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Velocity and pressure functions of an oscillating flow in a circular Hele-Shaw cell

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Abstract

In this study, we have investigated the form of velocity and pressure functions of a fluid oscillating between two parallel glass sheets that form a circular Hele-Shaw cell. The flow has been considered to be radial, incompressible and laminar. The time-dependent Navier-Stokes equation has been solved in cylindrical coordinates using Fourier transform, and the oscillating flow velocity across the thickness of the cell has been obtained at different times. The flow velocity function in the unsteady state is related to the vertical component of the coordinates in the form of parabolic functions and also to the inverse of the radial component. The time dependence appears as a simple harmonic with a frequency equal to the oscillation frequency. The velocity of the flow is maximum at the middle of the cell along its height and gradually decreases from the middle towards the top or bottom plane and reaches zero. Pressure does not depend on the height and changes logarithmically with the radius. The dependence of pressure on time is also a simple harmonic with the external frequency, but it has a phase shift with respect to the velocity.

Keywords: Hele-Shaw cell, oscillatory flow, radial flow, poiseuille flow

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