SOLAR PHOTOVOLTAIC POWER STATION SYSTEM BASED ON COMPOSITE HEAT SOURCE THERMAL POWER TECHNOLOGY

by

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In order to solve the shortcomings of single air source heat pump, single solar heat pump and solar air double heat source heat pump, one solar electric heat pump and multi-stage solar heat pump dual source heat pump, a solar integrated heat source heat pump is designed. The heating capacity and COP of the same heat pump and the solar double heat pump under three different operating conditions were simulated, and the simulation results were compared and analyzed. The simulation results were analyzed. The results show that the heat capacity and COP of the solar double heat pump system are higher than those of the heat pump system. With the continuous decrease of outdoor temperature, the advantages of solar wind tunnel hybrid heat pump system are more obvious.

Key words*: composite heat source, solar energy, heat pump system, solar air double heat source composite*

Introduction

With the development of the construction industry, the proportion of household energy consumption is also increasing, 65% of which is used for building air conditioning, heating and home heating. Most of these traditional heating methods are mainly coal heating, supplemented by electricity. Especially in northern cold regions, 95% of users use coal as the fuel source for heating [1]. Therefore, reducing energy consumption of heating and cooling and promoting clean energy utilization has become the focus of energy-saving development and improving overall energy utilization [2]. In the past, the sources of energy consumption were coal combustion or electricity consumption. Coal is a non-renewable energy, and its combustion pollutes the environment, so the cost of electric energy is high, therefore, people begin to look for ways to save energy and protect the environment to replace traditional methods. As a pollution-free renewable energy, it has been widely used in schools, factories, hotels and other different building systems [3, 4]. However, as the hot water produced by the solar water heater depends on the local weather and sunshine changes, it cannot stably provide constant temperature hot water, especially in the case of short sunshine time in winter or continuous rainy weather, it is more difficult to meet users' demand for heating and heating, therefore, as far as the current energy consumption is concerned, a single solar energy technology has not been widely used despite its promotion.Solar energy has the advantages of hygiene, large capacity, low cost, no limit area, good power quality, and has become the first resource for renewable energy. It can greatly utilize the heat in natural resources and waste heat resources, effectively reduce the

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input energy, and well meet the requirements of winter heating. The advanced technology of the utility model patented technology has the advantages of convenient installation and use, high energy consumption,the compression ratio decreases at the best value, and the compression system parameters are affected greatly by the traditional compression process, which leads to the increase in the exhaust pressure of the unit [5]. The increase of compression ratio will decrease the gas transmission coefficient, gas transmission capacity and performance of compressor. If the compression ratio is too high, the heat pump cannot operate normally in the coldest time in the north, the compressor exhaust temperature is over temperature. As shown in fig. 1, the comprehensive standardized technical system of solar photovoltaic industry [6, 7].

The compressor modelling mainly considers the suction and discharge state of the compressor, and does not consider the complex compression process inside the compressor, It is important to establish the relationship between compressor flow and power, evaporator and condenser, and calculate other factors which affect the performance of heat pump. The steady-state distributed parameter model is used to model condenser, capillary and evaporator. The condenser is divided into superheat zone, two-phase zone and supercooled zone according to refrigeration state. The supercooled area and the overheated area are divided into micro areas according to the refrigeration temperature drop, and the two-phase areas are divided into micro areas according to the refrigeration enthalpy [8].

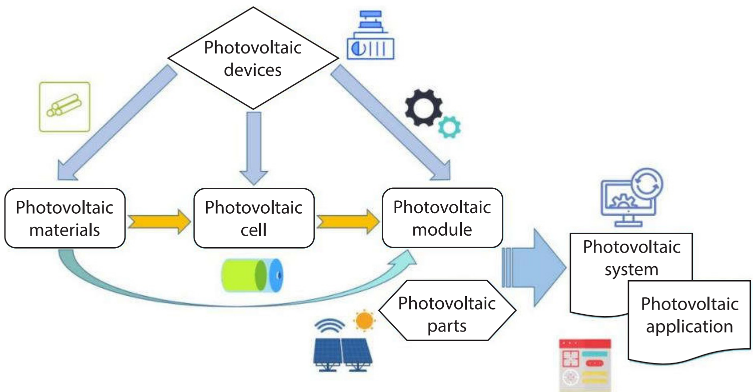

Figure 1. Integrated standardization technology system of solar photovoltaic industry

