Eur. Phys. J. Special Topics 228, 2491–2494 (2019)
© EDP Sciences, Springer-Verlag GmbH Germany, part of Springer Nature, 2019
https://doi.org/10.1140/epjst/e2019-900227-2

THE EUROPEAN PHYSICAL JOURNAL SPECIAL TOPICS

Editorial

Transport properties of nanofluids and applications

Santo Banerjee[1,2,a] and B. Rushi Kumar[3]

[1] Institute for Mathematical Research, Universiti Putra Malaysia, Serdang, Malaysia
[2] Malaysia-Italy Centre of Excellence for Mathematical Science, Universiti Putra Malaysia, Serdang, Malaysia
[3] Department of Mathematics, School of Advanced Sciences, Vellore Institute of Technology, Vellore 632014, India

Received 18 October 2019
Published online 6 December 2019

Over the past few decades, several researchers have produced a variety of nanofluids that are used as heat transfer fluids in many engineering and technological processes. A nanofluid is a kind of heat transfer fluid, containing nanoparticles (1–100 nm) that are uniformly and stably distributed in a base fluid. Nanoparticles can be metallic/intermetallic compounds, such as Ag, Cu, Ni, Au, Fe, and ceramic compounds such as oxides, sulfides and carbides. Liquids such as water, ethylene glycol, a mixture of water and ethylene glycol, diethylene glycol, polyethylene glycol, engine oil, vegetable oil, paraffin, coconut oil, gear oil, kerosene, and pump oil are used as base fluids. A wide range of applications for nanofluids in different areas have been reported in the literature. These include biomedical applications, lubrication, surface coating, petroleum processing, environmental remediation, and cooling systems for electronics.

1 Thermal, electrical and optical properties of nanofluids

Heat transfer fluids are designed to provide precise temperature control in a variety of applications such as microelectronics, heat exchangers, coolant preparation, hydrocarbon processing, chemical processes, and food and beverage processing. Heat transfer fluids such as water, ethylene glycol, and pumping oil exhibit poor thermal conductivity. There are several methods to improve heat transfer efficiency. One of the methods is increasing the thermal conductivity of the working fluid. It is well known that liquids have lower thermal conductivity than solids. High thermal conductivity of solids can be used to increase the thermal conductivity of a fluid by adding small solid particles to that fluid. However, these suspensions with micrometer or larger size particles are still not efficient. Importantly, particles finer than 20 nm carry 20% of their atoms on their surface, making them instantaneously available for thermal interaction. Therefore, developing highly efficient heat transfer fluids to solve the drawbacks of conventional fluids has become one of the most important priorities in the cooling industries. In the last decade, nanofluids have gained significant attention due to their enhanced thermal properties. Thermal conductivity is the most

[a] e-mail: santoban@gmail.com

significant thermo-physical property of nanofluids, which must be studied in order to demonstrate the capability of nanofluids for heat transfer applications. Experimental studies have shown that the thermal conductivity of nanofluids depends on many factors such as particle volume fraction, particle material, particle size, particle shape, base fluid material, mixture combinations, slip mechanisms, and temperature. In order to select efficient nanofluids with optimal characteristics for cooling applications, not only thermal conductivity but also viscosity must be assessed. In addition, the specific heat capacity and density of the nanofluid should be analyzed to describe nanofluid heat transfer characteristics.

