Thermal investigation of phase change materials based on LLDPE, paraffin wax and expanded graphite

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Abstract

Paraffin waxes which are saturated hydrocarbon mixtures, generally entailing of a mixture of different alkanes are frequently used as phase change materials (PCMs) due to their numerous advantages such as high latent heat of fusion, negligible super-cooling, low vapour pressure in the melt and chemical inertness.

Paraffin waxes, blended with appropriate polymers to avoid the leaching of paraffin during heating, seem to be the best way for preparation of smart PCMs for different applications such as thermal storage of solar energy, thermal protection of electronic devices, thermal protection of food and medical goods, passive storage in bioclimatic buildings and thermal comfort in vehicles.

Due to the relatively low thermal conductivity of LLPDE and also paraffin wax (approximately 0.2 W/m.K) it is necessary to improve the thermal conductivity of the PCMs by adding conductive fillers.

Nowadays, expanded graphite (EG) is commonly used to improve mechanical, electrical conductivity, thermal conductivity and other thermophysical properties.

In this contribution thermal properties of the PCMs based on LLDPE, paraffin wax RT42 (melting point around 42 °C) and expanded graphite were characterized by unique devices, namely PCGT and DICO devices, which allow an investigation of thermal properties of large sized samples in comparison with common Differential Scanning Calorimetry (DSC).

Storage and release of thermal energy of the PCMs have been performed by means of PCGT device. It was confirmed that all prepared PCMs were able to store and release thermal energy. Also reproducibility of storage and release heat of the PCMs by repeating of heating and cooling process has been demonstrated. The best results in view of time needed for storage and release energy were achieved with PCMs containing 15 wt.% of EG.

Thermal conductivity and diffusivity of the PCMs have been measured by DICO device. Increase of the EG content in the PCMs led to the increase of thermal conductivity and also thermal diffusivity for all investigated PCMs.

Image

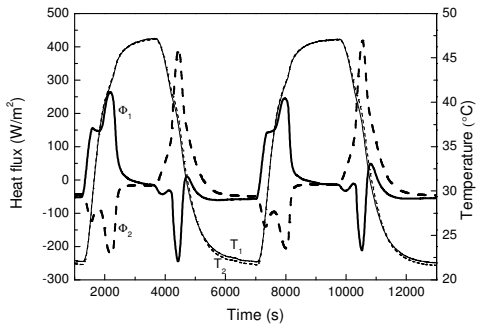


Figure 1: Heat flux and temperature evolution from solid to liquid for composition of LLDPE/WAX/EG blends 35/50/15 (w/w/w) for cyclic variation of temperature from 20 to 50 °C and reverse from 50 to 20 °C

Recent Publications.

[1]. Braiek A, Karkri M, Adili A. Ibos L, Ben Nasrallah S. Estimation of the thermophysical properties of date palm fibers/gypsum composite for use as insulating materials in building, Energy and building, 2017; 140 : 268-279. (Five Year Impact Factor: 4.599).

[2]. Mohaine S, Feliu J, Grondin,F, Karkri M, Loukili A. Multiscale modelling for the thermal creep analysis of PCM concrete, Energy and building, 2016; 131:99-112. (Five Year Impact Factor: 4.599).

[3]. Sobolčiak P, Abdelrazeq H, Gözde Özerkan N, Ouederni M, Nógellová Z, Al-Maadeed M, Karkri M, Igor Krupa I. Heat transfer performance of paraffin wax based phase change materials applicable in building industry, Applied Thermal Engineering 2016; 107:1313–1323, (Impact Factor: 2.7)

[4]. Karkri M, Lachheb M, Albouchi F, Ben Nasrallah S, Krupa I. Thermal properties of smart microencapsulated paraffin/plaster composites for the thermal regulation of buildings. Energy Build 2015; 88:183-92. (Five Year Impact Factor: 3.61)

[5]. Al-Maadeed M, Labidi S, Krupa I, Karkri M. Effect of expanded graphite on the phase change materials of high density polyethylene/wax blends. Thermochim Acta 2015; 600:35-44. (Five Year Impact Factor: 2.39)



Biography

Mustapha KARKRI obtained his PHD in heat transfer in polymer flow from Polytechnic High School of Nantes in 2004. He holds a full Associate Professor with University of Paris-Est Créteil since September 2007, and is affiliated with the Center for Study and Research on Thermal Science, Environment and Systems (CERTES). From 2005-2007, He has been Temporary Lecturer and Research Assistant position with Femto-st Institut and PostDoc with LEMTA Laboratory of Lorraine University. He has also coordinated many committees and developed national and international collaborations.
His research interest covers : Metrology and development of new measurements methods, Modeling and numerical simulation, Thermal energy storage (TES), Development of innovative device and inverse method to characterize thermal properties of hybrid material. Modeling of thermal energy storage of Phase change materials. Computational homogenization for the thermomechanical properties. Development of a new composite materials to optimize thermal insulation of building.
His teaching activities covers : Physics, Herat and mass transfer, Numerical simulation, Numerical methods in heat transfer, Composite materials and inverse method.
Level : L1, L2 and professional License at UPEC University. Master of Heat transfer and materials at Paris Ouest Nanterre University.
His main achievements : Implementation of new projects like : NPRP Project, European Cooperation COST Action TU0802 (NECOE-PCM), AUF CMCU Egide, MSME-CERTES Labex 2015, and development of new measurements methods coupled with inverse problem.

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