Mathematical model of heat pump system

Thermophysical parameter model of working medium

The calculation of thermophysical properties of working medium mainly includes the calculation of 36% ethylene glycol aqueous solution of refrigerant and thermophysical parameters of air [9, 10]. In the simulation calculation, the thermophysical parameter calculation module of these substances will be repeatedly called. Therefore, the accuracy, speed and stability of its calculation, it will directly affect the accuracy of numerical simulation results. The simplified calculation model of Cleland refrigerant thermodynamic properties is adopted for the calculation of refrigerant thermophysical parameters. The practical engineering application proves that the error is also in an acceptable range.

The air thermophysical parameters are calculated by correlation. According to the properties of binary mixture gas, the correlation equation establishes a calculation equation that expresses the thermophysical properties of moist air by air temperature, pressure and relative humidity [11, 12]. These calculation equations are not only of high accuracy but also convenient to use in engineering calculation, experiment and simulation research [13].

Mathematical model of system components

The compressor modelling mainly considers the suction and discharge state of the compressor, and does not consider the complex compression process inside the compressor, It is important to establish the relationship between compressor flow and power, evaporator and condenser, and calculate other factors which affect the performance of heat pump. The steady-state distributed parameter model is used to model condenser, capillary and evaporator. The condenser is divided into superheat zone, two-phase zone and supercooled zone according to refrigeration state. The supercooled area and the overheated area are divided into micro areas according to the refrigeration temperature drop, and the two-phase areas are divided into micro areas according to the refrigeration enthalpy [14]. For the two-phase zone, the enthalpy of refrigerator is very different, and the trace elements can be divided by different enthalpy equation. For the two-phase region, the temperature of the refrigerator varies greatly, so the trace elements can be divided by the difference of temperature.

System model

The model combines dual heat source evaporator, compressor, condenser and capillary tube into an organic whole, and simulates the system performance when the system runs stably under certain conditions. The model system takes the operating parameters, thermal parameters and capillary structure as input parameters [15].

Analysis of simulation results

The structural parameters of the dual-heat source compound heat exchanger are shown in tab. 1.

Table 1. Structural parameters of double heat source composite heat exchanger

Project	Numerical value	Project	Numerical value
Outer pipe diameter [mm]	15.7	Inner pipe diameter [mm]	9.52
The outer tube wall is thick [mm]	0.5	The outer tube wall is thick [mm]	0.3
Fin height [mm]	532	Fin spacing [mm]	1.65
Wing width [mm]	38	Fan diameter [mm]	400
Thickness of fin [mm]	0.2	Pipe spacing [mm]	38
Fin surface area [m^2]	11.25	Refrigerant passage area [m^2]	0.00009846
Annular volume [m^3]	0.00073	Outer surface area of outer tube [m^2]	0.366
Pipe length [m]	7.42	Equivalent diameter of ring [mm]	9.774

Three heat sources listed in GB/T7725-2004 are simulated, as shown in tab. 2. Under different operating conditions, different solar water heat flow. The experimental error can be controlled at 10% [16].

Table 2. Working conditions of double heat source compound heat pump

Working condition name	Experimental condition			
	Indoor dry bulb temperature	Indoor wet bulb temperature	Outdoor dry bulb temperature	Outdoor wet bulb temperature
Rated heating (high temperature) condition	20	12	7	6
Minimum heating condition	20	12	–5	-6
Rated heating (ultra-low temperature)	20	12	–7	–8

System performance analysis under rated thermal (high temperature) conditions

According to the heating parameters (temperature), when the heating capacity, COP and solar water temperature of the same heat pump are 0.2 m^3, 0.4 m^3, and 0.6 m^3 per hour, respectively, the changes of heat capacity and COP of solar dual-pump combined heat pump with inlet water temperature of solar hot water system are shown in figs. 2 and 3 [17].

