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The Design of Gas Station Controlling System Based on S7-400 PLC

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Abstract. This paper introduces the technological process, system composition and automatic control mode of the gas station of A steel plant. According to the control requirements, it establishes the overall control scheme of the gas station system based on PLC. Taking advantage of STEP 7 software, it develops conversion of analog input range, conversion of analog output range and temperature conversion, control loops, chain process and other important programs. Finally it designs the gas station controlling system.

1. Introduction

In recent years, due to rising oil prices, oil companies and intends to original oil as fuel units, more and more with economy is not reliable, so most of them have converted or used furnace gas. Special performance in some rolling mills, magnesium companies, glass companies, building materials companies, refractory companies. The use of energy in China must be based on the principle of coal, whether currently or in the future. The development of coal gas will be the major direction of China's energy policy, which is in line with China's long-standing strategic policy of coal oil generation.

2. Gas production technical

2.1. Gas production principle

The production process of gas producer is a process of completely transforming solid fuel into combustible gas under the action of oxygen. In the gasification of solid fuels, all combustibles are converted into combustible products of gases and liquids, and there are no residues except ash and ash.

The gasification of coal is carried out in a gas producer. The fuel is loaded into the gas producer through the hopper on the top, and the fuel and ash are supported on the bottom of the grate and ash tray. The ash generated during the gasification process is automatically discharged by the slag discharge knife when the ash tray is rotated. As the gasification process progresses, the fuel gradually declines, and in its original position, it continuously enters new fuel. The gas generated by the producer is gathered on the upper part of the fuel layer and is led out by the outlet pipe. The stirring hole is used to observe the operation state, the broken slag and the fuel layer of the gas producer, and used to shovel the fuel.

Producing carbon dioxide from the gas in the furnace is a layered process, but in actual production, there is no clear dividing line for each layer.
2.2. Two-stage gas generator
The two-stage gas producer is made up of the distillation section and the gasification section from top to bottom. First coal from the top coal bin enters the furnace body through the two sets of lower coal valves, and the coal is fully dried in the retorting section and long time low temperature retorting. Gradually forming a semi-coke, into the gasification section, the hot semi-coke fully reacts with the gasification agent that is blown into the bottom of the gasification section, passes through the reduction layer in the furnace, forms an ash layer, and is driven by a grate from the ash basin. Automatically discharged. The two-stage gas generator has two upper and lower gas outlets, which can output gas with different calorific value. Its gasification efficiency and overall thermal efficiency are higher than that of a single-stage furnace. The coal is completely retorted in the upper section of the furnace, and the lower gas is basically free of tar. The upper section of gas contains a small amount of light tar, which is not easy to block the pipeline. The gas value of the two sections of furnace gas is high and stable, the operation flexibility is high, the degree of automation is high, and the labor intensity is low. The two-stage furnace gas station does not pollute the environment, saves water, has a small footprint, and has low long-term operating costs. The grate rotation and coal adding part of the furnace can be mechanical or hydraulic according to the different requirements of the user. The grate is a heat-resistant cast iron. The gas permeability effect is better, and the flue gas gasification process is suitable.

2.3. Actors affecting gas quality
The quality of gas produced in the production of dual stage gas producer is affected by many factors. Such as: the furnace saturation temperature, the bottom of the ash removal rate, the bottom of the wind pressure, the upper and lower gas temperature and so on. For the control of two-stage gas furnace production, accurate analysis and judgment must first be made to determine the direction and purpose of control. Only by determining the direction of control can the system design achieve better results.

3. Introduction to SIMATIC S7-400

3.1. The working process of S7-400 series PLC
The working principle of PLC is basically the same as that of the computer. It implements control tasks by executing user programs. However, in terms of time, PLC execution tasks are serial and different from the execution of control tasks in relay logic control systems. The programmable controller accepts the external input signal through the input module and drives the external actuator through the output module. The logical relationship between various signals is realized through the user program. A programmable controller is essentially a computer, and like any other computer, it works according to the principle of time - to - division work. It can only perform one operation at every moment and do various operations step by step in a given order. The working process of S7 series PLC CPU is shown as in Fig. 1.
3.2. Software introduction
STEP 7 is a member of Siemens SIMATIC Industrial Software. It is a software package for configuring and programming SIMATIC programmable logic controllers. STEP 7 provides different versions to accommodate different applications and requirements.

1) STEP 7 Micro/DOS, STEP 7 Micro/WIN: It is suitable for programming and configuration software package of S7-200 series PLC.

2) STEP 7 Lite: Programming and configuration software package for distributed I/O of S7-300, C7 series PLCs, ET200X, and ET200S series.

3) STEP 7 Basis: Standard software package for programming and configuration of S7-300/S7-400, M7-300/M7-400 and C7 series.

