

Coupling heating system of solar heat storage and heat pump Starts

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Abstract

As a new type of energy, solar energy has the advantages of universality, cleanliness, economy, etc. In order to solve the problems of large environmental pollution caused by the conversion of coal to gas, insufficient resource supply, high cost, and the potential impact of the conversion of coal to electricity on the power grid, etc. According to the requirements of rural heating for temperature and safety, This project proposes a set of solar heat storage and heat pump coupling heating system. This device integrates roof heat storage technology, roof heat extraction, low temperature heat storage technology, and solar energy and heat pump synergy technology. The scientific coupling of solar thermal storage and heat pump meets the requirements of rural heating and realizes the economic and environmental protection of rural heating. Compared with the large-area solar collector, the cost of the device is greatly reduced, the efficient use of solar energy is realized, and the concept of energy saving and emission reduction is met.

Keywords

Rural heating; Roof heat storage; Solar energy and heat pump synergy; Low temperature heat storage.

1. Research background and significance

1.1 Research background

At present, traditional coal-fired heating in rural areas is still the mainstream, its cost is high and will cause serious environmental pollution. Although some regions have promoted the implementation of "coal to gas" and "coal to electricity" projects, However, the problems of insufficient resource supply and potential impact on the power grid still need to be solved. In addition, combined with the actual situation in rural areas, it is found that its heating has the characteristics of high dispersion, low temperature requirements, unstable rural heating load and high safety requirements. In contrast, solar thermal heating can solve the current problems in recent years.

China is one of the regions with the richest solar energy in the world, especially the western regions such as the Qinghai-Tibet Plateau, Ningxia, and Shaanxi. The annual sunshine time can reach more than 3000h, and most of China's areas without electricity are concentrated here.

In the countryside, due to the special structure of the house, the roof is the largest heat dissipation surface, and it is also a precious large-area natural solar heating surface, but it has not been well utilized. Nowadays, the investment in solar energy for heating is relatively large, the service life is

relatively short, and the maintenance cost is high. For rural areas, the cost of using solar collectors is higher than that of coal. Therefore, the efficient use of solar energy and the substantial reduction of rural heating costs are our focus.

1.2 Significance

In response to the various problems facing rural heating, we have adopted a solar heat storage and heat pump coupling heating system. The water in a certain amount of low-temperature water tank is raised to a predetermined temperature through the solar collector, and the ground source heat pump is used to extract heat from the soil, and the heat is transferred to the high-temperature water tank to maintain the temperature of the high-temperature water tank > 50 °C, thereby improving the floor Heating and heating. The device not only solves the problems of high heating cost and serious pollution in rural areas, but also realizes the maximum utilization of resources, thereby achieving the goal of energy saving and emission reduction of the device.

2. System scheme design

2.1 Principles of System Design

The solar energy and heat pump coupling heating system uses solar collectors to absorb solar energy to directly heat the water in the low-temperature water tank. After the temperature rises, it is further heated by the ground source heat pump and flows into the floor heating for users' heating. The system schematic diagram is shown in the figure. As shown in the first figure, it is mainly composed of a new type of solar collector tube, a high temperature water tank, a low temperature water tank, an auxiliary heat source, a ground source heat pump and its pipes and fasteners.see Fig.1.

