

Experimental Study on The Thermal Performance of Paraffin and Their Mixtures

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Abstract: In this paper, the thermal performances of several kinds of paraffin and their mixtures were studied experimentally by differential scanning calorimeter(DSC). Experimental samples included n-Heptadecane, n-Octadecane, n-Eicosane, 46# paraffin and 48# paraffin. The phase change temperatures of paraffin are from 20 to 50°C. The results show that the phase change temperature of paraffin can change with the composition. A wider range of phase change temperature can be achieved by changing the mixture proportion so as to satisfy different demands. Paraffin has larger phase change latent heat and no supercooling. The phase change temperatures of 46# paraffin or 48# paraffin with higher phase change temperature can evidently decrease when they were mixed with a little of n-Heptadecane or n-Octadecane with lower phase change temperature. The results in this paper can provide basis for the application of phase change material in the building field.

Keywords: Phase change temperature, phase change latent heat, paraffin, thermal performance

1. INTRODUCTION

Thermal storage of phase change materials has many advantages such as constant temperature, high density of thermal storage and heat efficiency. It has been used in the solar energy application, energy-saving in the building and industrial waste heat use. Especially, it has become focus in the heating and air-conditioning fields at home and abroad[1][2].

Phase change materials include solid-liquid materials and solid-solid materials. Paraffin was widely used in the energy storage because it has high phase change latent heat, suitable phase change temperature and lower prices and so on. Paraffin must be loaded by the containers in the practice so not as to leak. In order to avoid this disadvantage, shape-stabilized phase-change materials are developed. It is made up of supporting material and phase change material[3]-[5]. Phase change materials are mainly paraffin with different melting point[6][7]. Shape-stabilized phase-change material can be directly added into the building envelope and does not leak.

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Paraffin with lower phase change temperature is an ideal phase-change material used in the building fields. It can increase the capacity of thermal storage of the building envelope, save energy and improve indoor environment if paraffin was added into the building envelope such as the floor, the wall or the ceiling.

In the paper, the thermal performance of several kinds of paraffin and their mixtures were studied.

Phase change temperatures of phase change materials change by adjusting the mixture proportion.

2. EXPERIMENTAL EQUIPMENT AND MATERIALS

Experimental equipment includes differential scanning calorimeter, analytic balance, heating furnace, beaker and so on.

Experimental materials are n-Heptadecane, n-Octadecane, n-Eicosane, 46# paraffin and 48# paraffin made in Beijing reagent company.

Five kinds of different paraffin were mixed by different proportion and constituent to form several samples, and then samples were heated and melted. Take a few mixture samples, and put into aluminous crucible after weighting. The composition of samples used in the experiment is shown in the table 1.

Table 1: The composition of experimental samples

Sample number	constitution
1	n-Heptadecane+ n-Octadecane
2	n-Heptadecane+ n-Eicosane
3	n-Heptadecane+46# paraffin
4	n-Heptadecane+48# paraffin
5	n-Octadecane+ n-Eicosane
6	n-Octadecane+46# paraffin
7	n-Octadecane+48# paraffin
8	n-Eicosane+46# paraffin
9	n-Eicosane +48# paraffin
10	46# paraffin+48# paraffin

3. RESULTS AND ANALYSIS

Experimental results are shown in figure 1 to 4.

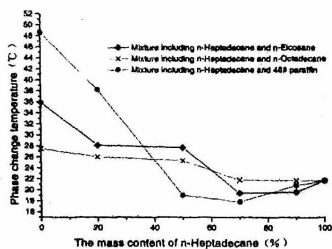


Figure 1: Phase change temperature of mixtures including n-Heptadecane

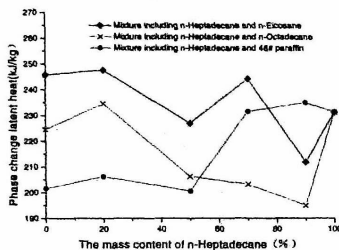


Figure 2: Phase change latent heat of mixtures including n-Heptadecane

The testing results of phase change temperatures and latent heat of mixtures consisting of n-Heptadecane and other paraffin were shown in figure 1 and 2.

From the figure we can see that the melting points of n-Heptadecane and n-Octadecane are lower, and they are 21.7°C and 27.5°C respectively. The phase change temperatures of mixtures consisting of n-Heptadecane and n-Octadecane are more than that of n-Heptadecane and less than that of n-Octadecane, and decrease with the increasing of the mass content of n-Heptadecane. But the changes in phase change temperature are small. The phase change temperatures of mixture materials can change between 20 °C and 28 °C by adjusting the compound proportion. The phase change latent heat of mixtures consisting of n-Heptadecane and n-Octadecane firstly increase and then decrease with the increasing of the content of n-Heptadecane.

The phase change temperatures of mixtures consisting of 48° paraffin and n-Heptadecane are much less than that of 48° paraffin, and decrease and finally less than that of n-Heptadecane with the increasing of the content of n-Heptadecane. The phase change temperatures of mixtures consisting of 48° paraffin and n-Heptadecane are between 17°C and 49

°C. The phase change latent heats of mixtures are bigger when the content of n-Heptadecane is bigger, and lower when the content of 48° paraffin is bigger.

