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Editorial

Mathematical Modeling of Heat and Mass Transfer in Energy Science and Engineering

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Technologically advanced societies have become increasingly dependent on external energy sources for transportation, the production of many manufactured goods, and the delivery of energy services. This energy allows people who can afford the cost to live under otherwise unfavorable climatic conditions through the use of heating, ventilation, and/or air conditioning. Level of use of external energy sources differs across societies, as do the climate, convenience, levels of traffic congestion, pollution, and availability of domestic energy sources.

The idea of this special issue of is to consider the study and applications of mathematical modeling method on energy science and technology. For example, the Polymer Electrolyte Membrane Fuel Cells (PEMFC) modeling has become standard module of some commercial software; the US Green Building Council's Leadership in Energy and Environmental Design Rating System (LEED) requires energy modeling to assess the energy use of a building and to quantify the savings attributable to the proposed design; Advanced Modeling and Simulation program was used to improve the reliability, sustain the safety, and extend the life of current reactors.

The modeling and simulation in Energy Science and Engineering is a significant topic. This special issue contains 14 papers, the contents of which are summarized as follows.

In "*Research on performance of H_2 rich blowout limit in bluff-body burner*" by H. Zheng et al., a CFD software FLUENT was used to simulate H_2 burning flow field in bluff-body burner, and the software CHEMKIN was adopted to analyze the sensitivity of each elementary reaction. Composition Probability Density Function (C-PDF) model was adopted to simulate H_2 combustion field in turbulence flame.

In "*A numerical study on the supersonic steam ejector use in steam turbine system*" by L. Cai and M. He, the Computational Fluids Dynamics (CFD) method was employed to simulate a supersonic steam ejector, and SST k-ω turbulence model was adopted, and both real gas model and ideal gas model for fluid property were considered and compared. The mixing chamber angle, throat length, and nozzle exit position (NXP) primary pressure and temperature effects on entrainment ratio were investigated.

In "*Numerical simulation and stability study of natural convection in an inclined rectangular cavity*" by H. S. Dou et al., the process of instability of natural convection in an inclined cavity based on numerical simulations is examined. The energy gradient method is employed to analyze the physics of the flow instability in natural convection. It is found that the maximum value of the energy gradient function in the flow field correlates well with the location where flow instability occurs. Meanwhile, the effects of the flow time, the plate length, and the inclination angle on the instability have also been discussed.

In "*Mathematical modeling of double-skin facade in northern area of China*" by Z. Huifen et al., this paper focuses on the operation principles of the double-skin facade (DSF) in winter of severe cold area. The paper discussed the main influence factors of building energy consumption, including the heat storage cavity spacing, the air circulation mode, the building envelope, and the building orientation.

In "*A numerical study on premixed bluff body flame of different bluff apex angle*" by G. Yang et al., in order to investigate effects of apex angle (α) on chemically reacting turbulent flow and thermal fields in a channel with a bluff body V-gutter flame holder, a numerical study has been carried out in this paper. With a basic geometry used in a previous experimental study, the apex angle varied from 45° to 150°. Eddy dissipation concept (EDC) combustion model was used for air and propane premixed flame. LES-Smagorinsky model was selected for turbulence. The gird-dependent learning and numerical model verification were done. Both nonreactive and reactive conditions were analyzed and compared.

In "*Cortex effect on vacuum drying process of porous medium*" by Z. Zhang et al., based on the theory of heat and mass transfer, a coupled model for the porous medium vacuum drying process with cortex effect is constructed. The model is implemented and solved using COMSOL software. The water evaporation rate is determined using a nonequilibrium method with the rate constant parameter K_r that has been studied. The effects of different vapor pressures, initial moisture contents, drying temperatures, and intrinsic permeability for cortex part on vacuum drying process were studied.

In "*Analytical solutions for steady heat transfer in longitudinal fins with temperature-dependent properties*" by P. L. Ndlovu and R. J. Moitsheki, explicit analytical expressions for the temperature profile, fin efficiency, and heat flux in a longitudinal fin are derived. Here, thermal conductivity and heat transfer coefficient depend on the temperature. The differential transform method (DTM) is employed to construct the analytical (series) solutions. Thermal conductivity is considered to be given by the power law in one case and by the linear function of temperature in the other, whereas heat transfer coefficient is only given by the power law.

