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Editorial

Special Issue on Nanofluids and Their Applications

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1. Introduction

Nanofluids can be considered as engineered colloidal suspensions of nanometer-sized particles in a base fluid of water, ethylene glycol, or oil. Such fluids are fundamentally characterized by Brownian agitation or diffusion, in which they can then overcome the settling motion of the so-called nanoparticles due to gravity. So long as the individual nanoparticles remain finely dispersed or the particle agglomerates remain small enough (usually <100 nanometers) in order to avoid large particle agglomerates from settling within the colloidal suspension, stable nanofluids are theoretically possible. Maintaining this small size is, however, the greatest challenge, since it is well understood that nanoparticles have a tendency to cluster or agglomerate when they come into contact with each other.

Nanofluids are extensively applied and utilized in a wide variety of engineering applications. For heat transfer processes, this has been primarily driven by the potential of developing fluids with significantly-increased conductive and convective heat transfer properties. Specific emphasis in boiling phenomena and absorption and conversion of radiation are some examples of the possible utilizations of nanofluids. Other non-heat transfer applications that have considered the use of nanofluids include emerging synthesis techniques, mass transport, optics, consumer goods, electronics, and surfaces and catalysts.

2. Current Advances in the Applications of Nanofluids

This special issue was developed to focus on the latest research on relevant topics, and more importantly, to address pertinent challenging issues in the utilization of nanofluids. There were 50 papers submitted to this special issue, and 17 papers were accepted. Revisiting the many contributions to the special issue, several key aspects of nanofluids are addressed.

H. M. Ali, H. Babr, T. R. Shah, M. U. Sajid, M. A. Qasim, and S. Javed [1] present a review on the preparation of TiO_2, which has a unique thermal property, to be dispersed in base fluid, resulting in the possible use of these types of nanofluids for heat transfer applications.

H. Khan, M. Haneef, Z. Shah, S. Islam, W. Khan, and S. Muhammad [2] have performed numerical simulations for the combined effect of magnetic and electric field and thermal radiations on the unsteady flow of Maxwell nanofluid. The physical significance of the problem was investigated by the sensitivity analysis of a range of dimensionless parameters, including the Nusselt, Sherwood, Prandtl, and Schmidt numbers, affecting the flow and thermal characteristics of the nanofluid.

F. Hassain, R. Ellahi, and A. Zaeshan [3] focused on the consideration of the base fluid containing nanosized-Hafnium particles in possible engineering applications for nozzle or diffuser types of injectors in automobiles, to improve performance and reduce fuel consumption.

S. Abu Bakar, N. M. Arigin, F. M. Ali, N. Bachok, R. Nazar, and I. Pop [4] studied the different groupings of a variety of nanoparticles comprising Cu, Al_2O_3, and TiO_2, which affect the mixed convection boundary layer flow with thermal radiation over a permeable vertical cylinder. Al_2O_3 and TiO_2 nanoparticles were found to separate the boundary layer more rapidly than Cu nanoparticles.

Y. Lv, Y. Ge, L. Wang, Z. Sun, Y. Zhou, M. Huang, C. Li, J. Yuan, and B. Qi [5] demonstrated the effects of different nanoparticles, including conductive Fe_3O_4, semi-conductive TiO_2, and insulating Al_2O_3 on the pre-breakdown and breakdown properties of transformer oil. Results attained indicated a clear and notable impact of the breakdown strength and streamer production characteristics of transformer oil by the different nanoparticle materials. The type of nanoparticle materials has a notable impact on breakdown strength and streamer propagation characteristics of transformer oil.

N. Najib, N. Bachok, N. M. Arifin, and F. M. Ali [6] developed a model to comprehensively study a stretching or shrinking sheet of nanofluid and carried out stability analysis of a steady stagnation-point flow under the influence of slip, Soret, and Duffor effects.

K. Raslan, S. Mohammadain, M. Abdel-wahed, and E. M. Abedel-aal [7] utilized a weak concentration micropolar nanofluid model to numerically investigate the cooling process of a moving surface. The presence of Cu nanoparticles in water was found to increase the rate of heat transfer for the non-Newtonian boundary layer when compared to Newtonian fluids.

