Journal of Building Engineering 89 (2024) 109323

Contents lists available at ScienceDirect

Journal of Building Engineering

journal homepage: www.elsevier.com/locate/jobe

Experimental and numerical investigation of a real-scale air to multiple PCM heat exchanger

Bashir Eskander Kareem *, Ahmed Mohammed Adham, Banipal Nanno Yaqob

Department of Technical Mechanical and Energy Engineering, Erbil Technical Engineering College, Erbil Polytechnic University, Erbil, Iraq

ARTICLE INFO

Keywords:
Phase change materials
Multiple PCM-To-air heat exchanger
Latent heat storage system
Free cooling

ABSTRACT

Energy consumption by residential sectors has proliferated due to urbanization and lifestyle changes. Passive cooling and heating systems can reduce energy consumption and CO_2 emissions in residential and commercial sectors. Phase change materials provide an efficient solution for passive energy storage, addressing a building's needs for free cooling and heating. These materials absorb and release heat energy, enhancing the overall efficiency of the energy management system. By employing energy storage devices, it becomes feasible to reduce and shift peak loads to off-peak hours. This study optimized the size and configuration of air-to-multiple PCM heat exchanger through the utilization of a 2D ANSYS (Fluent 19.2) model. This study employs multiple phase change materials (PCMs) with varying melting temperatures as a heat transfer technique to reduce the melting and solidifying times of the PCMs. Furthermore, it was observed that the arrangement of PCMs in series affected melting and solidification times, so two scenarios have been examined. The air-to-multiple PCM system has been investigated through numerical simulations and experimental analyses, focusing on the liquid fractions within the PCM and the outlet air temperatures across the air channels. The total time for entirely melting PCMs RT25HC and RT21HC is less than 4 h, but the solidification time for PCM-RT21HC needs more than 12 h. In both scenarios, PCM-RT21HC melted first, while PCM-RT25HC solidified first.

Nomenclature

H	Height (m)
L	Length (m)
T	Temperature (°C)
W	Width (m)

Abbreviations

CFD	Computational fluid dynamics
HTF	Heat transfer fluid
HVAC	Heating, ventilation and air conditioning
IEA	International Energy Agency
PAHX	PCM to air heat exchanger

* Corresponding author.
E-mail address: bashir.kareem@epu.edu.iq (B.E. Kareem).

https://doi.org/10.1016/j.jobe.2024.109323
Received 2 February 2024; Received in revised form 6 April 2024; Accepted 13 April 2024
Available online 16 April 2024