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Development of Solar Energy and Gas Coupled Heat Supply System

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Abstract:

The design of the system uses solar energy priority, then the gas boiler is body of the system. And it can maximize use solar energy in the preparation of floor heating. In the control system, PLC-200 of the SIEMENS series is the lower computer control and we can get the temperature acquisition, traffic and other basic thermodynamic parameters by using temperature pressure flow sensor. WinCC is used as the host computer system, which monitors the whole system operation. Database SQL can achieve the collection of data ,the real-time tracking, and monitoring alarm. After the experiment platform is built, the system is debugged. The results show that the monitoring system has good stability and reliability.

Keywords: *the solar energy ;gas ;PLC ; WinCC ; database*

I. INTRODUCTION

Vigorously developing renewable energy and clean energy is the inevitable direction of energy structure adjustment, which conforms to current China's national conditions[1]. Solar energy is one of the cleanest sources of energy, and it is also abundant. However, it has some disadvantages, including discontinuity, instability and low energy density, which leads to the instability of solar thermal system. Wall mounted gas boiler can be very rapid and convenient to provide domestic water and heating water with building, but using alone the gas boiler heating will consume a large amount of gas, and can not achieve the purpose of energy saving. The solar energy and gas coupled together. They learned from others' strong points and close the gap, which not only made full use of solar energy, but also alleviated the shortage of natural gas. It is of great significance for energy conservation.

II. OPTIMAL DESIGN OF SOLAR GAS COUPLING SYSTEM

Solar energy and gas coupled heat supply system is mainly composed of four core parts: solar heat collection system, gas auxiliary system, user thermal system and monitoring control system[2,3]. Solar collector system is mainly responsible for the collection of solar energy, and can ensure its safe and normal operation. Gas auxiliary system is mainly to compensate for the lack of solar energy caused by rainy days and it is responsible for rapidly providing heat. The user's thermal system is mainly responsible for the storage tank and the gas water heater. Monitoring and control system is responsible for ensuring that the whole system is in a controllable and measurable state. Adjust the direction and flow of hot water according to user's requirement.

This paper designs the solar coupling gas system[4,5], which is different from the traditional single heating system and the simple superposition of two kinds of simple system. According to the actual needs of users, we could be based on data feedback on energy monitoring platform and the actual local weather conditions, make full use of solar energy and gas heating floor heating. The heat storage tank is heated to improve the operation efficiency of the whole system. And the system has good practicability and the initial investment cost is very small, which saves traditional regenerative heating system are and resource. It also solves the biggest disadvantage of ground source heat pump technology, which is the imbalance of earth temperature field caused by the imbalance of load in summer and winter. And it improves resource utilization ratio.

III. DESIGN OF MONITORING SYSTEM

The heat collected by the solar collector is used for heating the water storage tank[6]. Circulatory system is controlled by temperature difference. When the difference of heat medium inlet temperature T1 and the outlet temperature T2 is higher than 8 ℃, the delay time is 3 minutes, and heat collecting circulating pump of heat collecting system B1 is opened. Accelerate the process of heat exchange to meet the demand of heat storage tank. The temperature difference between the T1 and T2 of the heat medium inlet and outlet is less than 3 ℃, the delay time is about 3 minutes. When the temperature difference tends to be stable, the B1 of the heat collecting circulating pump is closed, which avoids heat collecting circulating pump having frequent start and stop. When the T4 is above 75℃, the heat pump is turned off . The high temperature can cause irreversible damage to the water storage tank, which will affect the regenerator performance.

Hot water can come from the solar collector system and the domestic water heating system of gas boiler. By using the density difference of water at different temperatures, the thermal stratification of the cold water tank is formed and hot water is at the top. When the T4 is higher than 60 ℃, three-way valve B will be opened and domestic water is supplied. When the T4 is less than 60 ℃, three-way valve A is opened. Hot water can not be used directly and need to enter gas boiler heating further and domestic water can be met. The bottom of the heat storage water tank is provided with a water supply valve, which is used for supplementing water. The control flow chart is shown in figure 1.

