Environmental Science and Pollution Research (2022) 29:10717–10728
https://doi.org/10.1007/s11356-021-16393-z

RESEARCH ARTICLE

Exploring the thermo-physical characteristic of novel multi-wall carbon nanotube—Therminol-55-based nanofluids for solar-thermal applications

Poongavanam GaneshKumar[1] · Duraiswamy Sakthivadivel[2] · Rajendran Prabakaran[1,3] · Shanmugarajan Vigneswaran[4] · Manivannan SakthiPriya[2] · Amrit Kumar Thakur[5] · Ravishankar Sathyamurthy[5] · Sung Chul Kim[1]

Received: 5 July 2021 / Accepted: 3 September 2021 / Published online: 15 September 2021

Abstract
This work aims to develop a novel nanofluid using Therminol-55 (T-55) as heat transfer fluid and multi-wall carbon nanotubes (MWCNTs) as dispersants with various volume concentrations of 0.05, 0.1, 0.3, and 0.5% and assess its thermo-physical properties for solar-thermal applications. The pH values of nanofluid MWCNT/T-55 with various particle loading were too far-flung from the pH (I) value, which confirmed the good dispersion stability of nanofluid. The measured density shows tremendous deviation from predicted density with increasing MWCNT loading owing to the non-considering of microstructural parameters in Pak & Cho correlation predication. The highest augmentation in nanofluid thermal conductivity was 16.83% for 0.5 vol. % MWCNT at 60 °C. The maximum improvement in dynamic viscosity of nanofluid with 0.5 vol. % of MWCNT is found to be 44%, and this rise is reduced at higher temperatures. The thermal effectiveness of the nanofluids demonstrates that nanofluid with all volume fractions of MWCNTs was favorable at higher temperatures in the laminar region. Mouromtseff number ratio decreases with a rise in temperature and MWCNT volume concentration. It is concluded that the excellent thermo-physical properties and prolonged thermal stability of the MWCNT will be highly beneficial in improving the overall performance of various kinds of heat transfer fluids (HTFs) for process heating and solar-thermal applications.

Keywords Therminol-55 · Thermal effectiveness · Thermal efficacy · Multi-wall carbon nanotubes · Thermal conductivity

Introduction

With increasing population and industrialization, there is a significant rise in energy demand, leading to tremendous exploitation of fossil fuel resources. Increasing usage of fossil fuels leads to high greenhouse gas emissions and severely affects the environment. Among various clean energies, solar energy is simple, cheapest, and abundantly available, which makes the usage of renewable energy highly reliable for a long period (Thakur et al. 2021a; Thakur et al. 2021b; Thakur et al. 2021c; Poongavanam et al. 2019). Solar energy can generate heat and produce power. In recent years with technological advantages, there is tremendous growth in solar-based applications, and solar-thermal technology is widely explored in numerous applications such as solar-based water treatment (Thakur et al. 2021d), solar water heaters, solar distillations (Thakur et al. 2018), refrigeration, air conditioning, and building heating. It is also imperative to know that solar-thermal technology possesses

Poongavanam Ganesh Kumar, and Sung Chul Kim contributed equally to this work.

Responsible Editor: Philippe Garrigues

✉ Ravishankar Sathyamurthy
raviannauniv23@gmail.com

1 School of Mechanical Engineering, Yeungnam University, Gyeongsan, Gyeongbuk 712-749, Republic of Korea

2 School of Mechanical Engineering, Vellore Institute of Technology, Tamil Nadu 632014 Vellore, India

3 Department of Mechanical Engineering, Kongu Engineering College, Tamil Nadu 638060 Erode, India

4 Department of Energy and Environmental Engineering, Saveetha School of Engineering, 602105 Chennai, India

5 Department of Mechanical Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamil Nadu 641407, India