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The Analysis of the Performance of Heating and the Economical Efficiency of the Solar Energy and Gas Heat Pump

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Abstract

The solar and gas heat pump heating system is a system that combines the gas heat pump and the solar heat pump driven by electricity. On the one hand, the system makes full use of the solar, and it is a real High-efficiency, energy-saving system. On the other hand, the system use natural gas as an energy source which can relieve the energy crisis, reduce environmental pollution and relieve the pressure of the grid. During the operation of the system, it will save operating costs due to the cheaper price of gas compared with electricity. Therefore, the research of the solar and gas heat pump has a great sense of energy-saving and economical.

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1. Introduction

The solar and gas heat pump heating system is a system that combines the gas heat pump and the solar heat pump driven by electricity. On the one hand, the system makes full use of the solar, and it is a real High-efficiency, energy-saving system. On the other hand, the system use natural gas as an energy source which can relieve the energy crisis, reduce environmental pollution and relieve the pressure of the grid. During the operation of the system, it will save operating costs due to the cheaper price of gas compared with electricity. Therefore, the research of the solar and gas heat pump has a great sense of energy-saving and economical.

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Since entering the 21st century, there are more and more researches about the solar heat pump system. V•Badescu had a further study on the equipments in the solar heat pump heating system. The result shows that in the process of heating, if the volume of the device used to storage thermal increase, then the power of the compressor of the solar heat pump will increase, but the COP of the heat pump will decrease. R•Yumrutas and others researched the characteristic of the operation in the solar heat pump with seasonal underground thermal storage device. The result shows that there are two aspects will influence the performance of the whole solar heat pump heating system. One of them is the thermal properties of soil. Different soil has different thermal conductivity which will influence the experiment and get different results. Another one is the size of the storage device. When the size is so small, it will not present the heating system. When the size is pretty big, the device of the system will be pretty complex. So the size should be controlled in a reasonable range.

In the 1960s, our country has built the earliest solar hot water project. Tianjin University and Beijing Institute of Architectural Design designed the first solar water heater with natural circulation by researching a series of solar water heaters and built a bathroom with this technology which became an example of solar hot water heating. From 1980s, our country started the research about the gas heat pump. The first institution who started the research first in our country is Thermal Research Institute, Tianjin University. Their research conducted a series of feasibility analysis for the application of the gas heat pump. They also made a series of experimental studies about the gas heat pump which laid a solid foundation for the development of the gas heat pump.

2. Methods

This paper builds a system of solar energy heat pump which is driven by the gas engine, calculates and chooses proper equipments for the system, then simulates some specific parameters like the number that the compressor turns, rotate speed of the engine, the COP of the system and the amount of the heat release of the condensation on it by TRNSYS and Simulink.

Shenyang is located in northeast cold zone in China, the heat load in winter is bigger than the cooling load in summer. So it's necessary to choose the model of the ground heat pump on the basis of the annual heat load of the building. If we want to meet the heat and cooling require, we can not decrease the capacity of the gas heat pump system in the design condition because of the instability of the solar in the process of heating. What we should do is that we should leave a certain amount of capacity to assure the performance of the heating system. So we should assume one of the most unfavorable conditions first like that there is no solar half a day, then select the type of the gas heat pump.

The maximum heat load is 231KW, the design heat load of the gas heat pump is 70% of the whole heat load—162KW. We choose the gas heat pump designed by Rand Air Conditioning Company in this paper. The specific parameters of the system are shown in table 1.

Table 1 Gas heat pump parameters.

Type	GSHP-C0138D		
Heating Effect/KW	170	Input Power of the Refrigeration/KW	37.9
Refrigerating Effect/KW	152	Input Power of the Heating/KW	25.8
Water Flow of the Evaporator when Heating/ (m ³ /h)	12	Pressure Loss	≤28
Water Flow of the Condenser when Refrigerating/ (m ³ /h)	23	Pressure Loss	≤70

The main equipments of the solar and gas heat pump are solar collector and storage model, gas engine model, waste heat recovery model and heat pump model. We use TRNSYS to simulate the solar collector and storage model in the system and set the temperature of the water in the buffer tank to 10-20 °C. The other parameters like

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