Technical research on heat storage and function expansion of thermos cup

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Abstract. The new multi-functional heat preservation cup can not only achieve long-term heat preservation, but also keep the water temperature at a more suitable temperature for drinking in a short time. It uses paraffin phase change heat storage material as the filler of the inner liner sandwich, which can absorb the heat in the water temperature and achieve rapid cooling; solar panels are used above the cup cover to supply power for electronic devices, which can save energy and protect the environment and avoid the trouble of charging back and forth; At the same time, a variety of electronic devices are added to the cup cover to enrich the customer's experience.

1. INTRODUCTION

In recent years, with the development of the times and the progress of science and technology, people pay more and more attention to the sustainable development of energy and environmental protection, and the more convenient, faster and more diversified trend of the times has also come. In the face of such a big environment, our new multi-functional heat preservation cup with heat storage not only has the function of rapid cooling, but also uses solar energy for energy supply, which is convenient and environmentally friendly, it has complete functions and is suitable for a variety of people.

Fig. 1. structure diagram of new type multi-functional heat preservation cup with heat storage.
2. STRUCTURE OF MULTI-FUNCTIONAL HEAT PRESERVATION CUP WITH HEAT STORAGE

2.1. composition of thermos cup

This product is a new type of multi-functional heat preservation cup, which mainly includes three parts: cup cover, cup body and lifting belt.

The surface of the cup cover is provided with a buckle solar panel, and the upper solar panel can rotate 180 degrees to increase the light receiving area, so that it can fully carry out photoelectric conversion, and the generated electric energy can be used for various electronic components in the cup cover. In order to solve the problem that solar panels can not generate electricity in rainy days, we have batteries on both sides of the LCD to ensure that the LCD can work continuously in rainy days.

The outer shell of the cup is made of recycled environmental protection material PC7 plastic, and the inner liner is made of SUS316 stainless steel. SUS316 stainless steel has good plasticity, toughness, cold denaturation, welding process performance and high temperature strength, so it is suitable for the production of heat preservation cup liner. A vacuum insulation layer is sandwiched between the outer shell of the cup body and the outer wall of the inner tank to prevent heat dissipation and ensure long-time heat preservation.

The biggest highlight of the new multi-functional heat preservation cup is its heat storage. Paraffin phase change heat storage material is filled in the middle of the inner tank to store heat energy, which greatly increases the heat preservation effect of the new multi-functional heat preservation cup. A temperature probe is installed at the bottom of PCM, which can detect the temperature in real time.

2.2. phase change materials

In the design of new multi-functional heat preservation cup, the most important link is how to realize the heat storage, and the key to realize the heat storage performance is the selection of phase change heat storage materials. According to the performance of the insulation Cup, we need to select suitable phase change heat storage materials to achieve long-term insulation effect.

The temperature of phase change material itself remains unchanged in the process of phase change. Phase change material absorbs heat in the process of melting and releases heat in the process of solidification. This part of energy is called phase change potential. And we use this part of energy to control the temperature and keep warm for a long time.

In recent years, with the development and research of heat storage materials, it has gradually developed into two branches. The first is hydrated salt solid-liquid phase change materials, and the other is organic solid-liquid phase change materials. The first kind of phase change materials has a large latent heat, a fixed melting point and a relatively high thermal conductivity. The latent heat is generally (150-300) J/G, which is cheaper than other kinds of phase change materials; However, its significant disadvantages are phase separation and supercooling, and it will also cause corrosion to the container, so its application to hydrated salt materials is limited in more aspects. The other kind of phase change materials are mainly various organic compounds, which have the advantages of strong solid-state molding, making up for the defects of hydrated salt materials, stable performance analysis, low melting point, a small amount of toxicity, and long service life. However, this kind of phase change materials also have some obvious disadvantages, such as high price, and some materials are easy to burn It is easy to volatilize or be oxidized slowly by oxygen in the air.

According to the new multi-functional thermos cup designed by us, the phase change heat storage material needs to meet the following basic characteristics to ensure the stable and reliable operation of the new multi-functional thermos cup.

1. It is required to be temperature sensitive and can initiate phase transition rapidly;
2. No segregation and supercooling, good thermal stability;
3. Non toxic, non corrosive and non polluting;
4. Low cost and easy to obtain raw materials;
In order to find suitable heat storage materials for this product, we have carried out research on the above-mentioned kinds of phase change heat storage materials, through online access to information, material comparison, performance analysis, experimental research and other work. Finally, the paraffin phase change material is determined as the phase change material of the new multi-functional heat preservation cup. Paraffin materials have no segregation, supercooling and good thermal stability; At the same time, it is non-toxic, non-corrosive, non-polluting and low cost. Based on the above considerations, the use of paraffin phase change materials will not increase the cost of industrial production, but also ensure the product performance, killing two birds with one stone. Therefore, paraffin phase change material is added in the stainless steel interlayer of the product. When the cup is filled with hot water, because paraffin phase change material is sensitive to high temperature, it will absorb the heat of hot water from solid form to liquid form. When the temperature of hot water in the cup drops to a certain temperature value, it will transfer the stored heat back to the water in the cup, from liquid form to solid form, It not only prolongs the duration of hot water, but also achieves the effect of temperature control.

