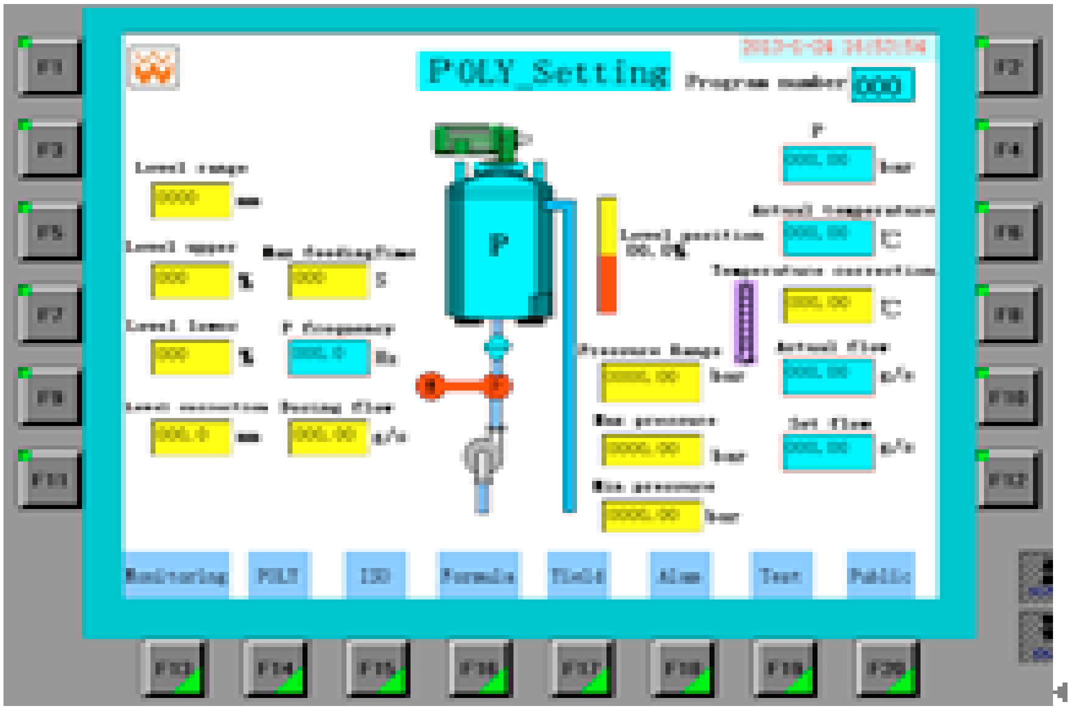

Fig. 2: P meterial parameters screen

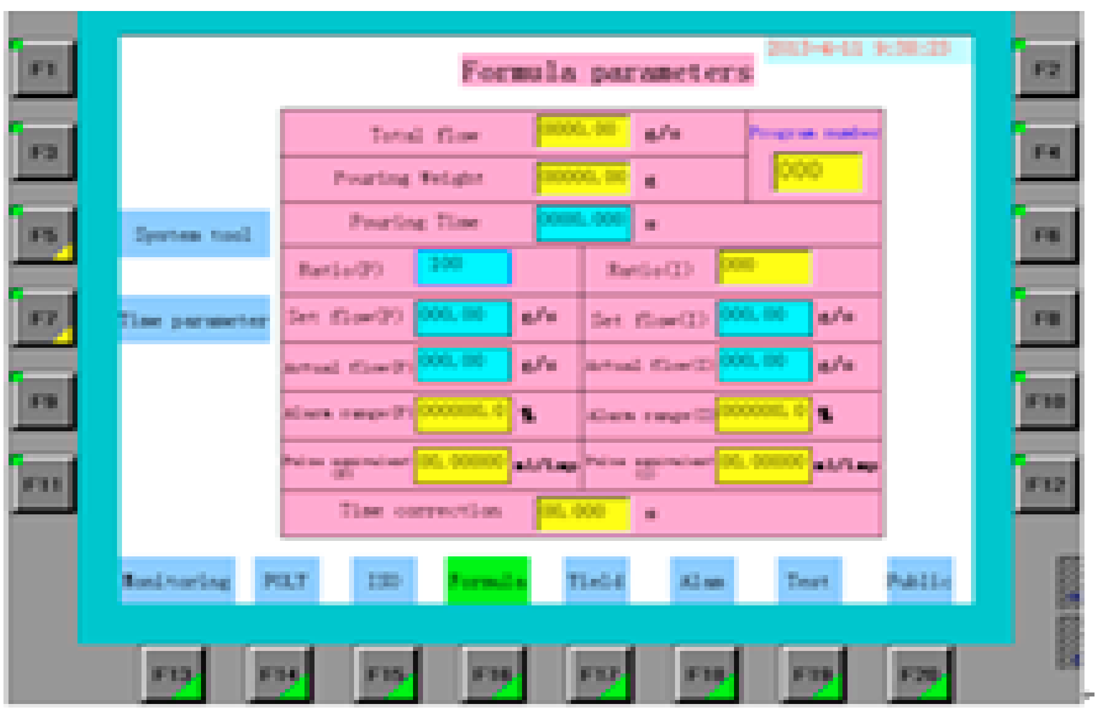

Fig. 3: Formula parameters

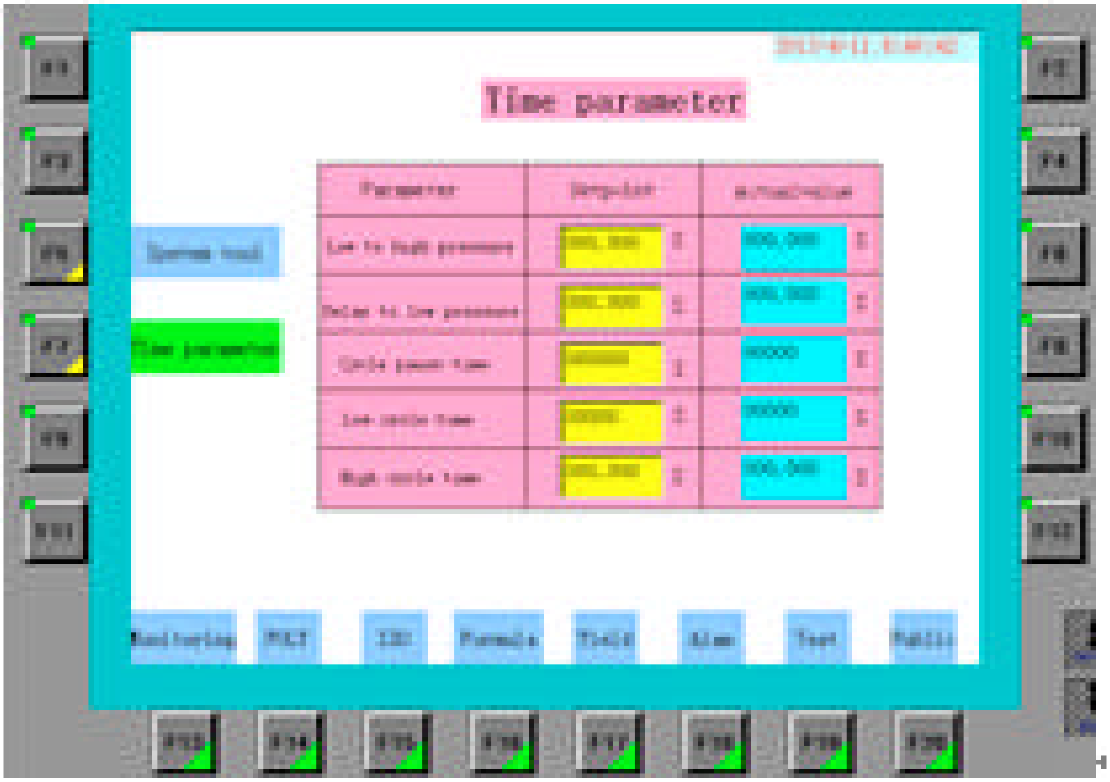

Fig. 4: Time parameters

- Test parameter Settings screen. Different product required raw material density is different. We can set flow and measurement time and calculate the flow parameters of raw material for the subsequent to prepare accurate control through the lower machine PLC control program in this picture
- Fault alarm display. It mainly displays the cause of the malfunction and the time information in the operation

Software design of PLC control: The PLC control software programming uses modular structure to complete all the tasks of the production process. The master control system coordinates the orderly operation of the various modules.

