Research and design of new type photovoltaic vacuum insulation cup

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Abstract. Aiming at the problem of limited insulation time of vacuum insulating cup, the modification and design of new photovoltaic vacuum insulating cup are completed, including selection of heating material, selection of power supply of photovoltaic insulating cup, power transmission and overall structure design. Compared with similar research, this paper focuses on the selection of heating materials and the use of wireless transmission devices to solve the problem of thermal insulation. In this paper, the structure of photovoltaic insulating cup is studied, and the optimum heating material is discussed. Combined with photovoltaic power supply and wireless power transmission technology, the design of insulation Cup is completed, and the insulation performance of this design is verified for more than ten hours.

1. Introduction
Thermal insulating cup is the daily necessities that we often use in our daily life. Especially when the users need to travel, the thermal insulation performance of drinking water is very important. Especially in winter, the cold air outside will increase people's demand for hot water. Ordinary cups can not meet people's demand for hot water. [1-2]

Current insulating cups are usually made of materials with high sealing and good thermal insulation performance, to achieve the effect of long-term thermal insulation. However, the maximum effective holding time of the existing cups is only 6 to 8 hours, which can not achieve longer holding time. The existing photovoltaic insulation cups can improve the insulation time, but the effect is limited because the vacuum insulation materials can not be used in the existing design of photovoltaic insulation cups. [3-5]

This design fully considers people's demand for economic thermal insulation. The water in the water cup is heated or refrigerated by the electric energy generated by solar energy, and the wireless transmission technology is adopted to ensure the use of vacuum insulation layer as insulation material. In the aspect of temperature control, the design will adopt temperature sensor control technology, which can be adjusted by users themselves to facilitate using of users.

2. Select heating material and verify heating effect

2.1. Select the heating material
The selection of the heating material is the core of the vacuum cup, so the product first selects the appropriate heating material. The product is selected from three semiconductor heaters, three heating resistor wires and two high temperature ceramic heaters and a 12 volt graphene electrothermal film. Under the condition of room temperature of 25 degrees, the same light intensity, the same time and place conditions, the comparison test was carried out, and the surface temperature of the heating material was measured at different times. The specific experimental results are shown in Figure 1.

From the experimental data, it can be found that although the semiconductor heater is convenient to use, the heating speed and the maximum temperature do not reach the desired result. When the heating wire is heated by the heating wire, the maximum temperature is relatively high, but the heating rate per unit time is slow. Graphene electrothermal film is not ideal as a heating material for all aspects of heating. The experimental results show that the heating rate of the 5 ohm high temperature ceramic heater and the maximum temperature during stabilization are ideal. Therefore, the product finally selected a 5 ohm high temperature ceramic heater as the heating material for the product.

2.2. Contrast experiment of heat preservation effect
In order to ensure the feasibility of this product, a comparative experiment with a 5 ohm high temperature ceramic heater and no heating material is carried out. The heating material is located at the bottom of the cup. The experiment uses a double vacuum cup, the water temperature in the initial cup is 80 degrees Celsius, and the parameters of insulating cup are 160.0 mm high and 65.0 mm diameter. The preliminary test proves that the vertical and horizontal heating effects of the cup are close, so the vertical position in the normal state is adopted. The test results are shown in Figure 2.
According to the comparative experimental results, it can be found that the heating effect of 5 ohm high temperature ceramic heater is better than that of the control group without heating material. Especially when the light intensity is sufficient in one day, the water temperature in the insulating cup can be relatively constant in ten hours of the day under the condition of sufficient internal light. The effect can not be achieved in the market.

3. Structure of photovoltaic vacuum insulation cup

This paper mainly introduces a new type of photovoltaic vacuum insulating cup. This design can absorb solar radiation and use wireless power transmission device to ensure that the vacuum insulation layer of the insulation cup is not damaged, to heat and keep warm the water or other liquid in the cup. And it is directly connected to the car through USB, and the car battery is used to supply electric energy to the heat preservation cup. This product is extremely convenient and practical.

From the figure 3 and figure 4, 1, Cup body, 101, vacuum layer, 2, solar film, 3, battery, 4, wireless conductive device, 41, micro inverter, 42, power output coil, 43, rectifier circuit, 44, power output Coil, 5, micro controller, 6, ceramic heater, 7, semiconductor refrigeration, 8, temperature sensor, 9, LED display, 10, temperature control knob, 11, charging interface, 12, USB output interface, 13, cup Cover, 14, pull ring.