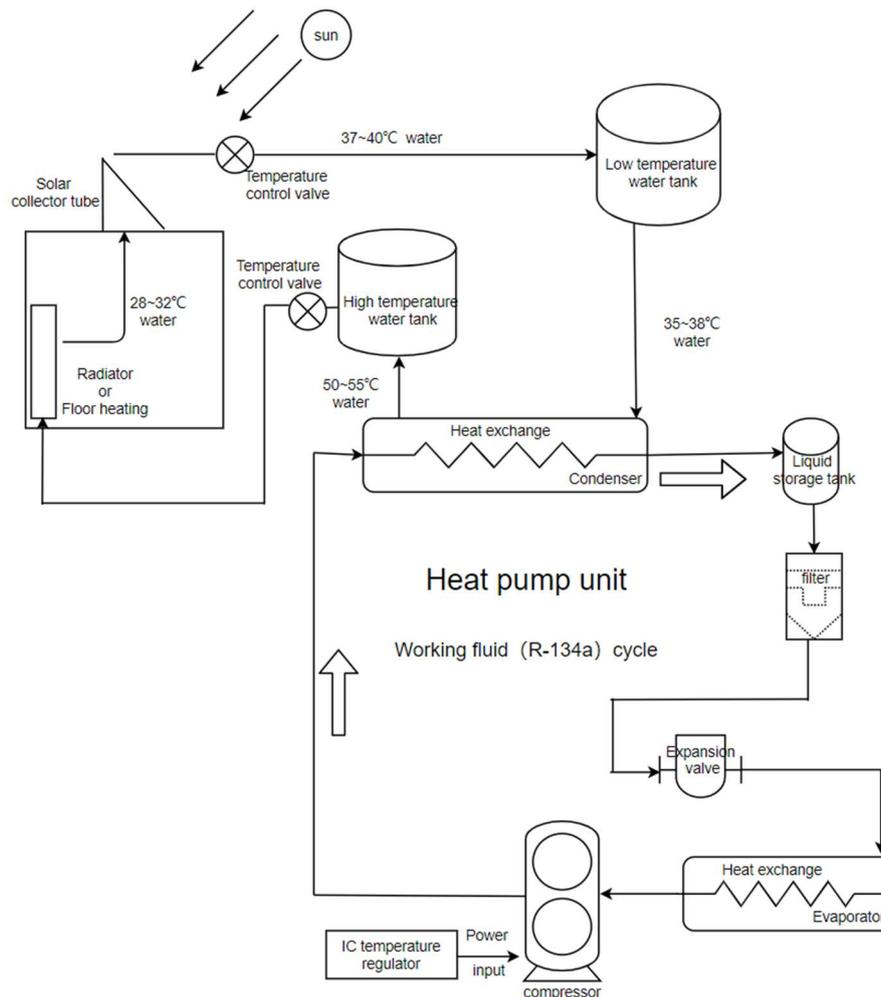


Fig. 1 System principle

2.2 Low temperature heat storage technology

Among them, the low-temperature hot water floor radiant heating system is the best form of solar hot water heating system. see Fig.2

(1) Low-temperature hot water floor radiant heating has certain restrictions on the floor surface temperature, which should not be too high. The water supply temperature is lower than the heating temperature of the convection radiator, and needs to be less than 60 °C. The solar hot water temperature can be adapted to it.

(2) The low-temperature hot water floor radiant heating system has high thermal inertia and strong heat storage capacity, which can make up for the instability of solar heating to a certain extent, and can store sufficient solar energy during the day to use it at night.

(3) The low-temperature hot water floor radiant heating room temperature comes from below, and the vertical temperature change is small. Under the same thermal comfort, the interior design temperature can be reduced by 2 to 3 °C, which reduces the heat load of the room, thereby reducing solar heat Initial investment in water system.

