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Guest Editorial

Recent Advances in Porous Media Transport

This special issue of *Journal of Heat Transfer* focuses on the recent advances in Porous Media Transport as related to applications in industry and biology. Transport phenomena through porous media have been the subject of various studies due to the wide range of applicability of these research areas in contemporary technology, for example, biological, electronics cooling, thermal insulation engineering, geothermal and environmental engineering, heat pipes, underground spreading of chemical waste, nuclear waste repository, grain storage and enhanced recovery of petroleum reservoirs. This interest is further driven by practical applications that can be modeled as transport through porous media such as packed bed heat exchangers, drying technology, catalytic reactors, petroleum industries, geothermal systems, tissue engineering, drug delivery, and advanced medical imaging as related to brain stroke.

The Porous Media theory has been involved in cutting-edge basic and applied research in Thermal and Fluid sciences, with a particular emphasis in developing systems that are compact in size and volume. Some examples include electronics and avionics, heat pipes, miniature refrigerators, nanoparticles added to dielectric coolants for enhanced heat transfer in nanofluids, microtextured surfaces for enhanced boiling, base stations in cellular communications, power electronics, automotive electronics, wearable electronics, etc. In the area of natural and forced convection, forced convection in a parallel plate channel occupied by a layered saturated porous medium with laminar pulsating flow is analyzed analytically in this issue. It is found from this study that the fluctuating part of the Nusselt number changes in magnitude and phase as the dimensionless frequency increases. An alternative way of modeling form-drag in a porous medium saturated by a power-law fluid is also discussed in this issue. In the area of phase change flow, a simple semi-theoretical method for calculating two-phase frictional pressure gradient in porous media is presented. The proposed model can be transformed into either a two-phase frictional multiplier for liquid flowing alone or two-phase frictional multiplier for gas flowing alone as a function of the Lockhart–Martinelli parameter. Another investigation includes the use of a nano- and micro-porous surface layer to enhance boiling heat transfer mechanism in a plate heat exchanger. The plate heat exchanger with the enhancement structure appears to have displayed a substantially enhanced heat transfer coefficient in the refrigerant channel. In an associated study, the topology and geometry of microstructures, which play a significant role in determining the heat transfer, performance in passive cooling devices such as heat pipes has been studied. Hexagonally packed spheres on a surface are identified to be the most efficient microstructure geometry for wicking and thin-film evaporation.

Porous media modeling has been applied in many biomedical applications. Examples include macromolecular transport in arterial walls, biofilms, characterization of heat transport through biological media, drug delivery, hyperthermia treatment, tissue replacement production, diffusion-weighted magnetic resonance imaging, biodegradable porous drug delivery devices, porous scaffolds for tissue engineering, polymerase chain reaction nucleic acid amplification applications, computational biology, and advanced medical imaging. The onset of electrothermoconvection in a dielectric porous medium, which is favorable for the design of artificial organs, and the onset of thermo-magnetic convection in a ferrofluid porous medium are covered in this issue. Decrease in magnetic field as well as Darcy number is found to delay the onset of ferrconvection. The application of porous media in a human lung is also addressed here. A porous media approach is proposed to investigate the bifurcating airflow and mass transfer within a lung.

In the geological applications, water coning is a serious problem encountered in active bottom-water drive reservoirs. A depletion strategy is developed in this issue for an active bottom-water drive reservoir to improve oil recovery and to reduce water production due to coning. In a related study, porous medium's geological model is developed to model fluid flow and energy transport in a large-scale porous medium such as oil and geothermal reservoirs. In another study, dual-permeability modeling of capillary diversion and drift shadow effects in unsaturated fractural rock is analyzed numerically. The drift-shadow effects describe capillary diversion of water flow around a drift or cavity in porous or fractured rock resulting in lower water flux directly beneath the cavity.

In this issue we cite Professor Adrian Bejan's accomplishments in the porous media area on the occasion of his 60th birthday. Adrian has worked in the field of designed porous media more recently as a branch of constructal theory and design, which he exudes. He introduced convection in porous media for the first time as a chapter in a course on convective heat transfer (in the book *Convection Heat Transfer*, Wiley, 1984, 1995, 2004). Adrian Bejan's contributions are best summarized by his methods of fundamental research on transport in porous media (e.g., scale analysis, constructal design of porous media, heatlines and masslines, intersection of asymptotes), and his books, *Convection in Porous Media* which is the most cited book in the field, and *Porous and Complex Flow Structures in Modern Technologies*, both published by Springer.

In conclusion, I would like to thank many reviewers that had helped us a lot with their careful and detailed critical reviews of the papers that were considered in this issue. I am thankful for all their helpful comments in improving the quality of the presentations in this issue.

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