Mathematical Modelling of Flow Through Porous Media


Proceedings of the 11th WSEAS Int. Conf. on MATHEMATICAL METHODS, COMPUTATIONAL TECHNIQUES AND INTELLIGENT SYSTEMS

On the Micropolar Fluid Flow through Porous Media

M.T. KAMEL[1], D. ROACH[2], M.H. HAMDAN[3]
[1,3] Department of Mathematical Sciences
[2] Department of Engineering
University of New Brunswick
P.O. Box 5050, Saint John, New Brunswick, E2L 4L5
CANADA
kamel@unb.ca , hamdan@unb.ca , droach@unb.ca

Abstract:- Field equations governing the steady flow of an incompressible micro-polar fluid through isotropic porous sediments are derived using intrinsic volume averaging. The model equations might be of applicability to the study of lubrication problems in configurations involving porous linings, and to the study of polymer and oil flow through porous structures.

Key-Words:- Micropolar Fluid, Porous Media, Intrinsic Volume Averaging

1 Introduction

Theory of micro-polar fluids was introduced by Eringen [5] in an attempt to model the flow of non-Newtonian fluids exhibiting microscopic effects that arise from the micro-rotational motion and spin inertia which enable them to support couple stress and body couples. Over the last four decades, the theory has been applied to the study of various physical and biological applications, including lubrication, the flow of blood in animal tissues, heat transfer, and boundary layer analysis, (cf. [1], [6], [9], [10], [13], [14]). More recently, there has been a renewed interest in application of micro-polar fluid flow through micro-channels [11]. This has been motivated in part by the need to design micro-fluidic devices involving micro-channels with small dimensions [11].

For these and many other applications, together with a more complete literature survey, one is referred to the work of Lukaszewicz [12].

The motion of a micro-polar fluid in free-space is described by a rigid-motion velocity vector and a micro-rotation velocity vector that accounts for the spin of fluid elements, in a given volume element, about the centroid of the volume element. In the absence of energy and heat transfer effects, the usual governing equations are composed of the conservation of mass equation, and a set of coupled linear and angular momentum equations. Solution to the governing equations in enclosures or in the presence of solid boundaries requires imposing appropriate boundary conditions. Typical of these is the usual no-slip flow condition of a viscous fluid and the assumption of no-spin there on geometrically-described solid boundary. This situation becomes formidable when the micro-polar fluid flows through a porous structure, due to the complexity of the pore geometry and the absence of a mathematical description of the solid matrix.

In order to circumvent this, we attempt to develop a set of field equations governing the flow of a micro-polar fluid through an isotropic porous structure using the method of intrinsic volume averaging. This procedure has gained popularity since the introduction of averaging theorems, (cf. [2], [3], [4] and the references therein), and has been successfully implemented in deriving various models of flow through porous media.

The models developed in this work might find applications in the study of high density and high viscosity polymers and oils in porous configurations, and in the study of lubrication problems in configurations possessing porous linings.

2 Governing Equations

The flow of a micro-polar fluid in free space is governed by the equation of continuity, the linear momentum equation, and the angular momentum equation [5]. When the fluid is incompressible, and body forces and body couple are absent, the equations governing steady-state flow can be written in the following form:

ISSN: 1790-2769 190 ISBN: 978-960-474-094-9

Alain P. Bourgeat, Claude Carasso, Stephan Luckhaus, and Andro Mikelic ( ) Mathematical Modelling of Flow Through Porous Media Proceedings of the.Mathematical Modelling of Flow Through Porous Media. Proceedings of the Conference. Conference on Mathematical Modelling of Flow Through Porous Media.A new mathematical model is proposed for time-independent laminar flow through a rigid isotropic and consolidated porous medium of spatially varying porosity. The model is based upon volumetric averaging concepts. Microscopic inertial effects are introduced through consideration of flow development within the pores.In this chapter a general model for the two-phase fluid flow in porous media is presented, together with its simplified form, known as the.Abstract - The paper is aimed at mathematical modeling of flows in porous medium. The results are compared with model experiments performed under.Abstract. Mathematical models have been widely used to understand, predict, heterogeneity of the porous medium, and developing e ective parameters in the.Buy Mathematical Modelling of Flow Through Porous Media on cassiewerber.com ? FREE SHIPPING on qualified orders.The mathematical models developped in this book will take into account the heterogeneity of the porous medium, (and hence cover the case of fractured.of the flow in porous media which exhibit double porosity/permeability. We first obtain a mathematical model for double porosity/permeability.Flow in porous media: physical, mathematical and numerical aspects. - CFD Stavanger. 2. OUTLINE. Darcy law; Mathematical issues; Some models: Black-oil .The mathematical modeling of the flow in nanoporous rocks (e.g., shales) becomes an important new branch of subterranean fluid mechanics.World Scientific. Mathematical Modeling, Numerical Techniques, and. Computer Simulation of Flows and Transport in. Porous Media. R.E. Ewing, R.D. Lazarov.Mathematical models of fluids flow in petroleum and gas reservoirs have Most of the models describing the flow through fractured porous media, such as.Contributions to the knowledge of modeling flow and transport, as well as to the characterization of porous media at field scale are of great relevance. This book.Mathematical Model and Solution for Fingering Phenomenon in fingering in double phase flow through homogenous porous media by using.Abstract It is assumed that water flow in porous media is proportional to the made it possible to get the mathematical model of the water flow in the con-.This work presents a mathematical model of nanofluid flow which has been developed as steady flow of a base fluid through a porous medium of Al2O3.Introduction The problem of multicomponent single-phase flow through porous media is encountered in the study of petroleum reservoirs, gas chromatographic .The development of mathematical modeling for nanofluid as a porous media in heat In the nanofluid-flow field, the nanoparticles could be assumed to be.velocity of the flow front and the pressure gradient. Flow models usually consider the flow as Darcy's flow [2] through a homogeneous porous medium. Although.

[PDF] Special Bebe : 4 nouvelles inedites (Coup de coeur t. 113) (French Edition)

[PDF] Changing Aging, Changing Family Therapy: Practicing With 21st Century Realities (Family Therapy and
[PDF] Stakeholder Analysis - Simple Steps to Win, Insights and Opportunities for Maxing Out Success
[PDF] Nissa: a contemporary fairy tale
[PDF] An essay on the external use of water. In a letter to Dr. **** ... By T. Smollett, M.D. The second e
[PDF] Multistate Bar Exam Success Strategies Study Guide: MBE Test Review for the Multistate Bar Examinati
[PDF] Romania - Calator Pe Mapamond (Romanian Edition)