In "*Heat and mass transfer with free convection MHD flow past a vertical plate embedded in a porous medium*" by F. Ali et al., an analysis to investigate the combined effects of heat and mass transfer on free convection unsteady magnetohydrodynamic (MHD) flow of viscous fluid embedded in a porous medium is presented. The flow in the fluid is induced due to uniform motion of the plate. The dimensionless coupled linear partial differential equations are solved by using Laplace transform method. The solutions that have been obtained are expressed in simple forms in terms of elementary function and complementary error function.

In "*Research on three-dimensional unsteady turbulent flow in multistage centrifugal pump and performance prediction based on CFD*" by Z. J. Wang et al., the three-dimensional flow physical model of any stage of the 20BZ4 multistage centrifugal pump is built which includes inlet region, impeller flow region, guide-vane flow region, and exit region. The three-dimensional unsteady turbulent flow numerical model is created based on Navier-Stoke solver and standard k-ε turbulent equations. The method of multireference frame (MRF) and SIMPLE algorithm are used to simulate the flow in multistage centrifugal pump based on FLUENT software. The distributions of relative velocity, absolute velocity, static pressure, and total pressure in guide vanes and impellers under design condition are analyzed.

In "*Numerical simulation of air inlet conditions influence on the establishment of MILD combustion in stagnation point reverse flow combustor*" by X. Liu and H. Zheng, this paper presents a numerical study of the nonpremixed stagnation point reverse flow (SPRF) combustor, especially focusing on the influence of air inlet conditions. Modified eddy dissipation concept (EDC) with a reduced mechanism was used to calculate the characteristic of MILD combustion.

In "*3D model-based simulation analysis of energy consumption in hot air drying of corn kernels*" by S. Zhang et al., to determine the mechanism of energy consumption in hot air drying, it simulates the interior heat and mass transfer processes that occur during the hot air drying for a single corn grain. The simulations are based on a 3D solid model. The 3D real body model is obtained by scanning the corn kernels with a high-precision medical CT machine. The Fourier heat conduction equation, the Fick diffusion equation, the heat transfer coefficient, and the mass diffusion coefficient are chosen as the governing equations of the theoretical dry model. The calculation software, COMSOL Multiphysics, is used to complete the simulation calculation. The influence of air temperature and velocity on the heat and mass transfer processes is discussed.

In "*The instability of an electrohydrodynamic viscous liquid micro-cylinder buried in a porous medium: effect of thermosolutal marangoni convection*" by G. M. Moatimid, and M. Hassan, the electrohydrodynamic (EHD) thermosolutal Marangoni convection of viscous liquid, in the presence of an axial electric field through a micro cylindrical porous flow, is considered. It is assumed that the surface tension varies linearly with both temperature and concentration. The instability of the interface is investigated for the free surface of the fluid. The expression of the free surface function is derived taking into account the independence of the surface tension on the heat and mass transfer. The transcendental dispersion relation is obtained considering the dependence of the surface tension on the heat and mass transfer. Numerical estimations for the roots of the transcendental dispersion relation are obtained indicating the relation between the disturbance growth rate and the variation of the wave number.

In "*A linear stability analysis of thermal convection in a fluid layer with simultaneous rotation and magnetic field acting in different directions*" by R. Avila and A. Cabello, it uses the Tau Chebyshev spectral method to calculate the value of the critical parameters (wave number and Rayleigh number at the onset of convection) as a function of (i) different kinds of boundaries, (ii) angle between the three vectors, and (iii) different values of the Taylor number T (rate of rotation) and magnetic parameter Q (strength of the magnetic force). For the classical problems previously reported in the literature, it compares our calculations with Chandrasekhar's variational method results and shows that the present method is applicable.

