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Mathematical Modelling of Blood Flow with Magnetic Nanoparticles as Carrier for Targeted Drug Delivery in a Stenosed Artery

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Abstract : A study on targeted drug delivery is carried out in an unsteady flow of blood infused with magnetic NPs (nanoparticles) with an aim to understand the flow pattern and nanoparticle aggregation in a diseased arterial segment having stenosis. The magnetic NPs are supervised by the magnetic field which is significant for therapeutic treatment of arterial diseases, tumor and cancer cells and removing blood clots. Coupled thermal energy have also been analyzed by considering dissipation of energy because of the application of the magnetic field and the viscosity of blood. Simulation technique used to solve the mathematical model is vorticity-stream function formulations in the diseased artery. An elevation in SLP (Specific loss power) is noted in the aortic bloodstream when the agglomeration of nanoparticles is higher. This phenomenon has potential application in the treatment of hyperthermia. The study focuses on the lowering of WSS (Wall Shear Stress) with increasing particle concentration at the downstream of the stenosis which depicts the vigorous flow circulation zone. These low shear stress regions prolong the residing time of the nanoparticles carrying drugs which soaks up the LDL (Low Density Lipoprotein) deposition. Moreover, an increase in NP concentration enhances the Nusselt number which marks the increase of heat transfer from the arterial wall to the surrounding tissues to destroy tumor and cancer cells without affecting the healthy cells. The results have a significant influence in the study of medicine, to treat arterial diseases such as atherosclerosis without the need for surgery which can minimize the expenditures on cardiovascular treatments.

Keywords : magnetic nanoparticles, blood flow, atherosclerosis, hyperthermia
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