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Effects of chemical reaction and space porosity on MHD mixed convective flow in a vertical asymmetric channel with peristalsis

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ABSTRACT

This work is aimed at describing MHD mixed convective heat and mass transfer peristaltic flow through a vertical porous space in the presence of a chemical reaction. The flow is examined in a wave frame of reference moving with the velocity of the wave. The channel asymmetry is produced by choosing the peristaltic wave train on the walls to have different amplitude and phase. The momentum, energy and concentration equation have been linearized under long-wavelength approximation. Expressions for dimensionless stream function, temperature and concentration field are constructed. The features of the fluid flow, heat and mass transfer characteristics are analyzed by plotting graphs and discussed in detail.

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1. Introduction

Peristaltic flows are generated by the propagation of waves along the flexible walls of the channel or tube. These occur widely in many biological and biomedical systems. In physiology, this plays an indispensable role in various situations such as urine transport from kidneys to bladder through the ureter, chyme movement in the gastrointestinal tract, transport of spermatozoa in the ductus efferents of the male reproductive tracts, movements of ovum in the female fallopian tube and circulation of blood in the small blood vessels. The mechanism of peristaltic transport has been exploited for industrial applications like sanitary fluid transport, blood pumps in heart lung machine and transport of corrosive fluids where the contact of the fluid with the machinery parts is prohibited. Peristaltic transport of a toxic liquid is used in nuclear industry to avoid contamination of the outside environment. Such flows are extensively studied in various geometries by using different assumptions of large wave length, small amplitude ratio, small wave number, creeping flow, etc. At present a wealth of literature on this topic dealing with the peristalsis in viscous and non-Newtonian fluid is available (see Refs. [1–12] and several references therein).

Heat transfer in biological tissues involves complicated processes such as heat conduction in tissues, heat convection due to blood flow through the pores of tissues, as well as radiation heat transfer between surface and its environment and there is also mass transfer in organisms. Research interest in flow as well as heat transfer phenomena in a channel/tube has increased substantially in recent years due to developments in the electronic industry, microfabrication technologies, biomedical engineering, etc. The interaction between peristalsis and heat transfer has been investigated recently, where the thermodynamic aspects of blood become significant in processes like oxygenation and hemodialysis [13–15]. Some recent interesting contributions pertaining to heat transfer aspects of peristaltic transport are cited in Refs. [13–25].

Very few investigations have been made to study the combined effects of heat and mass transfer in peristaltic literature [26–30]. Srinivas and Kothandapani [26] have analyzed the influence of heat and mass transfer on MHD peristaltic flow through a porous space with compliant walls. Nadeem et al. [27] have presented a mathematical model to understand

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