Themo-bioconvection of gyrotactic microorganisms in a polymer solution near a perforated Riga plate immersed in a DF medium involving heat radiation, and Arrhenius kinetics

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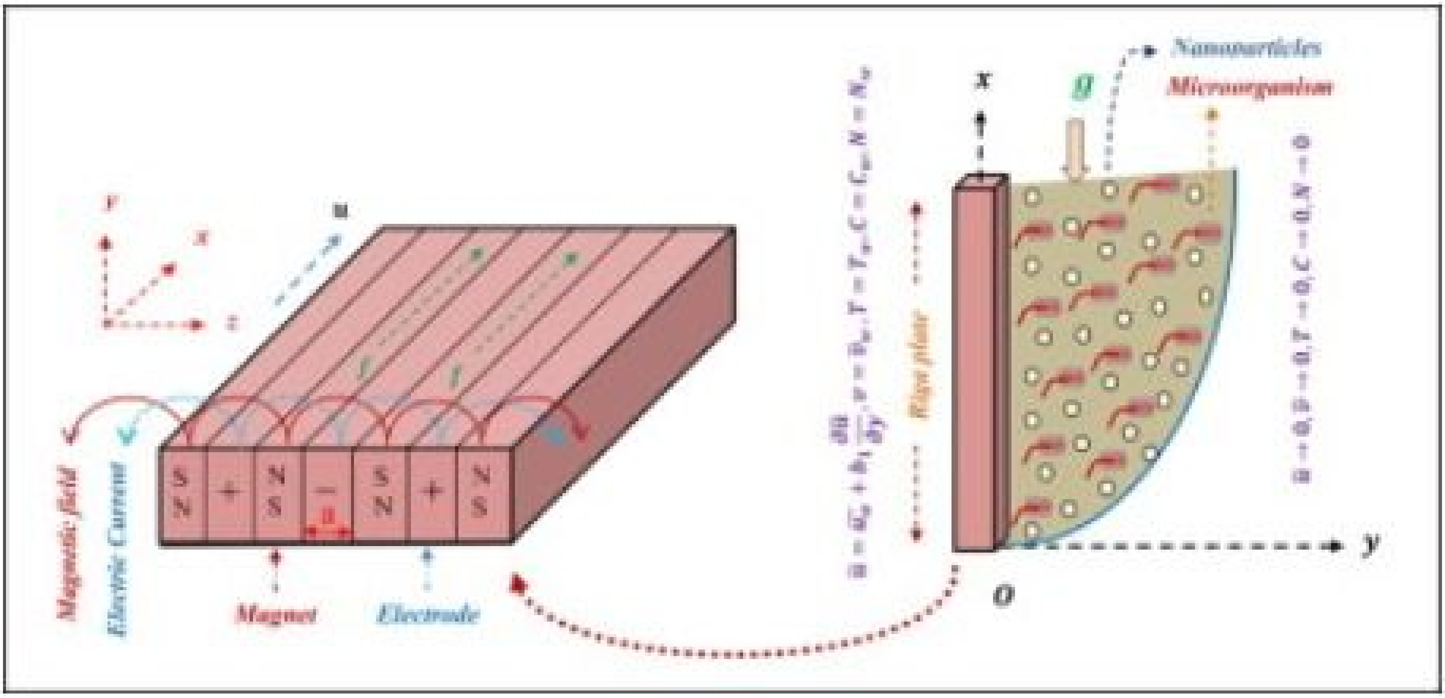
Abstract

In modern era, thermo-migration of microorganisms is an appealing research topic in bio-nanotechnology, bio engineering, and biomedical. In this context, a mathematical model describing thermo-bioconvection of Sutterby nanofluid flow including motile gyrotactic microorganisms near a perforated Riga plate under the physical impacts of heat radiation, and Arrhenius kinetics associated with binary chemical reaction is formulated and simulated here. The Darcy-Forchheimer (DF) law is applied to determine the porosity of porous media. The Grinberg term is taken for the Lorentz force owing to the parallel Riga plate wall. Appropriate translations are discharged to turn the constitutive partial differential equations (PDEs) into ordinary differential equations (ODEs), that are numerically computed by opting the Runge–Kutta-Fehlberg method (RKF-45) along with shooting strategy. The physical insights of various controlling variables on the transport profiles, Sherwood number, Nusselt number, and microorganisms density number are exemplified through requisite graphs and tables. It must be admitted that with enlarging Darcy number, the nanofluid velocity declines, while Forchheimer number has opposite consequence on it. The motile microorganisms density sharply decreases for improving values of activation parameter. The present modeling would provide preliminary guidances in a variety of biotechnological and industrial applications.

Graphical abstract



Introduction

Researchers and scientists have increased considerations regarding non-Newtonian fluids having diverse characteristics because of their promising utilizations in technological, industrial and pharmaceutical sciences. Communal cases of non-Newtonian fluids include synthetic lubricants, certain oils, paints, drilling muds, sugar solutions, soaps, shampoos,ice cream, clay coating, cleanser, deodorizer and biological fluid like blood. Because of the complexities in the mathematical representation, the rheological properties of non-Newtonian fluids present new challenges to researchers, because Navier–Stokes equations cannot currently represent the flow field of such fluids. In order to overcome this problem, many researchers have proposed various models like Powell-Eyring, Bulky, Maxwell, Sutterby, Jeffrey, Oldroyd-A, Oldroyd-B, Carreau, Casson, and so many. The non-Newtonian Sutterby fluid model is among the most well-known non-Newtonian fluid models since it can also be used to investigate non-Newtonian fluids' dilatant (shear thickening) and pseudo-plastic (shear thinning) properties. Also, the Sutterby fluid is an example of a fluid that successfully simulates heavy polymer standard solutions. This model incorporates the viscosity characteristics of several polymer solutions and polymer melts. This fluid is also referred as the polymer fluid for these reasons. Sutterby [1] established the Sutterby fluid model in 1966 and reported experimental data. In the converging channel experiment, he analyses the rheological behaviour of polymer solutions using viscosity measurements. Hayat et al. [2] experimentally investigated the Sutterby fluid flow through a moving system. The thermophysical properties of Sutterby liquid as well as Sutterby hybrid nanoliquid, which contain two nanoparticles, Silicon dioxide and Molybdenum disulphide, were examined by Nawaz et al. [3]. In terms of thermal conductivity, this study shows that the Sutterby fluid is less efficient than hybridized Sutterby nanofluid.. Sajid et al. [4] investigated the influence of activation energy effect on Maxwell-Sutterby liquid dynamics using an elastic sheet The researcher has created a mathematical model for improved analysis. Song et al. [5] explored the role of gyrotactic microorganisms in Sutterby nanofluids on