Flow char of the entire PLC system as shown in Fig. 5:

Tank control:

- Liquid level lower limit of the magnetic pirated/continuous level lower limit: Feed pump feeding
- Level lower limit (magnetic pirated): Machine alarm, metering pumps stop working
- Level cap magnetic pirated/continuous level cap: Fed pump stops working
- Machine alarm, fed on the pump stops working

The continuous level is here in order to increase the stability of the system. It is role with magnetic pirated. Its value is between on and under the limit of the magnetic pirated. In addition, the system also adds automatic feeding device and feed pump from time level lower limit to the level ceiling set for the maximum time to prevent automatic feeding pump feeding too much or feed pump is burned out for a long time idling motor in lack of raw materials complement.

Pressure control:

- Pre-pressure controls the digital indication of pressure gauge ranges 0-10 bar to prevent the pump from taking the time to pre-pressure setting to 2 bar. When the pre-pressure is below the set value, the control system alarm display "low pre-pressure"
- The high pressure control the digital pressure gauge indication ranges 0-400 bar for regulation and control the working pressure of components. Working pressure is set in the range of 50-180 bar. When the

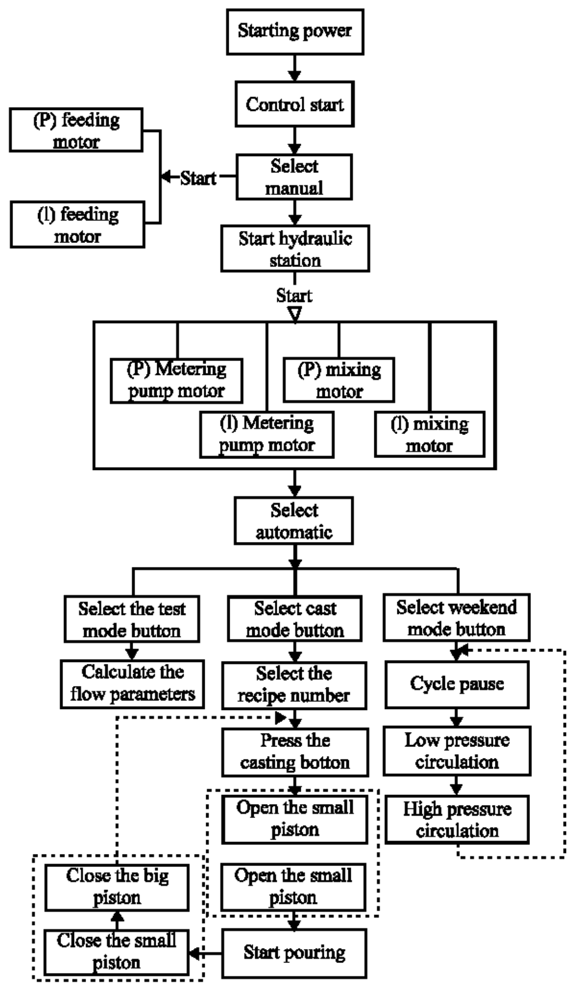

Fig. 5: System flow char

pressure is beyond this range, equipment must be shut down and work pressure is too low or too high pressure in the screen

- Flow inverter control VC-type flowmeter is installed in the measured high pressure outlet of the pump to the mixing head between the pipeline components. It is mainly used for the two components flow in the parts of the pipeline of the testing group. Flowmeter with a set of automatic control system will detect traffic on the OP panel, inverter motor automatically adjust the pump output flow component used to control traffic control in closed loop state
- High and low pressure cycle switch control the system has two sets of high and low pressure cycle switch unit device, by the two plunger high-pressure pneumatic valve body sensor switch with automatic lubricating device and place itinerary. It is primarily the assembled parts can form a low-power control cycle. The control valve via the solenoid valve open or closed, respectively two-component high and low switching cycle. Because of its importance, the segment of non-redundant control procedures alone on a function blocks to facilitate real-time selection of the system under different operating modes

