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Editorial

Nanofluids for Energy Applications

Muhammad Abdul Mujeebu

Department of Building Engineering, College of Architecture and Planning, Imam Abdulrahman Bin Faisal University, 31451 Dammam, Saudi Arabia.

Email: mmalmujeebu@iau.edu.sa; mamujeebu@gmail.com.

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Nanofluids are gaining attention in the exchange, conversion, and storage of energy, owing to their enhanced thermophysical characteristics. Since the thermal conductivity of metals are far higher than that of fluids such as water and oil, adding metal nanoparticles into such fluids can result in a new medium with improved heat transfer properties. Apart from pure metals, nanoparticles made of metal-oxides, silicon carbide, composites, bio-based materials, etc. are also used for this purpose. Nanofluids are produced by engineered-dispersion of nanoparticles in a base fluid, which significantly enhances the thermal conductivity of conventional heat transfer fluids (Ganji et al. 2018; Sheikholeslami 2019). However, the thermophysical characteristics of nanofluids depend on the size, shape, and volumetric fraction of the dispersed nanoparticles. An interesting breakthrough in nanofluids is the advent of hybrid nanofluids wherein two or more nanoparticles are immersed in the base fluid, which has shown further enhancement of the thermal and rheological properties (Kumar and Arasu 2018).

Nanofluids play important role in energy exchange and conversion applications (Jama et al. 2016;Nagarajan et al. 2014; Said et al. 2014; Reddy et al. 2017; Hussain et al. 2019; Muñoz-Sánchez et al. 2018; Bhalla and Tyagi 2017; Islam et al. 2015). Holkar et al. (2018) listed different nanofluids employed for energy harvesting and their advantages. Apart from these, cupric oxide nanofluid was proposed to improve the heat transfer performance of asphalt solar collectors that harvest solar energy from roads (Hashim 2014). The efficiency of direct absorption solar collectors could be improved by the use of nanofluids as the absorption medium (Nagarajan et al. 2014;Otanicar et al. 2010).

A major challenge in the use of nanofluids for energy applications is the contradictory behavior of thermal conductivity and specific heat. While the enhancement of thermal conductivity of base-fluid by the dispersion of nanoparticles is well established, there are no consistent findings on the enhancement of specific heat capacity (SHC) (Lu and Huang 2013), which is a desirable property for energy storage. Several studies reported decline of SHC of aqueous nanofluids, whereas non-aqueous nanofluids showed improvement of SHC (Shin and Banerjee 2010). This issue has been tackled in many studies, and it remains an ongoing challenge. Adding nanoparticles to molten salts that are used as heat transfer fluids in concentrated solar power (CSP) system could enhance the thermophysical properties including SHC and enable the CSP plants operate at higher temperatures (Shin and Banerjee 2010; Lu and Huang 2013). Muñoz-Sánchez et al. (2018) provided a comprehensive review on the use of molten salt-based nanofluids for energy storage and transfer at higher temperatures.

Owing to the growing environmental concerns on the conventional synthesis techniques of nanoparticles, the emerging trend is to adopt green synthesis approaches (Genuino et al. 2013; Ghulam 2016). The nanoparticles produced by green synthesis are termed as green nanoparticles, and the nanofluids prepared from them are known as green nanofluids (Narayanan and Rakesh 2019). Several researchers have reported development and characterization of green and eco-friendly nanofluids such as silver and gold nanofluids (Mollick et al. 2014)(John et al. 2015), grapheme-based nanofluids (Mehrali et al. 2016), and coconut fiber-based nanofluids (Adewumi et al. 2018). These green nanofluids would be promising alternatives for their conventional counterparts for various energy conversion applications.

References

Adewumi, Gloria, Freddie Inambao, Mohsen Sharifpur, and Josua Meyer. 2018. “Investigation of the Viscosity and Stability of Green Nanofluids from Coconut Fibre Carbon Nanoparticles : Effect of Temperature and Mass Fraction.” (January).

Bhalla, Vishal, and Himanshu Tyagi. 2017. “Solar Energy Harvesting by Cobalt Oxide Nanoparticles, a Nanofluid Absorption Based System.” Sustainable Energy Technologies and Assessments 24: 45–54.

Ganji, Davood Domairry, Yaser Sabzehmeidani, and Amin Sedighiamiri. 2018. Nonlinear Systems in Heat Transfer Heat Transfer in Nanofluids.

