Numerical solution of bio-nano-convection transport from a horizontal plate with blowing and multiple slip effects

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ABSTRACT

In this paper, a new bio-nano-transport model is presented. The effects of first- and second-order velocity slips, thermal slip, mass slip, and gyro-tactic (torque-responsive) microorganism slip of bioconvective nanofluid flow from a moving plate under blowing phenomenon are numerically examined. The flow model is expressed by partial differential equations which are converted to a similar boundary value problem by similarity transformations. The boundary value problem is converted to a system of nonlinear equations which are then solved by a Matlab nonlinear equation solver *fsolve* integrated with a Matlab ODE solver *ode15s*. The effects of selected control parameters (first order slip, second order slip, thermal slip, microorganism slip, blowing, nanofluid parameters) on the non-dimensional velocity, temperature, nanoparticle volume fraction, density of motile micro-organism, skin friction coefficient, heat transfer rate, mass flux of nanoparticles and mass flux of microorganisms are analyzed. Our analysis reveals that a higher blowing parameter enhances micro-organism propulsion, flow velocity and nano-particle concentration, and increases the associated boundary layer thicknesses. A higher wall slip parameter enhances mass transfer and accelerates the flow. The MATLAB computations have been rigorously validated with the second-order accurate finite difference Nakamura tri-diagonal method. The current study is relevant to microbial fuel cell technologies which combine nanofluid transport, bioconvection phenomena and furthermore can be applied in nano-biomaterials sheet processing systems.

KEYWORDS

Bioconvection; Motile micro-organism propulsion; Second-order velocity slip; Nanofluids; Boundary layers; Nano-bio green fuel cells; Numerical solutions

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