

Editorial

Recent Advances in Multiphase Flows in Engineering

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Received 28 July 2021; Accepted 28 July 2021; Published 1 September 2021

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1. Introduction

Multiphase phase flows include the flow of matter in two or more than two thermodynamic phases and involve solid-gas flows, bubbly flows, and sprays. They pervaded practically every feature of human life, and enhanced comprehension of multiphase flows can play a significant role in ensuring three essential requirements of humans, for instance, sustainable food production, clean water, and clean air. The understanding of multiphase flows is beneficial to examine the key mechanisms of the natural environment and in man-made systems. Multiphase flows have numerous applications in nanotechnology, chemical process, energy, environmentally sustainable technologies, critical infrastructures, and biological and healthcare applications, i.e., pharmaceuticals, manufacturing processes, and design materials. Table 1 shows the various classifications of multiphase flows. The examples given in the table are intended only to show the reader an overview of the applications and different types of multiphase flows that appear in various biological, industrial, and diverse natural systems.

Considering the importance of multiphase flows in engineering, this Special Issue was introduced. In total, 17 papers were submitted to this Special Issue, and out of them, 12 were selected for publication.

2. Recent Advances in Multiphase Flows in Engineering

Alqahtani et al. [1] discussed the heat and mass transfer process through a wedge. The applications of the problems mainly occur in civil engineering. The effects of magnetic

field and cross-diffusion gradients are also taken into consideration. According to their results, they found that the Prandtl number diminishes the temperature profile. However, mass transport increases due to higher values of Soret number and the converse effects shown for Schmidt number.

Rashid et al. [2] studied gold nanoparticles suspended in the water-based nanofluid under heat transfer effects. They contemplated various forms of nanoparticles, including lamina, hexahedron, column, sphere, and tetrahedron. The mathematical formulation is performed via similarity transformations, and the homotopy analysis method was used to determine the solutions. According to the results, it is found that heat transfer is maximum for the lamina shape nanoparticles and the sphere shape nanoparticles show a considerable behavior in temperature profile as compared to other types of nanoparticles.

Chu et al. [3] studied the cross-flow in the streamwise direction towards a moving surface under viscous dissipation and magnetic effects. They further determined the stability analysis and presented dual solutions. They found that the velocities in the direction of streamwise in addition to cross-flow reduces in the upper branch solution; at the same time, a converse impact is observed for the lower branch solution. Furthermore, the impact of suction on the velocities uplifts the solutions in the upper branch and diminishes the solutions in the lower branch.

Han et al. [4] used the CFD-DEM coupling technique to set up the simulation model of two-phase flow through a drill pipe. They determined the impact of cutting removal on air velocity, the mass flow rate of cutting on the flow properties, the cutting removal impact, and the pressure

TABLE 1: Classification of multiphase flows.

	Gas-solid flows	Liquid-solid flows	Gas-liquid flows	Liquid-liquid flows	Gas-solid flows
Natural	Sand storms, volcanoes, and avalanches	Sediment transport of sand in rivers and sea, soil erosion, mud slides, debris flows, and iceberg formation	Rain droplets, ocean waves, and mist formation	—	—
Biological	Aerosols (dust particles) and smoke (fine soot particles)	Blood flow	Aerosols (liquid droplets)	—	—
Industrial	Pneumatic conveyers, dust collectors, fluidized beds, and solid propellant Rockets, pulverized solid particles, spray drying, and spray casting	Slurry transportation, flotation, fluidized beds, water jet cutting, and sewage treatment plants	Boiling water and pressurized water nuclear reactors, chemical reactor desalination systems, boilers, heat exchangers, internal combustion engines, liquid propellant rockets, and fire sprinkler suppression systems	Emulsifiers, fuel-cell systems, microchannel applications, and extraction systems	Air lift pumps and fluidized beds

drop of cutting-gas-two-phase flow. According to their analysis, they found that the drag force of drilling cuttings becomes higher with an increment in air velocity. When the mass flow rate of cutting is constant, it enhances the air velocity for cutting removal and tends to enhance the pressure drop in the inner hole of the drill pipe. On the contrary, when the air velocity of cutting removal is constant, then the mass flow rate of cutting and the pressure drop in the inner hole of the drill pipe rises.