The phase change temperatures of mixtures consisting of n-Heptadecane and n-Eicosane decrease with the increasing of the content of n-Heptadecane and finally are less than that of n-Heptadecane. The phase change temperatures of mixtures are between 19 °C and 36 °C. The changes in the phase change latent heat of mixtures are small.

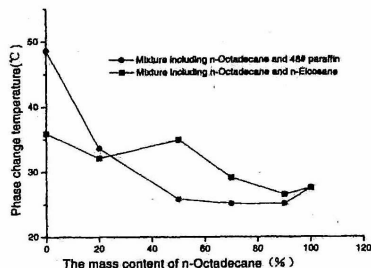


Figure 3: Phase change temperature of mixtures including n-Octadecane

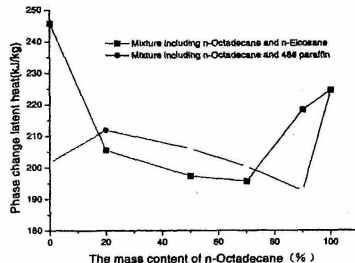


Figure 4: Phase change latent heat of mixtures including n-Octadecane

The testing results of phase change temperatures and latent heat of mixtures consisting of n-Octadecane and other paraffin were shown in figure 3 and 4.

The phase change temperature of n-Eicosane is 35.9°C. The phase change temperatures of mixtures consisting of n-Octadecane and n-Eicosane are less than that of n-Eicosane. The phase change temperatures of mixtures can be less than that of n-Octadecane when the content of n-Octadecane is up to 90 percent. The phase change temperatures of mixtures are between 26°C and 36°C. The phase change latent heats are less than that of n-Octadecane and n-Eicosane.

The phase change temperature of 48° paraffin is 48.6°C. The phase change temperatures of mixtures consisting of 48° paraffin and n-Octadecane are

much less than that of 48° paraffin, and decrease with the increasing of the content of n-Octadecane. The phase change temperatures of mixtures consisting of 48° paraffin and n-Octadecane are between 25°C and 49°C. The changes in the phase change latent heats of mixtures are small. The phase change temperatures of mixtures are less than that of n-Octadecane when the content of n-Octadecane is up to 50 percent.

The phase change temperatures of mixtures consisting of 46° paraffin and n-Heptadecane or n-Octadecane are much less than that of 46° paraffin, but the changes in the phase change latent heat are not evident.

The phase change temperature of 46° paraffin is 48.6°C. The phase change temperature is 47.9°C and latent heat is 194.7kJ/kg when mixing 46° paraffin with 48° paraffin by identical quality. Therefore, these mixtures are not significant because the changes in the phase change temperature are small.

Paraffin mixtures with different melting points can be gained by adjusting the composition in order to satisfy different use in the thermal storage fields. The phase change temperatures of several paraffin mixtures with different composition used in our experiment change between 17°C and 49°C, and the phase change latent heat is between 190 and 245kJ/kg.

The phase change temperatures of paraffin with higher melting point decrease rapidly and the change in the phase change latent heat is small when adding a little paraffin with lower melting point into them. In general, 46° paraffin and 48° paraffin have lower price, whereas n-Heptadecane, n-Octadecane and n-Eicosane are high-priced. It save invest and satisfy the demand that these paraffin mixtures are used in the thermal storage at the lower temperature such as the wall or the floor.

4. CONCLUSIONS

- 1) The phase change temperature of 46° paraffin or 48° paraffin decreased rapidly when they were mixed with a little paraffin with lower phase change temperature such as n-Heptadecane or n-Octadecane. The phase change temperatures of mixtures near or even less than that of n-Heptadecane or n-Octadecane when the content of n-Heptadecane or n-Octadecane is more than 40 percent. But the changes in the phase change latent heat are not evident.
- 2) In general, the phase change temperatures of mixtures consisting of two of several paraffin with lower melting point such as n-Heptadecane, n-Octadecane or n-Eicosane are between that of single constituent. The phase change temperatures of mixtures are less than that of any of constituent when the content of constituent with the lowest melting point is bigger. The phase

change latent heats of mixtures are less than that of single constituent.

- 3) The phase change temperatures of mixtures consisting of 46° paraffin and 48° paraffin have not evident differences with that of 46° paraffin or 48° paraffin. The phase change latent heats decrease after mixing.
- 4) The phase change temperatures of paraffin mixtures can change from 17 °C to 49°C and the phase change latent heat is between 190 and 245kJ/kg by adjusting the proportion or constitute of mixtures. Thus these paraffin mixtures can satisfy different demand in the thermal storage.
- 5) N-Heptadecane, n-Octadecane and n-Eicosane are high-priced. 46° paraffin and 48° paraffin are cheap. The former has lower melting point, and the later has higher melting point. When we need thermal storage phase change materials uses in the lower temperature, to compound them decreases melting point and invest simultaneously. This is very significant to thermal storage.

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