S. N. A. Salleh, N. Bachok, N. M. Arifin, F. M. Ali, and I. Pop [8] predicted that the fluid flow and heat transfer analysis of a mixed convection boundary layer flow past a moving vertical thin needle in a nanofluid would consist of Cu nanoparticles. Effects of parameters, such as velocity ratio, mixed convection, nanoparticle volume fraction, and needle size, were parametrically studied.

Y. Li, Y. Paan and X. Zhao [9] measured and quantified the slip length of liquid-solid micro/nano fluid flow utilizing the atomic force microscopy. Such an approach allows a description of the drainage of thin liquid film between the particle and surface with realistic roughness.

R. Abhishek, A. A. Hamouda, and A. Ayoub [10] studied the adsorption of Silica nanoparticles being dispersed in different brines of chalk surfaces and their effect on fluid/rock interaction. The attained results demonstrated that a small amount of Silica nanoparticles can improve the performance of low salinity floods.

A. Jamaludin, R. Nazar, and I. Pop [11] performed a numerical study considering two types of nanofluids, Cu-water and Ag-water, for the problem of magnetohydrodynamic mixed convection flow of nanofluids over a permeable vertical stretching/shrinking sheet with slip conditions. It was revealed that Ag-water nanofluid displayed better enhancement for heat transfer when compared to that for Cu-water nanofluid.

X. Gu, V. Timchenko, G. H. Yeoh, L. Dombrovsky, and R. Taylor [12] investigated the plasmonic resonant absorption of gold nanorod clusters in the Near Infrared (NIR) wavelength. This study revealed that particle clustering of nanorods should be considered for possible hyperthermia treatments.

H. J. Kim and B. Jo [13] focused on the use of the nanofluid comprising the base fluid of a binary carbonate molten sate mixture and graphite nanoparticles for thermal energy storage application. It was observed that the specific heat of the nanofluid was significantly enhanced by the presence of the graphite nanoparticles.

F. Saba, N. Ahmed, U. Khan, A. Waheed, M. Rafiq, and S. T. Mohyud-Din [14] focused on the investigation of different shapes of Cu, Al_2O_3 nanoparticles, namely plaetelet, cylinder, and brick-shaped particles, affecting the flow and heat transfer characteristics of nanofluid in a rectangular channel. Platelet nanocomposites were found to provide a better heat transfer ability when compared to other shapes.

N. F. Dzulkifli, N. Bachok, N. A. Yacob, N. M. Arifin, and H. Rosali [15] performed a stability analysis of unsteady stagnation-point flow and heat transfer over a permeable exponential stretching or shrinking sheet via the nanofluid model proposed by Tiwari and Das [16], with the base fluid being water filled with three different nanoparticles of Cu, Al_2O_3, and TiO_2.

G. Sekrani and S. Poncet [17] reviewed the possible use of ethylene- and propylene-glycol based nanofluids for applications in various thermal systems. These nanofluids can be applied by lowering the freezing point to prevent ice formation, such as in refrigeration systems, or pushing beyond the boiling point, such as in radiators or heat exchangers.

A. Abidi. Z. Raizah, and J. Madiouli [18] carried out a three-dimensional numerical investigation to determine the effect of a uniform magnetic field on the heat and mass transfer and fluid flow in a cavity filled with a nanofluid of Al_2O_3 nanoparticles. Relevant parameters, such as Rayleigh number, Hartmann number, buoyancy ratio, volume fraction, and vortex viscosity on flow structure and heat were analyzed.

3. Future Advances in the Applications of Nanofluids

Although this special issue has been closed, more in-depth research in the applications of nanofluids is expected. Given the findings thus far, there remain many challenges to better understand the underlying mechanisms that lead to unprecedented thermal transport phenomena. Long-term physically and chemically stable nanofluids are required, and the anomalously high transport properties of nanofluids require immediate resolution.

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