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A Study of Unsteady Fluid Flow of Co-axial Cylinder Through Porous Medium

PARMJEET, Assistant Professor, Deptt. of Maths, Chaudhary Devi Lal University, Sirsa

Abstract

The study of fluid flow through porous media has significant applications in engineering, geophysics, filtration systems, petroleum recovery, heat exchangers, and industrial fluid transport. This research investigates the unsteady flow of a viscous, incompressible fluid through a porous medium confined between co-axial cylinders. The mathematical formulation considers the temporal variation of the flow field and the resistance offered by the porous medium. The governing equations are developed using the fundamental principles of fluid dynamics and an appropriate porous-medium model, taking into account the effects of viscosity, permeability, pressure gradient, and transient flow conditions. Analytical and/or numerical techniques are employed to obtain solutions for velocity distribution and other relevant flow characteristics under suitable boundary and initial conditions. The influence of important dimensionless parameters, including the Darcy number, Reynolds number, and time-dependent flow parameters, is examined to understand their effects on the fluid motion. Particular attention is given to the development of the velocity profile and the rate at which the flow approaches its steady-state condition. The presence of the porous medium is found to modify the flow behavior by introducing additional resistance, thereby influencing velocity and momentum diffusion within the annular region. The results provide useful insights into the transient characteristics of fluid transport between co-axial cylindrical boundaries. The study contributes to a better understanding of unsteady porous-medium flows and may be useful in the design and analysis of systems involving cylindrical porous structures, filtration devices, lubrication mechanisms, and subsurface flow processes.

Keywords: Unsteady Fluid Flow, Co-axial Cylinders, Porous Medium, Viscous Fluid, Darcy Number, Reynolds Number, Velocity Distribution, Transient Flow, Permeability, Fluid Dynamics.

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