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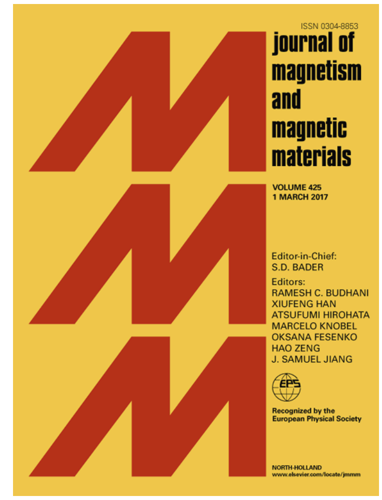

Transport of magneto-nanoparticles during electro-osmotic flow in a micro-tube in the presence of magnetic field for drug delivery application

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Transport of magneto-nanoparticles during electro-osmotic flow in a micro-tube in the presence of magnetic field for drug delivery application

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Abstract

In this paper, we have examined the motion of magnetic-nanoparticles and the flow characteristics of biofluid in a micro-tube in the presence of externally applied magnetic field and electrokinetic effects. In the drug delivery system, the motion of the magnetic nanoparticles as carriers is important for therapeutic procedure in the treatment of tumor cells, infections and removing blood clots. The unidirectional electro-osmotic flow of biofluid is driven by the combined effects of pulsatile pressure gradient and electrokinetic force. The governing equation for unsteady electromagnetohydrodynamic flow subject to the no-slip boundary condition has been solved numerically by using Crank-Nicolson implicit finite difference scheme. We have analyzed the variation of axial velocity, velocity distribution of magnetic nanoparticles, volumetric flow rate and wall shear stress for various values of the non-dimensional parameters. The study reveals that blood flow velocity, carriers velocity and flow rate are strongly influenced by the electro-osmotic parameter as well as the Hartmann number. The particle mass parameter as well as the particle concentration parameter have efficient capturing effect on magnetic nanoparticles during blood flow through a micro-tube for drug delivery.

Keywords: Magnetic nanoparticles, Electro-osmotic flow, Pulsatile flow, Hartmann number, Electrical double layer

1. Introduction

Electromagnetohydrodynamic flow of blood has attracted the attention of many investigators because of many important technological processes and applications such as in bio-chemical engineering, micro-electro-mechanical systems (MEMS) and targeting drug delivery system. The transport phenomena at the micro-scale level, Lab-on-a-chip technology are important for the development of micro-fabrication technology. Consequently, fundamental issues related to fluid flow with magnetic nanoparticles in a micro-tube need to be resolved for efficient design of microfluidic devices [1]-[3]. In microfluidic system, an electric field is applied for transporting small amount of fluid in a micro-tube. When an electric field is applied to an ionic aqueous solution, then a net attraction of counter-ions towards the wall along the co-ions takes place and thereby forms an electrical double layer (EDL). The thickness of EDL also depends on the ion size effects, which strongly influences the electrohydrodynamic behaviour in the microfluidic devices. For small magnitudes of ζ, the volumetric charge density distribution within the EDL invokes the Debye-H*ü*ckel linearization [4]. Rice and Whitehead [5] investigated fully developed electro-osmotic flow in a narrow cylindrical capillary for low zeta potential, using the Debye-H*ü*ckel linearization. The microfluidic devices fabricated out of polydimethylsiloxane (PDMS) or polymethylmethacrylate (PMMA), which are two among the most widely used materials in lab-on-a-chip applications [6] under the development of such small zeta-potential. Bhatti et al. [7] investigated the electro-osmotically driven peristaltic flow of particle-fluid suspension, heat and mass transfer through a planar channel with an applied transverse magnetic field. The Debye-H*ü*ckel linearization and the long wave length approximations have been invoked to model their problem. They observed that the electro-osmotic parameter enhances the velocity distribution significantly.

Blood is the physiologically relevant fluid, which can be treated as bio-magnetic fluid, affected under the influence of applied magnetic field. Since the erythro-

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