Experimental investigation on stability, thermal conductivity and rheological properties of rGO/ethylene glycol based nanofluids

Syed Nadeem Abbas Shah[a,b], Syed Shahabuddin[c], Mohd Faizul Mohd Sabri[a], Mohd Faiz Mohd Salleh[d], Mohamad Azlin Ali[a], Nasir Hayat[b], Nor Azwadi Che Sidik[e], Mahendran Samykano[f], R. Saidur[g]

[a] Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

[b] Department of Mechanical Engineering (Main Campus Lahore), University of Engineering and Technology Lahore, 54890, Pakistan

[c] Department of Science, School of Technology, Pandit Deendayal Petroleum University, Knowledge Corridor, Raisan Village, Gandhinagar, 382007 Gujarat, India

[d] Department of Electrical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

[e] Malaysia – Japan International Institute of Technology (MJIIT), University Teknologi Malaysia Kuala Lumpur, Jalan Sultan Yahya Petra (Jalan Semarak), 54100 Kuala Lumpur, Malaysia

[f] Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

[g] Research Centre for Nano-Materials and Energy Technology (RCNMET), School of Science and Technology, Sunway University, 47500 Selangor Darul Ehsan, Malaysia

ABSTRACT

The present study reports stability, thermal conductivity and rheological properties of reduced graphene oxide (rGO)/ethylene glycol (EG) based nanofluids at three volume concentrations (0.02%, 0.04%, 0.05%). The properties of the prepared nanofluids were comprehensively characterised and analysed by employing different techniques such as field emission scanning electron microscopy (FESEM), particle size analyser, Zetasizer, UV–vis spectrometry, rheometer, thermal conductivity meter and a pH measurement system. The effect of various surfactants such as SDS, SDBS and CTAB at four volume concentrations (0.05%, 0.5%, 1%, 2%) on the thermo-physical properties of the nanofluid were investigated. The experimental analysis revealed that the concentration of rGO and surfactants has greatly influenced stability, particle size distribution, dynamic viscosity and the thermal conductivity of the nanofluids. In addition, the viscoelastic rheological analysis shows considerable yield stress due to the presence of the rGO which was subsequently improved by surfactant, whereas non-Newtonian flow prevails at a shear rate below 10 s^{-1} followed by Newtonian behaviour afterward. Besides, temperature sweep measurements within temperature range (25–70 °C) indicates that the viscosity decrease with temperature and improvement persists. Consequently, the results suggested that the surfactants improve the zeta potential but the average particle size of colloids also increases due to agglomeration. The optimum rGO/EG nanofluid (0.02% rGO with 1% SDBS) was selected based on maximum thermal conductivity enhancement (11.3%), high relative concentration (~83% after four days) and the reduction in viscosity (~14.4% less than ethylene glycol). However, anomalous reduction in dynamic viscosity up to 22% and an increase in thermal conductivity up to 11.3% propose the use of surfactant base nanofluids in potential engineering applications.

KEYWORDS
Nanofluids; Colloidal stability; Reduced graphene oxide; Rheology; Thermal conductivity

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