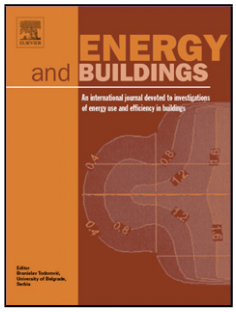

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Evaluating the passive and free cooling application methods of phase change materials in residential buildings: A comparative study

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Highlights

- Performance of passive and free cooling method of PCM in a house was compared.
- The comparative study was carried out using validated numerical models.
- Free cooling method resulted in higher zone temperature reduction than passive case.
- Optimum PCM temperature in passive case is equal to average indoor zone temperature.
- In free cooling optimum PCM temperature is equal to average outdoor air temperature.

Abstract

The integration of Phase Change Materials (PCMs) in buildings as a potential method to improve indoor thermal comfort can be achieved via three different approaches: passive, active and free cooling. A large number of studies have been reported the thermal performance enhancement of these methods, revealing that all three methods have a significant enhancement in energy efficiency or indoor thermal comfort. However, there is no study available in the literature comparing the effectiveness of different PCM application methods. Such comparative analysis is important to understand which application method would be best for increasing the energy efficiency and thermal comfort of a particular building type. The aim of the present study is to compare and analyze the effectiveness of passive and free cooling application methods of PCM in a residential building in Melbourne, Australia. The passive application method utilizes a macro-encapsulated PCM, so-called BioPCM mats, installed in the ceilings of the building. In free cooling, outdoor air was supplied to the indoor after passing it through a PCM containing heat exchanger. The comparative study was carried out using validated numerical models for both application methods. The simulation models were developed using building simulation software EnergyPlus V8.3 and computational fluid dynamics (CFD) software ANSYS V15.1. The results showed that, for the studied building, free cooling application of PCM is more effective than the passive application in reducing the indoor zone temperature. During the studied period of seven days, passive application of 25°C PCM resulted in up to 0.44°C reduction in peak indoor zone temperature compared to 2.63°C