Preface

Novelties and frontiers in porous media: special focus on analyticalmodels (part one)

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PREFACE: NOVELTIES AND FRONTIERS IN POROUS MEDIA: SPECIAL FOCUS ON ANALYTICAL MODELS (PART ONE)

1. INTRODUCTION

Analytical and semianalytical studies serve a wide range of research fields and industries with ease and rapidity in calculations. As compared to numerical and experimental methods, analytical methods require much less effort from the end-user side and can be implemented easily and efficiently. Moreover, conferring fast response time to crucial systems with respect to the external condition is vital in many applications, such as biomedical nanosensors, photonic integrated circuits, flexible electronics, etc. In short, their inherent simplicity and prompt solutions with an acceptable precision make the analytical models attractive, demanding, and applicable. In this field, one of the most important references is the *Handbook of Porous Media* by Vafai (2015), which covers a wide area of research, from recent studies related to current and future challenges and advances in fundamental aspects of porous media, viscous dissipation, as well as forced and double diffusive convection in porous media. It should be noted that the foundation of analytical studies is the development of accurate models capable of describing the thermohydrodynamics characteristics of the system. Without a precise model, the analytical solution has zero added value. For porous media, two outstanding studies of Vafai (Vafai and Tien, 1981; Vafai, 1984) have addressed the effects of important factors, namely, solid boundaries, variable porosity, and inertial forces on convective flow and heat transfer.

In this special issue, we aim to present a wide range of analytical and theoretical studies addressing problems related to porous materials in different engineering fields such as biomedicine, chemical engineering, mechanical engineering, etc. The modularity of analytical/computational approaches and the superiority of each noted approach in several research fields is also investigated. Although numerous studies have been dedicated to the numerical modeling (Sheikhnejad et al., 2015a,b, 2017a, 2019; Nejad et al., 2018) and experimental tests of porous materials (Vafai et al., 1985; Sheikhnejad et al., 2017b), analytical analyses can provide fast yet accurate results for researchers as well as industrial end-users. The submitted manuscripts for this special issue address an innovative analytical or semianalytical model for predicting different thermohydrodynamic, physical, mechanical, and manufacturing characteristics of porous media under various conditions. The analytical models are not only useful for fast calculations and estimations by the end-user, but they also offer new computational techniques to make use of such advantages, as the simplicity of the core model is an essential requirement in reaching the best results with the lowest time and cost requirements (Hedayati et al., 2019; Ghavidelnia et al., 2021). Ideally, such core models can be analytical rather than time-consuming iterative and expensive computational algorithms (Sheikhnejad et al., 2017c; Anusha et al., 2021).

2. RESEARCH WORKS

Among the published papers in this special issue, Maaoui et al. (2022) investigated the detection of water content in porous materials (soils, buildings, etc.) using dielectric measurements. In order to overcome the complexity of classical analytical models, the artificial neural network (ANN) method is adopted to extract the value of the volumetric water content in a soil sample from the sensitivity of the refractive index. Also, Khemili and Najjari (2022) developed a one-dimensional theoretical model based on an analytical solution of liquid water saturation and oxygen flow in the porous gas diffusion layer (GDL) of a proton exchange membrane fuel cell. They showed that the wetting characteristics of the GDL, the current density, and the porosity have a significant effect on the liquid water saturation and the performance of the PEM fuel cell. The steady-state performance of micropolar fluid lubricated single-layered and double-layered porous journal bearings (PJBs) was investigated by Bhattacharjee et al. (2022). They showed that using an ultrafine powder layer with low permeability enhances performance characteristics (i.e., enhanced load, stiffness coefficient,

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and decreased friction) as compared to a single-layered porous journal bearing with only a coarse layer. The presence of an ultrafine porous layer inside the double-layered PJB improves the capacity to store more lubricant, in contrast with single-layered PJBs.

Moreover, examples of porous media can be found in a wide range of applications, including heterogeneous composite reservoirs in which different rock compartments indicate different permeability properties. In these ultralow-permeability compartments, non-Darcy flow with a threshold pressure gradient happens which introduces a nonlinear motion boundary problem. Liu et al. (2022) applied Duhamel's principle in these compartments, where Darcy flow serves as a key procedure to analytically solve the model, and presented the deviation degree of the transient pressure curve. In another study, Ghasemi and Gouran (2022) investigated the impact of solar radiation and flow analysis for a thin liquid film on an unstable stretching sheet surrounded by a porous setting by an optimal homotopy asymptotic scheme and differential quadrature method. The last but not least work is a research study on the determination of heat transfer performance and flow characteristics of a hybrid nanofluid between two parallel disks. The squeezing aspects of the hybrid nanofluid as well as impacts of thermal radiation and suction/injection were investigated by Agrawal and Kaswan (2022) when the plates shift apart and come together.

3. SUMMARY

This special issue aimed to contribute to the novelties and frontiers in porous media with a special focus on analytical models and their comparison with numerical and experimental approaches. The published papers included within this special issue help engineers and programmers to keep the models of real apparatus as simple and accurate as possible and illustrate the broad and varied applications of porous media. To conclude, we would like to thank all the contributing authors, the respected reviewers and editors, and the Editorial Office of the *Journal of Porous Media*.

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