SEVERAL MAJOR FACTORS AFFECT THE ACCURACY OF THE SYSTEM AND THE SOLUTION

How to control the accuracy of the system and achieve the standard of corporate settings (the +/-0.5% g) is the focus and difficult of the system. This section several major influence factors proposed system solution:

- Pouring time the length of the pouring time directly affects the weight of the spray material of the device. In response to the business habits requires the total weight and the total flow of the known systems, theory pouring time formula:

$$\text{Pouring time} = \frac{\text{Total weight}}{\text{Total flow}} \tag{1}$$

However, due to the impact of external factors, such as hydraulic standing the path loss of the transmission of power, the scan time of the system, etc., resulting in the delay of the device operation. In considering this case, the system uses the time-compensation method and the actual pouring time formula:

$$\text{Pouring time} = \frac{\text{Total weight}}{\text{Total flow+Time compensation value}} \tag{2}$$

The program to achieve as shown in Fig. 6.

DB3.DBD212 is the theory cast the time, DB2.DBD146 is compensated temporal:

- Traffic parameters Flow parameter is the product of the density parameters and pulse equivalent. Since the raw material is concocted through layers of chemical reaction, the density parameter is an unknown parameter. The set precise flow parameter is very important, because the flow formula:

$$\text{Actual flow rate} = \frac{\text{Pulse acquisition value (pulse / sec)}}{\text{Pulse equivalent (mL pulse}^{-1}\text{)}} \times \text{Density (g mL}^{-1}\text{)} \tag{3}$$