In "*Estimation of wellbore and formation temperatures during the drilling process under lost circulation conditions*" by M. Yang et al., based on energy exchange mechanisms of wellbore and formation systems during circulation and shut-in stages under lost circulation conditions, a set of partial differential equations were developed to account for the transient heat exchange process between wellbore and formation. A finite difference method was used to solve the transient heat transfer models, which enables the wellbore and formation temperature profiles to be accurately predicted. Moreover, heat exchange generated by heat convection due to circulation losses to the rock surrounding a well was also considered in the mathematical model.

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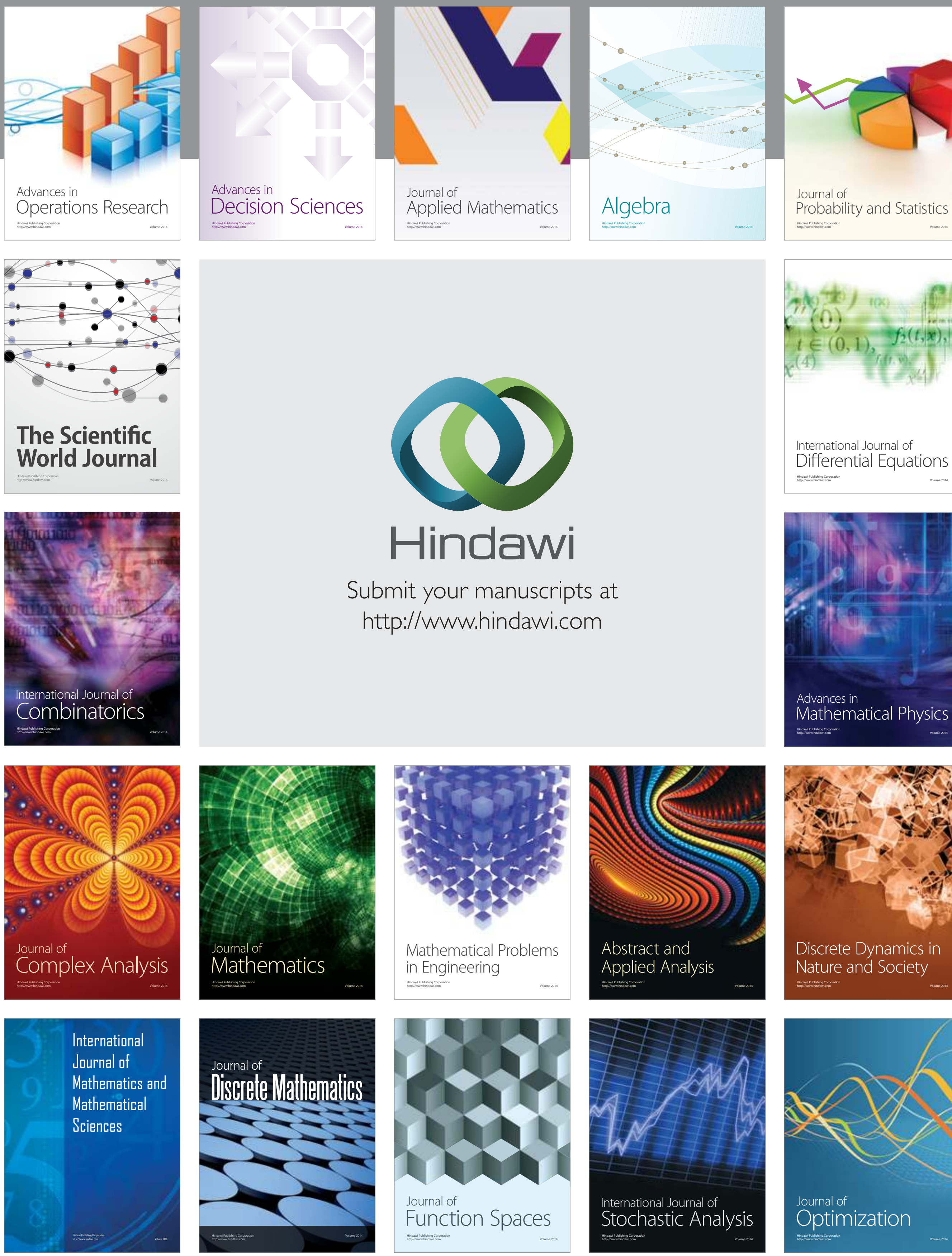
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