2.3. polysilicon solar panels
Solar panels have been developed for many years, including silicon solar cells. Monocrystalline silicon solar cells and polycrystalline silicon solar cells are widely used in industrial production because of their high photoelectric conversion efficiency and easy to obtain materials; Amorphous silicon is seldom used because of its low conversion efficiency and poor stability.

When molten silicon solidifies under supercooling condition, silicon atoms are arranged into many crystal nuclei in the form of diamond lattice, and the crystal nuclei grow into grains with different orientations. The crystal of these grains is polycrystalline silicon. Due to the wide source of polysilicon raw materials, no pollution to the environment, low price, and continuous improvement of conversion efficiency in industrial application; It will play an important role in the future development of solar energy industry. Due to the adjustment of the energy structure target in the 12th Five Year Plan, the focus is to achieve the two goals of increasing the proportion of non-fossil energy and carbon emission reduction, which provides policy guarantee for the development of polysilicon solar cells.

The surface of the cup cover of this product adopts polysilicon solar panels, with low price, high performance and easy installation, which can fully meet the daily photoelectric conversion and realize the energy supply for electronic components. In order to solve the problem that solar panels can not generate electricity in rainy days, we have batteries on both sides of the LCD, so that the excess power of polysilicon solar panels can be stored to ensure that the LCD can also work continuously in rainy days.

3. CHARACTERISTICS OF NEW MULTIFUNCTIONAL THERMAL INSULATION CUP WITH HEAT STORAGE

3.1. temperature control
At present, the cup in the market only has the function of heat preservation, which leads to people unable to drink when the water temperature is too high. Based on this disadvantage, the product adds phase change heat storage material in the middle of stainless steel interlayer, and when hot water is added to the cup, the phase change material can absorb the heat in the water temperature; When the temperature of hot water drops to a certain temperature, the phase change material will transfer the heat to the water supply. In this way, the water temperature can be controlled in a suitable temperature range for a long time to meet the requirements of the suitable water temperature in people's lives.

3.2. thermal insulation
The inner and outer layers of the inner and outer layers of the product are stainless steel, and the intermediate part is equipped with phase change heat storage material, which can store heat energy.
Meanwhile, there is a vacuum insulation layer between the outer layer and the outer shell of the inner liner to prevent heat dissipation and ensure long-term heat preservation.

### 3.3. energy conservation

The product uses solar panels to power the functional devices such as voice, timing and temperature measurement, which not only saves energy, but also does not worry about the need to charge the battery of the thermal insulation cup frequently. The cup cover uses the snap in solar cell board, which increases the light receiving area and improves the conversion efficiency, which provides the guarantee for the normal use of all functional devices.

### 3.4. convenience

The product is of moderate volume and quality, which can provide convenience for the people traveling and traveling, and students can go to school and walk for the elderly. Temperature measurement and display function, ensure people drinking water at the right temperature; Customize voice reminder function to prevent people from missing the best time for drinking water and taking medicine; The removable medicine storage box on the side of the cup can store emergency medicine, which is very helpful for home and out of the house.

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![Comparison of temperature control and heat preservation performance of a new type of heat storage multifunctional heat preservation cup](image)

**Fig. 2.** Comparison of heat preservation performance of new type heat storage multifunctional heat preservation cup.

We compared the new multi-functional heat storage cup with the ordinary heat preservation cup. The results showed that the new multi-functional heat preservation cup had a certain amount of cooling in half an hour, but it was stable above 55°C for a long time. Compared with the ordinary heat preservation cup, it still maintained a higher temperature after 24 hours.
4. PROMOTION OF NEW MULTI-FUNCTIONAL HEAT PRESERVATION CUP WITH HEAT STORAGE

Due to the continuous improvement of people's living standards, the practical requirements of goods are also higher and higher, but at present, the mug in the market only has the function of heat preservation, and the more advanced one can only display the temperature and voice prompt, so there is an urgent need for a new multi-functional Mug in the market to meet people's needs. Our new multi-functional thermos cup integrates heat preservation, storage, temperature display, voice prompt and so on. In response to the call of the country to save resources, the cup cover surface of this product is equipped with a buckle solar panel. The upper solar panel can rotate 180 degrees, which can better absorb sunlight for photoelectric conversion, and supply power for the electronic devices of the thermos cup. It can be seen that this product can meet the requirements of people in modern society and has good commercial value. Demand promotes development, and high technology provides technical support for the development of thermos cup, which has become a strong thrust of thermos cup market. As a derivative product of vacuum insulation Cup, the new multi-functional insulation cup with heat storage has an immeasurable industry prospect.

5. CONCLUSIONS

At present, China's insulation Cup market is in good condition, and has basically achieved popularization. Compared with the traditional thermos cup, the new multi-functional thermos cup with heat storage is more practical and convenient, and can really drink hot water at any time, providing great convenience for the public. If put into production, it will have a broad market space and a high degree of industrialization.

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