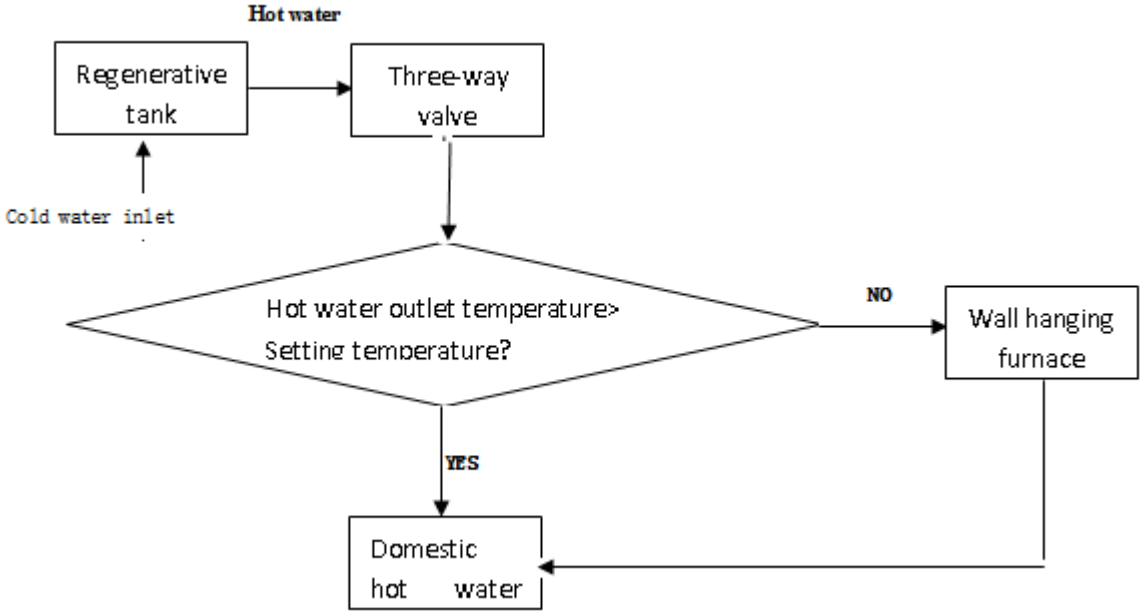


Figure.1 Life Hot Water Loop Flow Chart

After the water is heated gas boiler and enter the floor heating coil system, there is a comparison between the return water temperature T6 and the heat storage water tank top T4. When T6 is higher than T4, the heating return water has the value of heat recovery. Three-way valve B is opened and water enters into the heat exchange coil. The heat storage water tank is further heated to maximize the heat utilization. When the T6 is lower than T4, the three-way valve A is opened. The heating return water goes directly into the heating gas boiler and completes heating cycle.

The software design of the lower part of the system is based on the SIEMENS S7-200, and the corresponding program is written by soft STEP 7-Micro/Win V4.0.SIEMENS S7-200. The working state of internal components can be carried out with software monitoring. It can quickly and accurately find

the fault point and eliminate the fault in time by combining program specific programming and internal self diagnostic function, which saves the maintenance time and maintenance cost of the system.

When it is automatic mode, the solar heat collection circulation pump B1 and domestic hot water circulation pump B2 are both open. At the same time, the three-way valve 1 is open in B direction and the three-way valve 2 is open in B direction, which makes the whole heating system loop water cycle at any time. After running 3minutes,, the thermal cycle pump B1 determines its start stop by temperature difference between collector outlet temperature and tank temperature. Hot water circulation pump choices to start and stop according to user needs. The three-way valve 1 and 2 could determine the direction of automatic switch on according to temperature. When it is manual mode, the user can choose to open the pump B1 and B2 start stop according to their own needs.