4) STEP 7 Professional: In addition to the standard components in the STEP 7 Basis standard, the STEP 7 extension package is also included, such as SCL, GRAPH, and PLCSIM.

3.3. Hardware introduction
The S7-400 automation system uses modular design. Its template extension and configuration functions enable it to flexibly assemble according to different needs. One system includes: a power supply template, a central processing unit (CPU), various signal templates (SM), a communication template (CP), a function template (FM), an interface template (IM), and a SIMATIC S5 template.

4. Determination of control plan
The control flow chart of the gas station is shown in Fig. 2. According to the control requirements, the control scheme of the gas generation system is established.
Figure 2. Gas Station Control Flow Chart.

5. Control system development

5.1. Equipment selection

According to the determined control plan, the equipment selection, the specific results are shown in Table 1.

Table 1. Equipment Selection.

| Name                | Type               | Order Number     | Number | Remark          |
|---------------------|--------------------|------------------|--------|-----------------|
| Mechanical          | UR2                | 6ES7 400-1JA01-0AA0 | 1      | 9 Slots         |
| Power module        | PS 407 10A        | 6ES7 405-0KR02-0AA0 | 1      |                 |
| CPU module          | CPU 414-2 DP      | 6ES7 414-2XK05-0AB0 | 1      |                 |
| Interface module    | IM 153            | 6ES7 153-1AA00-0XB0 | 1      |                 |
| Analog input        | SM 331            | 6ES7 331-1KF01-0AB0 | 6      | 8aislesx13 bit  |
| Analog output       | SM 332            | 6ES7 332-5HF00-0AB0 | 7      | 8aisles*12Bit   |
| Digital input       | SM 321            | 6ES7 321-1BL00-0AA0 | 1      | 32*DC24V        |
| Digital input       | SM 321            | 6ES7 321-1BH02-0AA0 | 4      | 16*DC24V        |
| Digital output      | SM 322            | 6ES7 322-1BL00-0AA0 | 7      | 32*DC24V/0.5A   |
| Communication       | CP 443-1          | 6GK7 443-1EX11-0XE | 1      |                 |
5.2. Hardware configuration
After the project is created, first the hardware configuration, enter the "SIMATIC 400 Station", the right window can see the Hardware and CPU icon, double-click the Hardware icon, you can enter the hardware configuration interface, as shown in Figure 3.

![Figure 3 hardware configuration program interface](image)

In STEP 7, the configuration of the host can be completed by simple drag and drop operations. During configuration, the order number of modules added to the main frame should be consistent with the actual hardware. The concrete steps are described as follows:

1. Create a new project directly. Insert a SIMATIC 400 Station in the project. Double-click the "Hardware" icon to open the hardware configuration program. Locate the S7-400 rack in the hardware catalog and drag the "UR2" to the upper left view to add a main rack.

2. After inserting the main frame, power supply is added to slot 1 in the rack, and CPU is added in slot 3. Some CPU models in the hardware directory have multiple operating system (Firmware) versions. When adding CPU, both the CPU model and the operating system version are consistent with the actual hardware.

3. Signal modules, function modules, communication processors, etc. can be added to slots 4 to 11. These modules are located in the SM-400, FM-400, and CP-400 directories in the hardware catalog. In the configuration process, STEP 7 can automatically check the correctness of the configuration. When a module in the hardware directory is selected, the slot in the rack is allowed to become green, and the slot color inserted by the module is not allowed to change.

5.3. System Simulation
After completing the compilation of the program, we use S7-PLCSIM to carry out the simulation of the project. The use of S7-PLCSIM has a few advantages: It does not rely on hardware S7 program test on PG/PC; it can eliminate errors at the early stage of program development; reduce development costs, accelerate the development process, improve the quality of the program; suitable for a variety of S7 series Programming software installation.

The hardware configuration and user program completed on the PG/PC must be downloaded to the PLC via a programming cable, and by the hardware and software debugging can ultimately achieve automatic control tasks.

6. Conclusion
This design is based on the production process and control requirements of Dalian special steel gas station, using STEP 7 programming software to achieve automatic control of gas producer gas production. In-depth analysis of the factors that affect the gas production process, and a very good
control, and achieved a good control effect for the company, which has created good economic and social benefits for enterprises.

References
[1] Dong-Liang Zhang. The present situation and development of Chinese coal gasification process (technology). [J]. coal chemical industry, 2004,111(2):1-5.
[2] Shu-Qing Wang. Industrial process control engineering. [M]. Beijing: Chemical Industry Press.1999,21(4):32-35.
[3] Siemens. explain the profound in simple terms of Siemens S7-3OO PLC[M]. Beijing university of aeronautics and astronautics press.2004.8.