Shape-Stabilized Phase Change Materals : Frozen Gel fom Polypropylene and *n*-Octadecane for Latent Heat Storage

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Introduction

Today, I will present about preparation and characteristic of polymeric materials for thermal phase change. All pure substances in nature are able to change their state. Solids can become liquids (ice to water) and liquids can become gases (water to vapor) but changes such as these require the addition or removal of heat. The heat that causes these changes is called latent heat.
A Phase change material is a substance with a high heat of fusion which, melting and solidifying at certain temperatures, is capable of storing or releasing large amounts of energy.

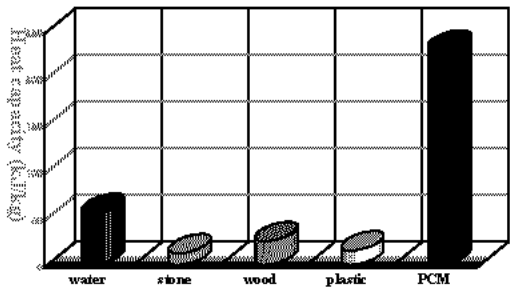

Figure1. Comparison of Heat Capacity of Materials (from Rubitherm GbmH)

A graph for comparison of heat capacity of materials. We can see the specific heat capacity of latent heat of stone, water, wood, plastic and phase change material. The advantage of a phase change material is the use of the latent heat which is available during the phase change process. A smaller amount of the heat storage capacity consists of sensible heat. As you know that the heat storage capacity depending on the temperature difference.
Consequently, latent heat PCM offer five times higher heat capacity by volume or mass, than water at low operating temperature differences. It means that the phase change material is very useful material for capturing or releasing heat.

Experimental

The preparation methods are to be used as "melting method" and "absorption method", respectively. In melting method, the reaction mixture of two different kinds of polypropylene chip and four kinds of phase change materials such as normal octadecane, respectively.
And the reaction mixture is heating up under nitrogen gas atmosphere.
In absorption method, polypropylene powder was mixed in the molten phase change materials with stirring at relatively low temperature.
The reaction mixture in the reaction container was heating up the reaction mixture to 200 °C for 2 hour. The mixing time of lab scale preparation should be provided quit long, instead of the short working time in a compounder vessel. Melting point *n*- octadecane in this experiment is 28 °C. And melting temperature of polypropylene is around 160 °C. Used polypropylenes for melting method are chip type polypropylene with melt index (MI=17) and 37, respectively. So, the reaction mixture was heating up to 200 °C to melt down the reaction mixture, perfectly. After the reaction complete, the reaction mixture cooling down to room temperature The PP-PCM mixture in the reaction container was heating up the mixture around 60 - 80 °C for 12 hour. In here, powder shape polypropylene with melt index (MI=4.8) was used. we mixed up polypropylene powder and *n*- octadecane, respectively. A melting method of frozen gel with 50/50 weight ratio of polypropylene-normal octadecane was prepared by adding polypropylene chip and normal octadecane. An absorption method of frozen gel with 70/30 weight ratio of polypropylene 4.8-normal n-octadecane was prepared by adding polypropylene powder and normal octadecane.

Results and discussion

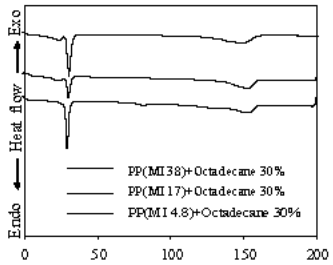

Figure 2. DSC Thermo-diagrams of PP(MI 38,17,4.8) and *n*- octadecane 30%

Thermal properties of frozen gels via melting method are measured using differential scanning calorimetry with ramping rate 5.0 K/min. And the line shows a thermogram of frozen gel from melting and absorption method using polypropylene chip and 30 weight % of normal octadecane as phase change material. As shown in here, we can see two melting points around 28.0 °C and 154 °C. These two melting points are associated with melting point of normal octadecane and polypropylene chip. In here, we measured heat of fusion from low temperature region that comes from normal octadecane, because only this heat of fusion is important for latent heat energy storage for application.

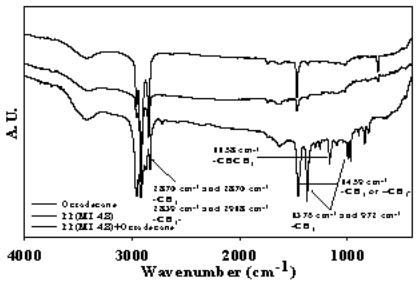

Figure 3. Prepared PP(4.8) –*n*-Octadecane Frozen Gel

In order to confirm the incorporation of phase change materials into binding polymer by absorption method, infra-blue spectroscopy of polypropylenes, phase change materials, and prepared frozen gels were measured. we can see that the spectrum is a typical polypropylene IR spectrum. We confirmed that phase change materials were successfully incorporated into the binder polymer from absorption method from infra-red spectroscopy results

Conclusions

The composition and properties of prepared frozen gels from polypropylene and *n*- octadecane was observed from DSC, WAXD, FT-IR spectra, ARES and Elemental analysis. From the experimental results, we can prepare proper frozen gels for different temperature for latent heat storage materials as controlling composition of phase change material as well as using different incorporating phase change materials.

References

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