ScienceDirect

Journal of Energy Storage
Volume 50, June 2022, 104573

Research papers

Air cooled lithium-ion battery with cylindrical cell in phase change material filled cavity of different shapes

M.N. Khan [a], Hayder A. Dhahad [b], Sagr Alamri [c], Ali E. Anqi [c], Kamal Sharma [d], Sadok Mehrez [e, f], Mohamed A. Shamseldin [g], Banar Fareed Ibrahim [h]

[a] Department of Mechanical and Industrial Engineering, College of Engineering, Majmaah University, Al-Majmaah, 11952, Saudi Arabia
[b] Mechanical Engineering Department, University of Technology, Baghdad, Iraq
[c] Department of Mechanical Engineering, College of Engineering, King Khalid University, Abha 61421, Saudi Arabia
[d] Institute of Engineering and Technology, GLA University, Mathura, U.P. 281406, India
[e] Department of Mechanical Engineering, College of Engineering at Al Kharj, Prince Sattam bin Abdulaziz University, 16273, Saudi Arabia
[f] Department of Mechanical Engineering, University of Tunis El Manar, ENIT, BP 37, Le Belvédère, 1002 Tunis, Tunisia
[g] Dept. of Mechanical Engineering, Faculty of Engineering & Technology, Future University in Egypt, 11845 New Cairo, Egypt
[h] Department of Information Technology, College of Engineering and Computer Science, Lebanese French University, Kurdistan Region, Iraq

Received 5 January 2022, Revised 17 March 2022, Accepted 29 March 2022, Available online 14 April 2022, Version of Record 14 April 2022.

https://doi.org/10.1016/j.est.2022.104573

Highlights

- Thermal management of a cylindrical Li-ion battery (CLIB) with forced airflow and PCM was carried out.
- The battery was placed in chambers of different shapes filled with PCM and graphene nanoparticles.
- The simulations were implemented using the FEM.
- A rise in the nanoparticle content of PCM improved thermal management and temperature distribution.
- The battery within the triangular PCM chamber showed the largest heat transfer coefficient.

Abstract

The present study numerically investigates the effects of phase change materials (PCMs) in chambers of different shapes on the thermal management of cylindrical Li-ion batteries (CLIB). A battery cell in a PCM-filled chamber inside an air-cooled system was simulated two-dimensionally in a transient state. An Organic PCM with graphene nanoparticles (NPs) was employed. Square, circular, triangular, lozenge, and hexagonal chambers were tested at different airflow velocities. The finite element method (FEM) approach was used to implement the numerical simulations. The CLIB temperature, heat transfer coefficient (HTC), melting PCM content, and the output temperature (T_{OU}) of the cooling system were studied at different airflow velocities and PCM volume fractions at different times for different PCM shapes. It was found that a rise in the airflow velocity decreased the average CLIB temperature (T_{AVE-B}) and T_{OU} and increased the HTC of the PCM chamber. The CLIB within a triangular chamber was observed to have the lowest temperature and largest HTC; on the other hand, the lozenge chamber had the lowest heat transfer. The triangular chamber led to 63% higher heat transfer compared to the lozenge chamber. The addition of graphene NPs at a volume fraction of 4% to the PCM improved the HTC by 65% at 5000 s.

Previous Next

Keywords

Thermal management; Cylindrical Li-ion battery; Organic PCM; Nanoparticles

Special issue articles Recommended articles

Cited by (0)

View full text