Gonzalez-Trejo et al. [5] studied fluid dynamics within a pair of submerged entry nozzle models with a square cross-section bore. They contemplated water as a working fluid with the Froude similarity criterion. The proposed model comprises a square-shaped tube having one inlet and two lateral squared exits at the bottom; however, the model does not have exit ports. The proposed turbulence model is presented as a large eddy simulation having dynamics k -equation filtering. According to the results, it is found that with one large vortex, the flow pattern within the pool nozzle can be defined, whereas, in the nozzle without the pool, the flow pattern depicts a complex mechanism distinguished by two small vortexes.

Yousaf et al. [6] presented a novel method known as the cubic trigonometric B-spline technique based on the Hermite formula. They used this method to solve the convection-diffusion equation. They found that the main benefit of this scheme is that the approximate solution is obtained as a smooth piecewise continuous function, which enables us to determine the approximate solution at any point in the location with higher accuracy.

Basit et al. [7] examined heat transfer with forced convection from arrays of prolate particles is formulated by employing the second-order immersed boundary Lattice Boltzmann technique. They found that Reynolds number and solid volume fraction significantly enhanced the Nusselt number and Hermans orientation factor. Furthermore, they noticed that the impact of orientation on Nusselt number is remarkable.

Irfan et al. [8] examined the theoretical impact of magnetized stagnation point flow on heat and mass transfer towards a shrinking and stretching porous surface. Furthermore, they elaborated the behavior of chemical reaction, thermal radiation, swimming of gyrotactic microorganisms, and heat source/sink. MATLAB software has been used to examine the solutions using the *bvp4c* command. They concluded that the skin friction coefficient increases due to an increment in porosity and magnetic parameters. Moreover, they discussed that the Peclet number and Lewis number enhanced the motile microorganism profile.

Arain et al. [9] studied bioconvection flow with nanoparticles under the presence of an induced magnetic field. They have contemplated Carreau fluid which is moving between a pair of rotating circular plates. Furthermore, they used the DTM-Pade approximation to determine the numerical solutions. They also discussed the effects of shear-thinning, shear-thickening, and Newtonian fluid models as a special case of the proposed study.

Song et al. [10] presented a design and implementation of the array logging tool for horizontal production logging. The proposed project has designed a staggered probe array flow meter well logging apparatus based on the characteristic of electromagnetic wave specific retention meter that can fully cover the wellbore fluid and improve the flow measurement accuracy. According to the application in horizontal wells, the accuracy of this measuring instrument has been proved to be more than 90%. It can meet the requirements of production logging interpretation in horizontal wells.

Farooq et al. [11] employed a simplified finite difference technique to examine the nanofluid mechanism through an exponentially stretching surface under the effects of thermal radiation. They discussed the efficiency of the proposed scheme by comparing the results with other similar methods. Their outcomes found that the Eckert number enhanced the velocity profile; however, the thermal Grashof number opposes the temperature profile.

Riaz et al. [12] discussed the entropy mechanism of a three-dimensional wavy flow using Eyring–Powell nanofluid. Mathematical and physical modeling is performed based on the lubrication approach. Furthermore, they used the homotopy perturbation approach to solve the coupled nonlinear differential equations. They showed that entropy generation reduces due to concentration parameters but upsurges due to viscous dissipation. Moreover, it is presented that Eyring–Powell depicts the difference in behavior in the entropy generation and the presence of nanoparticles due to the significant dissipation effects. In addition, it travels faster than the viscous fluid. This study may be helpful for cancer therapy in biomedicine by nanofluid properties in multiple drugs contemplated as a non-Newtonian fluid.

Conflicts of Interest

The editors declare that there are no conflicts of interest.

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