

The Thermal Buffering Studies of PCM Based Packaging Box Using COMSOL®

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Abstract

The temperature maintenance plays a crucial role in the transportation of heat sensitive materials like fruits, vegetables, food products and blood etc. The refrigeration of these products (during transport) utilizing energy from fossil fuels burning will involve CO₂ emission. Thermal insulators such as expanded polystyrene, bubble wrap etc. are used for temperature maintenance. Phase change materials (PCM) obtained from green energy resources may be an alternative for thermal buffering application due to their ability of high energy storage density. Accumulation of latent heat during phase change of these materials place is ahead of conventional thermal insulators or fuels to increase the efficiency of packaging box. PCMs are used in either encapsulated form or composite form to reduce its interactions with the surroundings. A packaging box need to be designed for the transportation of sensitive products with combination of insulation liners and PCM composite. The PCM (m.p. 11oC and melting enthalpy 57 J/g) composite made from activated charcoal as base material is considered in this study.

Efficacy of thermal buffering with (i) thermal insulation liners and (ii) PCM-AC composite in a packaging box were evaluated using COMSOL Multiphysics® simulation software. This simulation involves heat transfer by conduction, convection and phase change phenomena. Phase change simulation interface is provided in Heat Transfer Module of COMSOL Multiphysics® simulation. The defined problem is solved using the basic equations of conduction, convection and phase change using apparent heat capacity method. The fluctuations in temperature of the inner chamber through the different resistances (insulation layers) from particular outside temperature with respect to time is estimated through this simulation. This will provide an idea of the time up to which the packaging box can maintain the inside temperature to the permissible level where the temperature sensitive material in the box could stay without any degradation.