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Advanced Thermal Energy Systems Based On Paraffin Waxes Applicable In Building Industry

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Abstract

Thermal energy storage systems are crucial for reducing dependency on fossil fuels and minimizing CO2 emissions. The building sector is a major sector responsible for producing high levels of CO2 in most countries (including Qatar).
Thermal energy storage can be accomplished either by using sensible heat storage or latent heat storage components. Latent heat storage is more attractive than sensible heat storage because of its high storage density with smaller temperature fluctuations.[1]
The materials able to utilize latent heat which can undergo phase changes (usually solid to liquid changes) at relatively low temperatures, while absorbing or releasing high amounts of energy are called phase change materials (PCMs).[2]
Most promising PCMs are paraffin waxes which contain saturated hydrocarbon mixtures. They are frequently used due to their numerous advantages such as high latent heat of fusion, negligible super-cooling, and chemical inertness.[3,4]
In this contribution, thermal properties of the PCMs based on linear low density polyethylene (LLDPE), different types of paraffin waxes with melting points, 25 oC and 42 oC, and expanded graphite (EG) were characterized by unique transient guarded hot plate technique (TGHPT), which allow to identified thermal properties of large sized samples[5] in comparison with commonly used ifferential scanning calorimetry (DSC).
It was confirmed that all prepared PCMs were able to store and release huge amount of thermal energy. The 25 % increase of capacity to store and release a thermal energy was observed by PCMs contains paraffin wax with melting point 25 oC in comparison with paraffin wax with melting point 42 oC. Also reproducibility of storage and release heat of the PCMs by repeating of heating and cooling process has been demonstrated.
Moreover, the increase of the EG content in the PCMs led to the increase of thermal conductivity from 0.24 W/mK for PCMs without EG to 1.3 W/mK for PCMs contain 15 wt.% of EG.
Additionally, life cycle assessment of prepared PCMs has been demonstrated to identify the effects of these new materials on the Qatar environment. Our results indicate that using of PCMs in building industry can reduce emission of CO2 up to 10%.

Keywords:
phase change materials; latent heat; storage and release energy; thermal conductivity; life cycle assessment

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