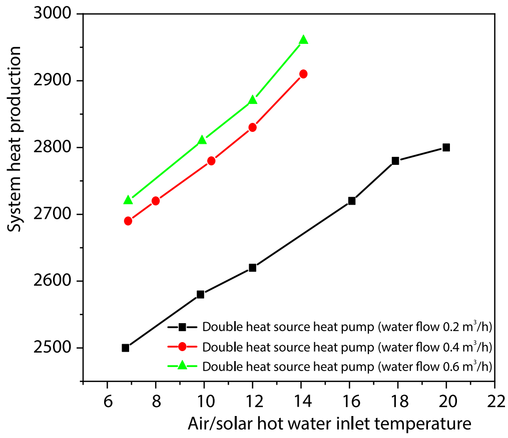

Figure 2. System heating capacity under rated heat (high temperature) condition

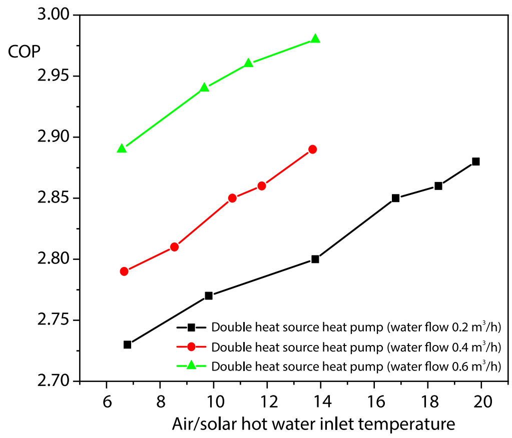

Figure 3. The COP of the system under rated heat (high temperature) condition

Within the maximum possible heat transfer temperature difference between two heat exchangers (the maximum allowable temperature when both heat sources provide heat to two heat exchangers simultaneously). The heating capacity of the same heat pump is 2923 W, and the COP is 2.99. Compared with this operation, the heating capacity of the same heat pump was increased by 20.2%, and the COP of the system was increased by 9.9%.

System performance analysis under minimum heating condition

When the heat capacity, COP and solar water heat flow of the same heat pump are 0.2 m^3, 0.4 m^3, and 0.6 m^3 per hour, respectively, the changes of heat capacity and COP of the solar heating dual source heat pump with inlet temperature of the solar water heater are shown in figs. 4 and 5.

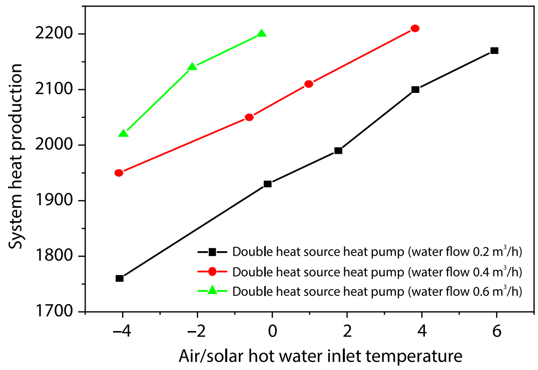

Figure 4. System heating capacity under minimum heating condition

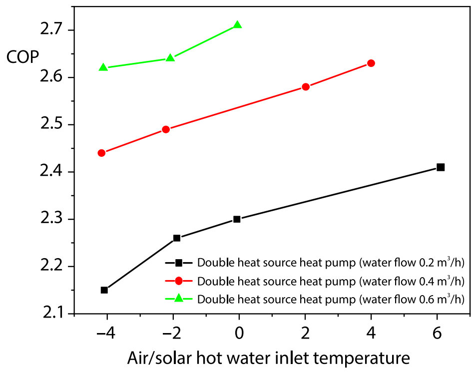

Figure 5. System COP under minimum heating condition

The heat capacity and COP of the system increase with the solar water temperature flow and water inlet temperature.