Developed of the PC monitoring software is based on SIEMENS's SIMATIC WinCC 7.0 configuration software. At the same time, it has the function of Web browser, and can be used to monitor the dynamic picture of the real time. It communicates with the lower computer PLC through OPC (OLE Process Control), which makes production data more intuitive reflected in the man-machine interface. The test system mainly includes the following functions:

(1) The design of heating system interface makes the work flow of the combined heating system more intuitively appear in front of the user. The dynamic display effect of the key parts in the combined heating process is developed by using WinCC7.0, which can simulate the working state of the whole system in real time.

(2) The design of the picture is standardized, and the automatic mode and manual mode are designed according to the design principle and non professional users. It could take Online monitoring alarm to critical temperature and pressure variables by using WinCC own alarm function.

The host computer of the system collects data from PLC in real time. The monitoring system is mainly composed of graphical interface, parameter detection interface, process control and corresponding security mechanism. Its monitoring software system structure diagram is as shown in figure2.

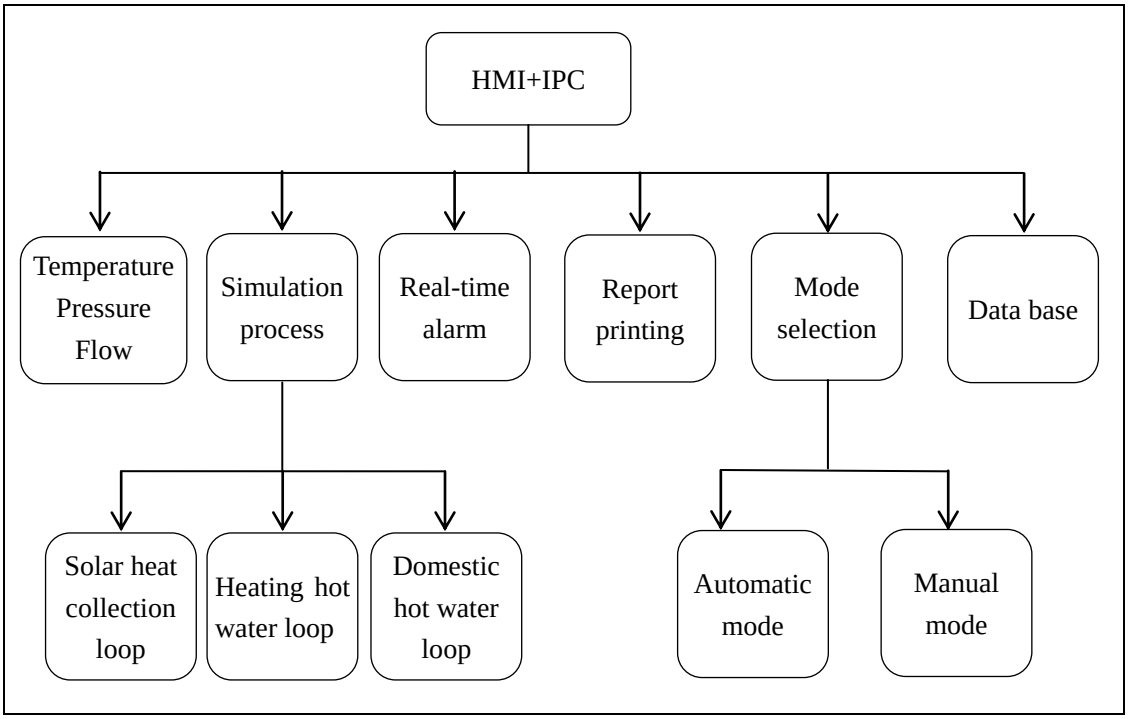


Figure.2 Structure Diagram of Monitoring System

IV. TEST RESULTS AND ANALYSIS

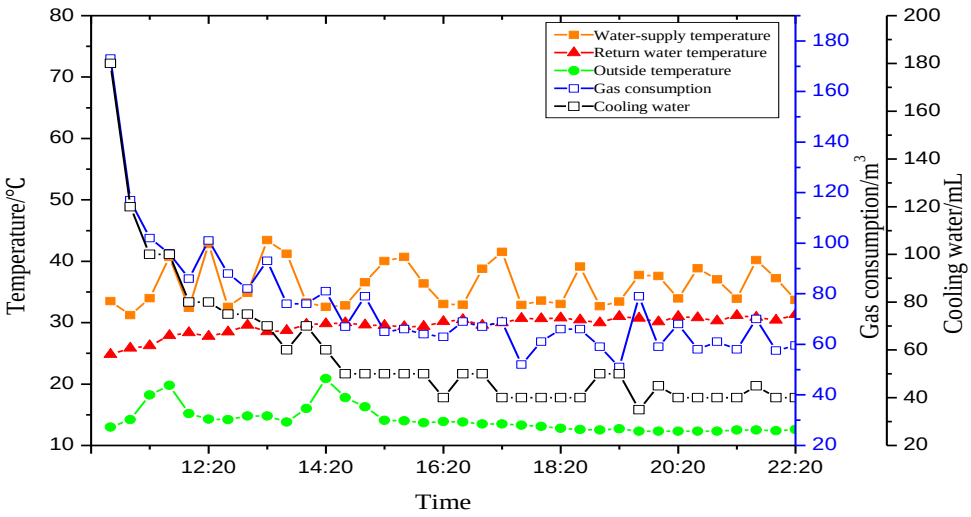
Solar and gas combined heating system after the completion of the preliminary inspection work, start the PLC software, and the relevant procedures into the PLC CPU; and then start the WinCC detection software, and check whether the two can communicate properly.

After communication is normal, we can enter the main interface of the monitoring system software and select the manual mode. At this time, we can also test all kinds of parts. Until all the equipment can work properly, we can switch the manual mode to automatic mode. Now we analysis parameters of gas boiler test and the database data is shown on table 1.

