Magnetic Drug Targeting in a Microvessel – Effect of Blood Rheology, Vessel permeability and Inertia of Carrier Particle.

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A mathematical model is presented to investigate noninvasive magnetic drug targeting of a multifunctional spherical carrier particle in blood in a microvessel. The Herschel-Bulkley and Casson models are chosen to describe the non-Newtonian nature of blood flowing through the microvessel. A dilute solution suspended with the carrier particle is injected into the microvessel upstream from the tumor located inside the body and a cylindrical magnet is positioned in the vicinity of body surface to capture the carrier particle near the tumor zone. Both the aspects of microvessel impermeability and permeability are considered for analysis and discussion. The inertia term is considered in the equation of motion of the carrier particle and it is assumed that the body force (buoyancy) is also significant in comparison with the fluidic drag force and the external magnetic force experienced by the carrier particle. Along with the therapeutics, biocompatible $Fe_3O_4$ nanoparticles of spherical shape are assumed to be present in the carrier particle. Consequently, an effective density for the carrier particle is introduced. The numerical solution of the resulting coupled nonlinear equations of motion reveals that due to the assumption of buoyant force along with the acceleration of the carrier particle, lesser magnetization is sufficient to attract the carrier particle more effectively near the tumor. Effective capturing conditions are discussed for varying position of the magnetic field, size and shape of the carrier particle.

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