System performance analysis under rated heat condition

When the heating capacity and COP and solar hydrothermal flow of the same heat pump are 0.2 m^3, 0.4 m^3, and 0.6 m^3 per hour, respectively, the heating capacity and COP changes of the solar double pump with solar hydroheat inlet are shown in figs. 6 and 7 [18].

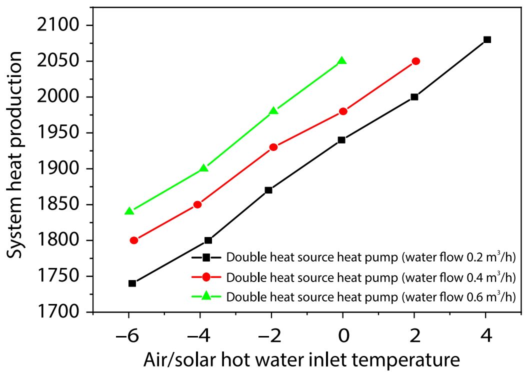

Figure 6. System heating capacity under rated heat (ultra-low temperature) condition

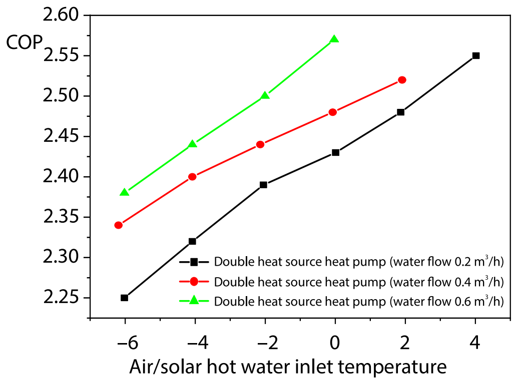

Figure 7. The COP of the system under rated heat (ultra-low temperature) condition

Produced by the solar water heater depends on the local weather and sunshine changes, it cannot stably provide constant temperature hot water, especially in the case of short sunshine time in winter or continuous rainy weather, it is more difficult to meet users' demand for heating and heating, therefore, as far as the current energy consumption is concerned, a single solar energy technology has not been widely used despite its promotion. Solar energy has the advantages of hygiene, large capacity, low cost, no limit area, good power quality, and has become the first resource for renewable energy. It can greatly utilize the heat in natural resources and waste heat resources, effectively reduce the input energy, and well meet the requirements of winter heating. The advanced technology of the utility model patented technology has the advantages of convenient installation and use, high energy consumption,the compression ratio decreases at the best value, and the compression system parameters are affected greatly by the traditional compression process, which leads to the increase in the exhaust pressure of the unit. The increase of compression ratio will decrease the gas transmission coefficient, gas transmission capacity and performance of compressor, at the same time, the high discharge temperature of the compressor will sharply reduce the viscosity of the lubricating oil and affect the lubrication of the compressor. If the compression ratio is too high, the heat pump cannot operate normally in the coldest time in the north, the compressor exhaust temperature is over temperature [19].

In this study, when the solar water heater flow rate is 0.6 m^3 per hour, and the COP is 2.56. Compared with this operation, the heating capacity of the same heat pump was increased by 38.9%, and the COP was increased by 29.29% [20].

Conclusion

The advanced technology of the utility model patented technology has the advantages of convenient installation and use, high energy consumption,the compression ratio decreases at the best value, and the compression system parameters are affected greatly by the traditional compression process, which leads to the increase in the exhaust pressure of the unit. The increase of compression ratio will decrease the gas transmission coefficient, gas transmission capacity and performance of compressor, at the same time, the high discharge temperature of the compressor will sharply reduce the viscosity of the lubricating oil and affect the lubrication of the compressor. If the compression ratio is too high, the heat pump cannot operate normally in the coldest time in the north, the compressor exhaust temperature is over temperature. The performance of a single heat pump and a solar double heat pump combined heat pump under different operating conditions is simulated, and the simulation results are analyzed. The analysis results provide good support for the popularization and utilization of solar dual heat exchanger.

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