Table.1 Gas Loop Test Results

Date	Time	Water supply temperature	Backwater temperature	Gas consumption	condensate water	Outdoor temperature
15-03-02	9:40:09	33.52	24.82	173	180	13.11
15-03-02	10:00:09	31.23	25.85	117	120	14.21
15-03-02	10:20:09	33.99	26.24	102	100	18.22
15-03-02	10:40:09	40.71	27.88	96	100	19.83
15-03-02	11:00:09	32.42	28.35	86	80	15.27
15-03-02	11:20:09	42.77	27.75	101	80	14.39

This test is Winter alone wall mounted gas boiler for floor radiant heating, and the specific testing process is shown in figure 3.



Fgure.3 Gas Loop Test Results

From the figure we can see that when open gas boiler at the first, the gas consumption and condensate emissions are more because of low temperature of room. With the operation of the gas system, the room temperature gradually increased and the consumption of gas and condensate emissions gradually reduced. Because of the intermittent operation of the gas boiler, it will result in a high and low water supply temperature. From the above data, the temperature, flow and other data of the detection system measured have a good stability and accuracy.

V. CONCLUSION

The combined operation of solar energy and

gas can achieve all-weather uninterrupted operation, and in the premise of ensuring the comfort of the room, the solar energy can be used to minimize the consumption of gas in the daytime. Through the design of the system, the main conclusions are as follows:

(1) According to the requirements of solar energy and gas heating water supply, the system monitoring interface is optimized to enable users to operate more intuitively and observe the operation of the system.

(2) Through the analysis of the data collected by the monitoring system, the stability and accuracy of the data collected by the system are verified.

(3) The combination of solar energy and gas changes the traditional solar or gas heating mode alone, which can save energy and it provides reliable basic data for the construction of the domestic solar energy system.

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