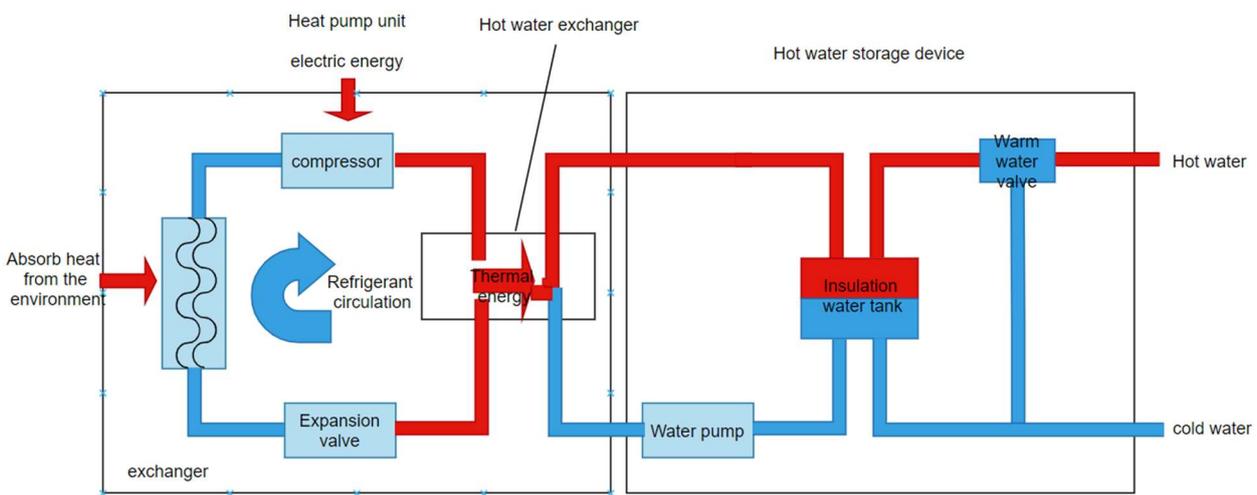


Fig. 2 Connection of heat pump and hot water storage device

2.3 Cooperative technology of solar energy and heat pump

After the heat collection tube absorbs the solar heat, it first preheats the water to make the water temperature reach 37-40°C. The improved ground source heat pump unit is used to increase the temperature of the water, so as to achieve the effect of floor heating. Using the synergy technology of solar thermal storage and heat pump unit, fully realize the utilization of solar energy and soil thermal energy, and achieve the coupling of solar energy and heat pump.

2.4 Compared with existing solar collectors

The existing solar collector tubes are made of glass, and the wind is relatively high in the north and northwest plateau areas. The solar collector tubes are at risk of fragmentation and displacement. In addition, the efficiency of heat collection in winter is poor, which makes it difficult to achieve the purpose of heating. However, traditional coal-fired gas heating is not only expensive and environmentally friendly, but also causes great environmental pollution. This set of solar thermal storage and heat pump coupling heating system not only has low requirements for the use environment and solar energy duration, it is environmentally friendly and pollution-free, and the cost is extremely low. It is suitable for large-scale popular use in the northwest rural areas with abundant solar energy resources.

3. Improved heat pump technology

3.1 Insulation shell of condenser tube

In order to achieve the effect of heat preservation and reduce heat loss, a heat preservation shell was added to the condenser tube. After a variety of material selection experiments, the final choice was a vacuum insulation board with a thermal conductivity of only 0.008. The vacuum material is made of inorganic fiber core material and high-strength The gas barrier film is made by vacuum packaging technology, and has the characteristics of low density, small material thickness, and long life.

3.2 Working fluid improvement

In order to achieve the maximum heat exchange with the ground source heat, it is necessary to choose a working fluid with a lower boiling point, which forms a large temperature difference with the soil temperature, and chooses R-134a working fluid, which is non-flammable and non-explosive, and has good safety performance , R-134a has a very low boiling point, so it maintains a vaporized state in a normal temperature environment. The direct expansion heat pump technology is used to make the refrigerant have higher thermal performance.

4. Promotion prospects

In winter, people need timely heating, but the energy used in rural areas is still mostly coal, which is extremely harmful to the environment. And our products can make full use of the vast area of rural roofs without consuming a lot of resources and manpower. They use the cleanest solar energy resources. Compared with ordinary coal-fired heating, the price of heating coal stoves is about 2000./Year, and the cost of our entire device is estimated to be around 2,000 yuan, which can be used for 15-20 years and requires only a small amount of additional power supply each year. Low-cost realization of large-area solar heat collection; rapid conversion of the collected solar energy for heating low-temperature water, and scientifically coupling solar heat collection and solar heat storage to heat houses.

With the continuous improvement of the living standards of the rural population, there is a greater demand for heating in winter. However, most of the energy used is non-clean energy. The application of this system fully reflects the concept of energy saving and environmental protection, while reducing heating costs. However, the current penetration rate of this type of system is very low, and it has a good promotion prospect.

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