The automotive lighting industries are adopting compact cooling systems for high power light emitting diodes to overcome the heating issues in headlamps. Rammohan and Kumar [1] found that the junction temperature was reduced by 26% with the help of a nanofluid-based cooling system, and the light intensity improved by 30% when the nanocoolant was circulated at 0.3 m/s. The linear and weakly nonlinear stability of Rayleigh-Benard convection in a water-copper-alumina hybrid nanoliquid bounded by rigid isothermal boundaries was studied analytically by Kanchana et al. [2]. The study showed that, compared to a single nanoparticle, the combined influence of two nanoparticles is more effective on heat transfer. The percentage of heat transfer enhancement in water due to Al_2O_3-Cu hybrid nanoparticles is almost twice that of Al_2O_3 nanoparticles. It was found that convection in water with hybrid nanoparticles of Al_2O_3-Cu is more effective than mono nanoparticles of Al_2O_3. Basha et al. [3] reported the characteristics of nonlinear radiation and induced magnetic field on the forced convective Falkner-Skan flow of a Single-Walled Carbon NanoHorn(SWCNH)/diamond-ethylene glycol and water nanofluid over a wedge, plate, and stagnation point. Results showed that an SWCNH nanoparticle has higher heat transfer compared to a diamond nanoparticle. Increasing the nanoparticle volume fraction with the suspensions of SWCNH and diamond nanoparticles enhances the temperature over the wedge, plate and stagnation point. A theoretical study on the flow of Casson nanofluid past a linear stretching sheet in a non-Darcian porous medium, under the influence of an inclined magnetic field, was performed by Trivedi and Ansari [4]. Heat transfer characteristics along with Joule and viscous dissipation were analyzed by considering the effect of nonuniform heat source/sink and it was found that the inclination angle parameter increases the thickness of the thermal boundary layer. Ragupathi et al. [5] have presented the investigation of steady, three-dimensional flow of $H_2O/NaC_6H_9O_7$ base fluids with Fe_3O_4/Al_2O_3 nanoparticles past a Riga plate implanted in a non-Darcian porous medium with internal heat generation/absorption effects.

2 Computational and theoretical modeling of nanofluids

Talarposhti et al. [6] have analyzed the micropolar nanofluid flow between two pargallel plates in a rotating system. A numerical simulation for entropy generation due to magnetohydrodynamics (MHD) mixed convective flow of a water-copper nanofluid in a C-shaped cavity with a heated corner was performed by Mansour et al. [7] and the authors reported that the outcomes show better thermal performance at low volume fractions and Hartmann numbers. In general, the rate of entropy generation increases by increasing both the Hartmann number and the volume fraction. Kumaran et al. [8] numerically studied the two-dimensional incompressible, magnetohydrodynamic Falkner-Skan flow of a Carreau nanofluid over the wedge, plate and stagnation point of the flat plate with convective boundary conditions and chemical reactions. Results indicate that the influence of the magnetic parameter on velocity is high over the flat plate compared with the wedge and stagnation point of the flat plate. Heat transfer performance is higher on a shear-thinning fluid compared with a shear-thickening fluid. Furthermore, an increase in Brownian motion decreases the heat transfer rate but enhances the mass transfer rate. Renuka et al. [9] analyzed the nanofluid flow between two infinite rotating disks with the influence of homogeneous/heterogeneous reactions. The energy of the liquid is enhanced with an increasing value of thermophoresis parameter, and concentration is elevated for higher values of heterogeneous parameter. Heat transfer and fluid flow of a hybrid nanofluid into a horizontal rectangular porous channel were investigated numerically by Jarray et al. [10] and the authors reported that the flow is characterized by thermo-convective cells which are influenced by the variation of permeability and addition of hybrid nanoparticles into the base fluid. The heat transfer rate increases by increasing the permeability and the porosity of the porous medium. The heat transfer rate is also enhanced for certain nanoparticle volume fractions depending on the Darcy number. The effect of nanoparticles on the enhancement rate of heat transfer increases for higher values of Richardson and Darcy numbers.

