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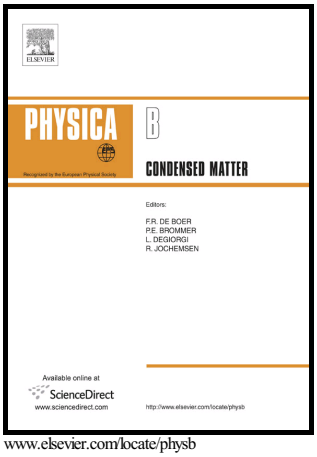

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Natural convection in square cavity filled with ferrofluid saturated porous medium in the presence of uniform magnetic field

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Abstract

This article contains numerical results for free convection through square enclosure enclosing ferrofluid saturated porous medium when uniform magnetic field is applied upon the flow along *x*-axis. Heat is provided through bottom wall and a square blockage placed near left or right bottom corner of enclosure as a heat source. Left and right vertical boundaries of the cavity are considered insulated while upper wall is taken cold. The problem is modelled in terms of system of nonlinear partial differential equations. Finite element method has been adopted to compute numerical simulations of mathematical problem for wide range of pertinent flow parameters including Rayleigh number, Hartman number, Darcy number and Prandtl number.

Analysis of results reveals that the strength of streamline circulation is an increasing function of Darcy and Prandtl number where convection heat transfer is dominant for large values of these parameters whereas increase in Hartman number has opposite effects on isotherms and streamline circulations. Thermal conductivity and hence local heat transfer rate of fluid gets increased when ferroparticles are introduced in the fluid. Average Nusselt number increases with increase in Darcy and Rayleigh numbers while it is decreases when Hartman number is increased.

Keywords Natural convection; Porous medium; Ferrofluid; Cavity flow; Finite element method.

1. Introduction

The term ferrofluid refers to suspension of nano meter sized magnetic particles in base fluid. The solid magnetic particles are dispersed throughout the fluid while Brownian motion of fluid particle and its viscosity prevents the solid particles from settling out. This colloidal suspension remains stable if solid particles have diameter of approximately 10nm. Attractive forces among particles can cause agglomeration issue which may be dealt by coating these particles with a stabilizer layer. Generally iron oxides (magnetite) or iron salts particles are used in ferrofluids. Firstly ferrofluids were developed by NASA in 1960 ground by natural magnetite and objective of invention of ferrofluid was to move the liquids through space. These ferromagnetic materials used to be permanently magnetic at macroscale but at nano scale their particles become paramagnetic i.e. they behave as magnet only in the presence of magnetic field. Therefore when a strong magnet is nearby, particles in ferrofluids are magnetised temporarily and form structures in the fluid, consequently ferrofluid starts behaving like solid. On the other hand, when magnet is removed, particles get demagnetised causing ferrofluid to behave as liquid again. The foremost advantage of ferrofluid over