Thermophysical properties enhancement and characterization of CuO nanoparticles enhanced HITEC molten salt for concentrated solar power applications

Hatem Ahmad Aljaerani a, M. Samykano a,, A.K. Pandey b,c,*, K. Kadirgama d, Mathew George e, R. Saidur b*

aCollege of Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia
bResearch Center for Nano-Materials and Energy Technology (RCNMET), School of Engineering and Technology, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, Petaling Jaya 47500, Selangor Darul Ehsan, Malaysia
cDepartment of Energy & Environmental Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences,Saveetha University,Chennai, India
dFaculty of Mechanical & Automotive Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
eHigher Institution Centre of Excellence (HICoE), UM Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D, University of Malaya, Jalan Pantai Baharu, 59990 Kuala Lumpur, Malaysia

ABSTRACT

Molten salts are utilized in concentrated solar power (CSP) as a working fluid to store and transfer solar thermal energy. In this study, we attempted to enhance the thermal energy storage (TES) characteristics of the ternary nitrate molten salt of KNO3, NaNO2, and NaNO3, also known as HITEC molten salt, using cupric oxide (CuO) as additives for CSP applications. HITEC was doped with 0.1, 1, 3, and 5 wt% of CuO nanoparticles using the twostep wet method. Differential scanning calorimeter (DSC) was utilized to evaluate the specific heat capacity, melting point, and latent heat of the prepared material. Thermal stability was measured by thermogravimetric analysis (TGA) while the characterization analysis was performed using Fourier-Transform Infrared (FT-IR) spectroscopy, Field Emission Scanning Electron Microscope (FESEM), and Energy Dispersive X-ray Spectroscopy (EDS). The results showed that 0.1 wt% CuO nanoparticles is the optimum CuO nanoparticles concentration which resulted in a specific heat capacity enhancement of 5.6%, a 30% improvement of latent heat, and 9% enhancement of thermal stability. The morphological analysis revealed the formation of bright chain-like nanostructure due to nanoparticle dispersion, which may the possible reason for the thermophysical property enhancement.

KEYWORDS: Molten salt, Concentrated solar power, Thermal energy storage, Thermophysical properties, Nanomaterials

DOI: https://doi.org/10.1016/j.icheatmasstransfer.2022.105898

ACKNOWLEDGEMENT

The authors would like to thank Universiti Malaysia Pahang (UMP) and Ministry of Higher Education Malaysia for the financial support given under Fundamental Research Grant Scheme: FRGS/1/2021/STG05/UMP/02/5 and Sunway University for the research facilities provided.

REFERENCES

[1] A. Awad, *et al.*, **Latent and sensible energy storage enhancement of nano-nitrate molten salt**, Solar Energy: Part, 2 (172) (2018), pp. 191-197, 10.1016/j.solener.2018.04.012

[2] M.K. Saranprabhu, K.S. Rajan, **Magnesium oxide nanoparticles dispersed solar salt with improved solid phase thermal conductivity and specific heat for latent heat thermal energy storage**, Renew. Energy, 141 (2019), pp. 451-459, 10.1016/j.renene.2019.04.027

[3] M. Chieruzzi, *et al.*, **A new phase change material based on potassium nitrate with silica and alumina nanoparticles for thermal energy storage**, Nanoscale Res. Lett., 10 (2015), p. 273, 10.1186/s11671-015-0984-2

[4] …