The wireless conductive device 4 comprises an energy output coil 42 and an energy input coil 43. The power input coil 43 and the power output coil 42 are respectively embedded in the upper and lower surfaces of the vacuum layer 101 at the bottom of the cup body 1. The ceramic heater 6 and semiconductor refrigerant 7 in the cup body 1 can realize electrification through wireless transmission between the electric energy input coil 43 and the electric energy output coil 42, so that there is no wire passing through the vacuum layer 101 in the cup body 1, which guarantees the integrity of the vacuum layer 101 and the good thermal insulation characteristics of the vacuum layer 101. At the same time, wireless transmission technology can also ensure the safety of power transmission process to prevent short-circuit and circuit break.

The wireless conductive device 4 also includes a micro-inverter 41. The input end of the micro-inverter 41 is electrically connected with the storage battery 3. The output end of the micro inverter 41 is electrically connected with the power output coil 42. The power output coil 42 is radio connected with the power input coil 43. The power input coil 43 is electrically connected with the microcontroller 5 through the rectifier circuit 44. The micro-inverter 41 converts the DC current of battery 3 into AC and supplies it to the power output coil 42. The power output coil 42 transmits the electric energy to the power input coil 43 through wireless transmission. The rectifier 44 converts the AC current of the power input coil 43 into DC current.
The battery 3 is also electrically connected with charging interface 11 and USB output interface 12, respectively. The charging interface 11 and the USB output interface 12 are respectively installed on both sides of the bottom of the cup body 1. When there is no sunshine or indoor, the charging interface 11 can also be used to charge the battery 3, so that the ceramic heater 6 and the semiconductor refrigerant 7 can work properly. At the same time, in the sunny area, the battery 3 can also output electricity to the outside through the USB output interface 12.

4. Working principle of each part of photovoltaic vacuum flask

As shown in Figure 5, solar thin film 2 can convert solar energy absorption into electric energy and transmit it to battery 3. The micro-inverter 41 converts the DC current of battery 3 into AC and supplies it to the power output coil 42. The power output coil 42 transmits the power to the power input coil 43 by wireless transmission. Rectifier circuit 44 converts the AC current of power input coil 43 into DC current, and adjusts the temperature of insulating cup by supplying ceramic heating sheet 6 and semiconductor refrigerating sheet 7 with microcontroller 5.
5. photovoltaic vacuum flask innovation point

When there is no electricity and sunshine outside, customers can use the water in the cup to heat or refrigerate. At present, the solar water cups on the market are limited to heating, while summer mountaineering or outdoor sports are hot and sweaty. At the time, drinking a cool water is simply enjoyable. So our water cup utilizes the properties of semiconductor materials and high temperature ceramic heaters to make refrigeration and heating in one.

From a home point of view, the product has a charging interface that allows the cup to be heated and cooled indoors or when there is no sunlight.

The power device of the design uses a wireless charging device that is not activated by the water cup on the market. Since the charger and the electric device of the device transmit energy by a magnetic field, there is no wire connection between the two, so the charger and the device are used. The electrical device can be exposed without conductive contacts. With this, the vacuum layer of the cup can be perfectly separated without worrying about the interference of complicated lines.

Considering the high cost of solar water cups on the market, the products use low-cost but high-efficiency materials in the construction of water cups, and try to lower the price while ensuring user comfort, such as the new energy solar energy we use. Film and wireless charging device. All the devices and materials used in this design are environmentally friendly materials. They are green, environmentally friendly, and make full use of new energy sources. For example, the semiconductor wafers we use avoid refrigerant contamination during the refrigeration process.

Considering that the water in the cup is excessively heated under the strong sunlight, the product adds temperature and temperature-controlled cut-off devices to the cup to reduce the risk of customer use. Finally, a USB port is provided for outdoor travel. Emergency charging of the phone when the phone is out of power.

The cup is equipped with an LED display to display real-time temperature, making the product more friendly and more user-friendly.

6. conclusion

A series of analysis, design and experiments show that 1) the high-temperature ceramic film is the most suitable heating material for such a vacuum cup. 2) Adopting wireless transmission efficiency is more efficient than destroying the vacuum layer to select wired transmission. 3) There are many innovations in this type of vacuum flask. 4) The design of the device at noon in the north can ensure that the water temperature remains relatively constant for more than 10 hours during the day. It goes without saying that the discussion on the selection of heating and cooling materials is far from complete and comprehensive. The project is the Shenyang Agricultural University Innovation and Entrepreneurship Training Program, which combines photovoltaic power supply and radio energy transmission technology to complete the design of the insulation cup, which is conducive to improving students' independent learning ability and innovative design ability. In-depth study of this issue needs to be improved in the following aspects: 1) Try more heating materials. 2) Adopt a more scientific and reasonable experimental method. 3) Solve the problem of heat dissipation when using a semiconductor cooling sheet. 4) Improve the efficiency of solar panels to absorb solar energy.

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