Preface

Novelties and frontiers in porous media: special focus on analytical models (part two)

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

1. INTRODUCTION

Analytical models have always been in the center of researchers' interests due to their outstanding features, especially for the engineering world where swift effortless computation is considered highly beneficial. Since they are not required to wait for time-consuming iterative methods to be converged, as to the boldest trait of numerical models, they could provide rapid answers. Also, as they naturally include most of the involved parameters, they are considered as inclusive models. Analytical and semi-analytical models play an important role in sophisticated systems such as enormous applications that consist of heat and mass transfer through complicated geometry of porous media. The other area where permeable porous media are of great advantage is where high mechanical properties with low weight are required. This special issue targets a broad span of analytical and theoretical research works associated with engineering problems requiring porous materials including, but not limited to, the applications encompassing mechanical engineering, chemical engineering, biomedicine, and other applications. With this objective, reviewing the literature will show us some distinguished works.

The organized and comprehensive Handbook of Porous Media by Vafai (2015) has well covered the wide range of its characteristics based on analytical models. Moreover, the influence of key factors such as inertial forces and different boundary's conditions, as well as variable porosity on convective flow through porous media, was well established in Vafai (1984) and Vafai et al. (1981).

Porous media has proven itself as a potent solution for the heat transfer enhancement (Nejad et al., 2018; Sheikhnejad et al., 2017, 2019), high specific mechanical properties (Ghavidelnia et al., 2021; Hedayati et al., 2018), and energy absorption improvement (Reza Hedayati et al., 2011). Among several other applications, some researchers have investigated the behavior of porous structures under magnetic fields (Anusha et al., 2021) and with non-Newtonian fluid (Vishalakshi et al., 2022), while still many more applications are remained to be investigated.

The overall objective of this special issue is to provide analytical and semi-analytical models for behaviour of fluid passing through porous media under various external effects, as well as the mechanical and physical properties of porous structures. The analytical models have several advantages over experimental works including fast calculations, easy implementation in computational packages, and being more cost-effective.

2. RESEARCH WORKS

Among the published papers in this special issue, Shyamala et al. (2022) addresses the steady axisymmetric Stokes flow of couple-stress fluid through a porous sphere while parameters such as kinematic viscosity of mutual non-penetrability, continuity of tangential stress and velocity, and vanishing couple stress conditions are applied on the surface of the porous sphere. They present expressions for the velocity and couple stress tensor components in terms of Macdonald functions and Gagenbauer's polynomials. Also, Anurag et al. (2022) studies transient, fully-developed free convection flow in a vertical concentric cylinder occupied with a porous medium by finite Hankel transform technique; the results are expressed in terms of velocity, temperature, mass flow rate, skin friction, and Nusselt number. They conclude that increasing the Prandtl number will cause deceleration of the velocity and temperature profiles. Padmaja and Kumar (2022) investigate the steady-state incompressible Al_2O_3–H_2O nanofluid flow passed through a semi-infinite porous plate considering the impacts of a magnetic field, as well as a first-order chemical reaction under ohmic heating, thermal buoyancy, and concentration buoyancy effects. They conclude that the concentration of the nanofluid gradually subsides as the number of solute molecules involved in the fluid drop for higher values of chemical reaction parameter and the Schmidt number. Also, the local rate of mass transfer determined by the Sherwood number increases for higher values of the Schmidt number. In another work, Haq et al. (2022) investigate an unsteady magnetohydrodynamic flow of viscous fluid over an infinite perpendicular inclined plate embedded in a permeable mechanism subjected to heat absorption/generation chemical diffusivity under the assumption of the slip wall condition at boundary. Finally, Nagaraju et al. (2022) perform laminar boundary layer analysis to examine the diffusion of an incompressible, chemically reactive, constant density micro-polar liquid flow which is induced by a porous stretching/shrinking sheet which goes through one-stage homogeneous reaction as it diffuses into the vicinity of the liquid. The constituent of highly non-linear, partial differential in nature are mapped via a similarity transformation into a set of non-linear ODEs and are then solved analytically. The prescribed surface concentration and prescribed concentration flux cases were studied for chemically-reactive species and the exact solution of mass transfer characteristics was obtained in terms of the incomplete gamma function. They observed that the micro-polar liquids help in the decrease of drag forces and act as cooling agents.

3. SUMMARY

This special issue presents up-to-date studies on porous media with a special focus on analytical models and their capability in reconstructing numerical and experimental results. The published papers included within this special issue provide analytical and semi-analytical models for a wide range of problems including micro-polar liquid flow induced by stretching/shrinking sheet, unsteady magnetohydrodynamic flow, incompressible nanofluid flow under the effect of ohmic heating and magnetic field, free convection flow, and axisymmetric Stokes flow of couple-stress fluid. We would like to thank all the authors, reviewers, and editors for their valuable contribution to this special issue. We are also grateful for the continuous support by the Editorial Office of the *Journal of Porous Media*.

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