3 Rheological and tribological properties of fluids

Elnaqeeb [11] theoretically studied Au nanoparticle-blood flow through a catheterized artery with multiple stenoses under a radial magnetic field effect. The results showed that Au nanoparticles enhance the blood flow through a stenosed artery, when a strong radial magnetic field is applied. Sucharitha et al. [12] studied the influence of wall properties and aligned magnetic fields on the peristaltic transport of a Jeffrey/Newtonian nanofluid in a tapered channel. The velocity and temperature are higher for a Newtonian fluid than a Jeffrey fluid, but the opposite trend is observed in the case of a concentration field. The large values of the magnetic parameter suppress the velocity and temperature fields, but the reverse trend is seen in the case of a concentration field. It was also observed that the inclination angle of a magnetic field and wall parameters have a significant effect on this investigation. Sebastian and Nagarani [13] examined the dispersion of a solute in a Casson fluid flow in an annulus subject to the flow unsteadiness due to the pulsatile pressure gradient and wall oscillations. Results indicate that both qualitative and quantitative changes are seen in mean concentrations in the case of wall movement compared with the case of no wall oscillations. Due to the combined action of wall oscillations and flow oscillations, the dispersion coefficient is observed to change cyclically, and took both positive and negative values, which differs from the case of no wall oscillations where the dispersion coefficient was seen to take only positive values. Mandi et al. [14] studied the damped forced modified Korteweg-de Vries equation in an unmagnetized collisional dusty plasma consisting of negatively charged dust grain, positively charged ions, q-nonextensive electrons, and neutral particles in the presence of external periodic force. The effects of different physical parameters such as the entropic index, dust ion collisional frequency, strength and frequency of the external periodic force, speed of the traveling wave, and the parameter which is the ratio between the unperturbed densities of the dust ions and electrons were investigated. It was observed that these parameters have significant effects on the structures of the damped forced dust ion acoustic solitary waves. The results of the present paper may have applications in laboratory and space plasma environments. The dynamics and complexity of a noise-induced blood flow system were investigated by Yan et al. [15]. Changes in the dynamics were recognized by measuring the fluctuation of periodicity over significant parameters. Numerical results showed a strong correlation between the dynamics and complexity of the noise-induced system.

We would like to express our sincere thanks to all the editorial members of the EPJST for their motivation and support. We also extend our profound thanks to all the authors for contributing their research articles which address the recent developments and research efforts on nanofluids with the purpose of providing guidelines for future research directions.

References

1. A. Rammohan, C.R. Kumar, Eur. Phys. J. Special Topics **228**, 2495 (2019)
2. C. Kanchana, P.G. Siddheshwar, Y. Zhao, Eur. Phys. J. Special Topics **228**, 2511 (2019)
3. H.T. Basha, R. Sivaraj, A.S. Reddy, A.J. Chamkha, Eur. Phys. J. Special Topics **228**, 2531 (2019)
4. M. Trivedi, M.S. Ansari, Eur. Phys. J. Special Topics **228**, 2553 (2019)
5. P. Ragupathi, A.K. Abdul Hakeem, S. Saranya, B. Ganga, Eur. Phys. J. Special Topics **228**, 2571 (2019)
6. R.A. Talarposhti, Z. Asadi, H. Rezazadeh, D.D. Ganji, A. Bekir, Eur. Phys. J. Special Topics **228**, 2601 (2019)
7. M.A. Mansour, T. Armaghani, A.J. Chamkha, A.M. Rashad, Eur. Phys. J. Special Topics **228**, 2619 (2019)
8. G. Kumaran, R. Sivaraj, A.S. Reddy, B.R. Kumar, V.R. Prasad, Eur. Phys. J. Special Topics **228**, 2647 (2019)
9. A. Renuka, M. Muthtamilselvan, D.H. Doh, G.R. Cho, Eur. Phys. J. Special Topics **228**, 2661 (2019)
10. A. Jarray, Z. Mehrez , A.E. Cafsi, Eur. Phys. J. Special Topics **228**, 2677 (2019)
11. T. Elnaqeeb, Eur. Phys. J. Special Topics **228**, 2695 (2019)
12. G. Sucharitha, K. Vajravelu, P. Lakshminarayana, Eur. Phys. J. Special Topics **228**, 2713 (2019)
13. B.T. Sebastian, P. Nagarani, Eur. Phys. J. Special Topics **228**, 2729 (2019)
14. L. Mandi, K.K.Mondal, P. Chatterjee, Eur. Phys. J. Special Topics **228**, 2753 (2019)
15. B. Yan, S. Mukherjee, S. He, Eur. Phys. J. Special Topics **228**, 2769 (2019)