AN OVERVIEW ON PROPERTIES AND CLASSIFICATION OF WAX PHASE CHANGE MATERIALS (WPCMs)

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The properties and classification of wax phase change materials (WPCMs) such as melting point, fusion heat, density, thermal conductivity and specific heat capacity have been reviewed in the present article. Three types of packaging wax methods have also been discussed such as the direct mixing method, the soaking and absorption method and the container packing method. The complete development of WPCMS has been resulted in good economic and social benefits.

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INTRODUCTION

Wax is one of the important chemical products in an oil refinery. It is a white to yellowish-white in colour, gelatinous, crystalline, water-insoluble substance. Its main content includes n-paraffin. Its carbon number, molecular weight, distillation range and density are 16-32, 300-540, 350°C-500°C and 0.880-0.915, respectively.[1] As a phase change material, wax plays an important role in the global industrial processes such as construction, air conditioning and textitles, etc. WPCM not only changes their phase but also absorbs or releases a lot of latent heat with the change of the reaction temperature. The advantages of WPCM are that it has a high temperature thermal storage capacity, high thermal efficiency and also maintains energy at a constant temerature.[2]

In the present paper, the properties, classification and three kinds of packaging wax have been discussed, in comparison to the properties and classification of WPCM.

DISCUSSION

Classification of wax phase change material

Phase change material (PCM) is classified into two kinds of materials such as organic phase change material (OPCM) and inorganic phase change material (IPCM). [3] IPCM mainly includes pure salt with high melting point, base metal, alloy and mixing salt etc. IPCM has a high heat of fusion and constant melting point. However, it is strongly corrosive and super-cooling in nature and has a tendency that phase change material is separated during the phase changing process. For the investment point of view of the manufacturer, the regeneration system must use specific materials in order to avoid equipment corrosion. On the other hand, OPCM consists of wax classes with high rates of fatty acid classes, polyolefin and alcohol etc. The advantages of WPCM are to generate good moulding ability. It is very hard to separate and create super-cooling during the phase changing process. OPCM has low corrosive properties also which are proved to be stable over time. However, it has very low thermal conductivity. Moreover, its poor heat transfer is due to a poor thermal contact between the two surfaces. Its heat transfer performance will be improved by adding high heat materials such as copper or aluminium powder or graphite.

The properties of wax phase change material [4]

Table 1 shows the heat properties of n-paraffins. The melting point of even-numbered n-paraffins increased with an increase in the molecular weight. Furthermore, even-numbered n-paraffins had higher melting heat than that of odd-numbered n-paraffins. However, odd-numbered n-paraffins did not follow any rule with the molecular weight.

Table 1. the heat properties of n-paraffin wax

Molecular formula	Molecular weight	Melting point (°C)	Melting heat ($J \cdot g^{-1}$)
$C_{16}H_{34}$	226	16.7	236.81
$C_{17}H_{36}$	240	21.4	171.54
$C_{18}H_{38}$	254	28.2	242.67
$C_{19}H_{40}$	268	32.6	-
$C_{20}H_{42}$	282	36.6	246.86
$C_{21}H_{44}$	296	40.2	200.83
$C_{22}H_{46}$	310	44.0	251.04
$C_{23}H_{48}$	324	47.5	234.30
$C_{24}H_{50}$	338	50.6	248.95
$C_{25}H_{52}$	352	53.5	-
$C_{26}H_{54}$	366	56.3	255.22
$C_{27}H_{56}$	380	58.8	234.72

Three kinds of packaging wax

Wax is a solid-liquid phase material, which is used in the different areas due to its different types of packages, such as the direct mixing method, the soaking and absorption method and the container packing method. In the direct mixing method wax is mixed with other materials. Wang Qishan[5] mixed wax with gypsum that was used during summer. Its advantages were to control amount of wax easily, distribute evenly and a simple process, however, it

is easily separated between solid phase and liquid phase and causes leaking. In the soaking and absorption method wax is soaked and absorbed with porous materials and then packaged. Luo Qing[6] introduced bricks those were soaked and absorbed into wax to produce the phase change material on their surface. The advantage of this method was that its construction was very simple, but wax was unevenly distributed and easily leaked from bricks. Further, the bricks' temperature was hard to control and they were easily polluted or corroded. The container packing method includes the microscopic and the macroscopic structure packaging method. Miroslaw Zukowski[7] used the polyethylene bag to seal wax and studied on the possibility to store the energy. Nowadays the phase change material is widely used in the different areas such as air conditioner and solar energy etc. But the phase change material has less surface to touch with outside atmosphere, so its heat transfer ability is very poor. Hu Xiaofang [8] used porous ceramics with soft tissue to absorb wax, and produced phase-change-material particles whose diameters were between 1μm and 100μm. These were having the advantages of simple process, stable performance, high energy storage and high thermal conductivity.

CONCLUSION

Based on the above discussion and review, wax phase change materil is widely used in different areas such as construction, air conditioning and textitle, etc. *China* owns a considerable amount of paraffin base petroleum and high quality wax. It is not only used as high value product for the requirement of residents and factories, but also increase *Chinese* Government Revenue also. It is an urgent need for *Chinese* scientists to find new methods and technologies which easily transfer from wax product to wax phase change material.

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