$$\text{Set flow} = \text{Total flow} \times \text{proportion} \tag{4}$$

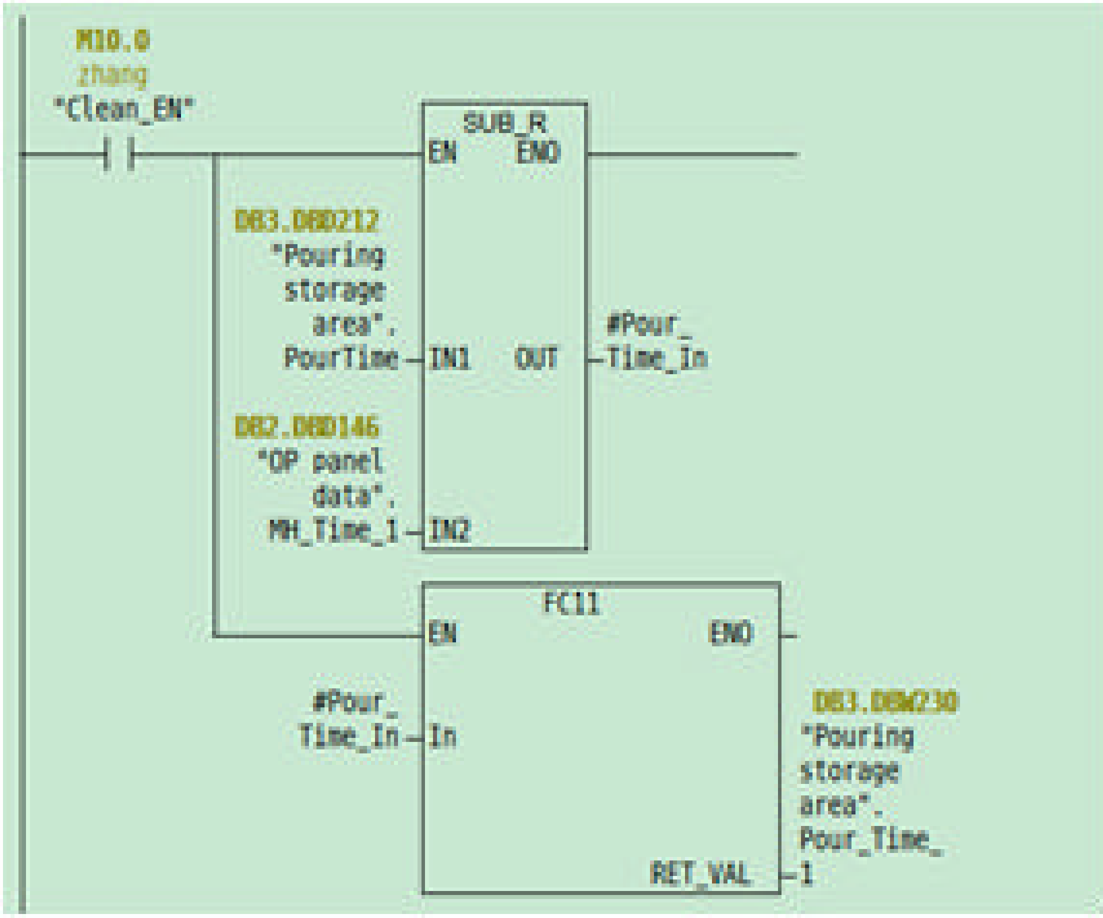

Fig. 6: Time compensation

When the flow parameter setting does not match the actual situation, such as the set is too large, the metering pump flow achieve the set flow is just a false phenomenon under the regulation and control of system PID. In this case, the actual acquisition of the pulse number will be less than the theoretical value, thereby affecting the weight of the spray material. At this point, the system dedicated function block to achieve the correction of the flow parameters,

The procedure is as follows:

- 1. A Q 3.1
- 2 = L 0.0
- 3. L 0.0
- 4.FP M 110.3
- 5. JNB _001
- 6. L DB27.DBD 18
- 7. T DB2.DBD 490
- 8. _001: NOP 0
- 9. A L 0.0
- 10. FN M 110.5
- 11. JNB _002
- 12. L DB27.DBD 18
- 13. T DB2.DBD 494
- 14. _002: NOP 0
- 15. L DB2.DBD 494
- 16. L DB2.DBD 490
- 17. -D
- 18. T DB2.DBD 498
- 19. NOP 0
- 20. L DB2.DBD 498
- 21. DTR
- 22. T DB2.DBD 522
- 23. NOP 0
- 24. L DB2.DBD 474
- 25. L DB2.DBD 522
- 26. /R
- 27. T DB2.DBD 164
- 28. NOP 0

OB35 cycle interrupt time and PID control sampling time set. OB35 is a fixed time interval to perform cyclic interrupt organization block. The default interval is 100 milliseconds. The user can modify this time which range from 1-60000 milliseconds (Dong, 2007; Nan *et al*., 2010). Used due to the cyclical nature of the system interrupt organization block OB35 continuous controller Continuous Controller, cycle interrupt time control sampling time CYCLE should meet CYCLE = n*T_in = 1,2,3,……_j. Interrupted time the smaller, the higher control accuracy and of course, the premise must ensure that the periodic interrupt OB's running time is far less than the time interval, to avoid causing system instability due to interruption error (Wang, 2008). The cycle of the system interrupt time is 5 msec; the PID control sampling time is set to 200 msec.

SYSTEM DEBUGGING

Siemens S7-300PLC a major feature is the use of structured programming. Its role is to simplify the program organization, more readable and standardized favor of the common functions. In view of this, we began commissioning work in each block based test.

The first is the hardware debugging; you can use the variable table to test the hardware, by observing the fault indicator on the CPU module, or using troubleshooting tools to diagnose the fault. Download the program before the CPU memory reset. The CPU switches to STOP mode. When you download the user program, you should download the hardware configuration data at the same time. Depending on the system characteristics, it is the first to debug startup organization block, then to debug the most deeply nested block FB or FC. For example, FC135 is the pressure of the system function block. If it has any error, we simply need to modify the function program which does not affect other system functions. If there is no problem, you can package standardized follow-up direct call and follow by debugging low-level nested function blocks, such as the system FC3, thereby completing the control of the sensor.

In addition, according to production needs, the system design has three operating modes: casting mode, test mode, the weekend mode. Debugging is also from the single to joint and finally reaches the system to perform different functions in different contexts.

CONCLUSION

This design makes full use of the characteristics of the Siemens S7-300 in structured programming procedures and proper chooses the system function block. It had written many blocks which can be called directly and suitable in different environments. It not only guarantees the function, but also greatly shortens the length of the program at the same time. Response to the external factors affecting the system error, it has done some appropriate compensation method and with the software realization, which has greatly improve the accuracy of the system. Industrial control configuration software WINCC flexible complete man-machine interface for real-time monitoring and management system. The implementation of a reliable and effective as a basic level PLC split control.

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