Genuino, Homer C. et al. 2013. New and Future Developments in Catalysis: Catalysis for Remediation and Environmental Concerns Green Synthesis of Iron Nanomaterials for Oxidative Catalysis of Organic Environmental Pollutants. Elsevier B.V.

Ghulam, Tahir. 2016. “Peel Extract Mediated Green Synthesis of Nanoparticles, Their Characterization and Application for the Degradation of Xenobiotic Compounds.”

Hashim, Ghasaq Adheed. 2014. “Numerical Study of Heat Transfer Enhancement in Asphalt Collector Using CuO Nanofluid.” : 48709.

Holkar, Chandrakant R, Saransh S Jain, Ananda J Jadhav, and Dipak V Pinjari. 2018. “Scale-Up Technologies for Advanced Nanomaterials for Green Energy.” In Nanomaterials for Green Energy, Elsevier Inc., 433–55.

Hussain, Imtiaz M., Jin Hee Kim, and Jun Tae Kim. 2019. “Nanofluid-Powered Dual-Fluid Photovoltaic/Thermal (PV/T) System: Comparative Numerical Study.” Energies 12(5).

Islam, M. R., B. Shabani, G. Rosengarten, and J. Andrews. 2015. "The Potential of Using Nanofluids in PEM Fuel Cell Cooling Systems: A Review." Renewable and Sustainable Energy Reviews 48: 523–39.

Jama, Mohamoud et al. 2016. "Critical Review on Nanofluids: Preparation, Characterization, and Applications." Journal of Nanomaterials 2016.

John, Jisha et al. 2015. "Shape Dependent Heat Transport through Green Synthesized Gold Nanofluids." Journal of Physics D: Applied Physics 48(33).

Kumar, Dhinesh D., and Valan A. Arasu. 2018. "A Comprehensive Review of Preparation, Characterization, Properties and Stability of Hybrid Nanofluids." Renewable and Sustainable Energy Reviews 81(May 2017): 1669–89.

Lu, Ming Chang, and Chien Hsun Huang. 2013. "Specific Heat Capacity of Molten Salt-Based Alumina Nanofluid." Nanoscale Research Letters 8(1): 1–7.

Mehrali, Mohammad et al. 2016. "An Ecofriendly Graphene-Based Nanofluid for Heat Transfer Applications." Journal of Cleaner Production 137: 555–66.

Mollick, Md Masud Rahaman et al. 2014. "Green Synthesis of Silver Nanoparticles-Based Nanofluids and Investigation of Their Antimicrobial Activities." Microfluidics and Nanofluidics 16(3): 541–51.

Muñoz-Sánchez, Belén et al. 2018. "Molten Salt-Based Nanofluids as Efficient Heat Transfer and Storage Materials at High Temperatures. An Overview of the Literature." Renewable and Sustainable Energy Reviews 82(February 2017): 3924–45.

Nagarajan, P. K., J. Subramani, S. Suyambazhahan, and Ravishankar Sathyamurthy. 2014. "Nanofluids for Solar Collector Applications: A Review." Energy Procedia 61: 2416–34.

Narayanan, Vishnu M., and S. G. Rakesh. 2019. "Analysis of Heat Transfer Characteristics of Nanofluid Synthesized Using Green Method." IOP Conference Series: Materials Science and Engineering 577(1).

Otanicar, Todd P. et al. 2010. "Nanofluid-Based Direct Absorption Solar Collector." Journal of Renewable and Sustainable Energy 2(3).

Reddy, K. S., Nikhilesh R. Kamnapure, and Shreekant Srivastava. 2017. "Nanofluid and Nanocomposite Applications in Solar Energy Conversion Systems for Performance Enhancement: A Review." International Journal of Low-Carbon Technologies 12(1): 1–23.

Said, Z., R. Saidur, N. A. Rahim, and M. A. Alim. 2014. "Analyses of Exergy Efficiency and Pumping Power for a Conventional Flat Plate Solar Collector Using SWCNTs Based Nanofluid." Energy and Buildings 78: 1–9.

Sheikholeslami, Mohsen. 2019. Application of Control Volume Based Finite Element Method (CVFEM) for Nanofluid Flow and Heat Transfer Various Application of Nanofluid for Heat Transfer Augmentation.

Shin, Donghyun, and Debjyoti Banerjee. 2010. "Effects of Silica Nanoparticles on Enhancing the Specific Heat Capacity of Carbonate Salt Eutectic (Work in Progress)." The International Journal of Structural Changes in Solids-Mechanics and Applications 2(November): 25–31.