Journal of Building Engineering 82 (2024) 108269

Contents lists available at ScienceDirect

Journal of Building Engineering

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

Experimental analysis of air-multiple pcm heat exchanger in evaporative cooling systems for supply air temperature stabilization

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:
Air to multiple PCM heat exchanger
Evaporative cooling system
Thermal comfort
PCM-RT21
PCM-RT25

ABSTRACT

The free cooling system is a highly efficient solution that effectively regulates indoor temperature when the ambient air temperature fluctuates within the thermal comfort range. Compared to traditional cooling systems, the evaporative cooling system excels in cost-effectiveness and has exceptional efficiency in hot and dry climates. However, the system's performance is significantly influenced by the environment, leading to fluctuations in the outlet temperatures of the evaporative cooler. A novel approach to integrating thermal energy storage with an evaporative cooling system has been studied to achieve free cooling and stabilize the system's supply air temperature to address this challenge. The evaporative cooler's design, construction, and experimental testing have been carried out in highly challenging hot and dry environments. The utilization of phase change materials (RT21HC and RT25HC) as a thermal energy storage system has been implemented. Incorporating phase change materials has notably improved the stability of the outlet air temperature from the evaporative cooling system. Furthermore, the outlet air temperature from the system exhibited consistent fluctuations within the range of 21–25 °C, requiring a significant amount of energy absorption and release to exceed these temperature thresholds. The findings demonstrate that the proposed system effectively reduces and shifts peak load to off-peak hours. Moreover, thermal energy storage can deliver free cooling during the spring and autumn. However, integrating the PAHX into an evaporative cooling system becomes crucial in regions characterized by extremely hot summer seasons. The maximum deviation between numerical and experimental results is 4 %.

Nomenclature

H	Height (m)
L	Length (m)
T	Temperature (°C)
W	Width (m)
m_a	Air mass flow rate (kg/s)

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

https://doi.org/10.1016/j.jobe.2023.108269
Received 1 July 2023; Received in revised form 10 November 2023; Accepted 3 December 2023
Available online 8 December 2023