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Heat transfer on the cross flow of micropolar fluids over a thin needle moving in a parallel stream influenced by binary chemical reaction and Arrhenius activation energy

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Abstract

Emerging engineering and industrial needs made the prime concern of this article to investigate the thermal management on the cross flow of micropolar fluids over a thin needle moving in a parallel stream. The flow is subject to binary chemical reaction and Arrhenius activation energy. The mathematical model of the considered physical problem consists of coupled nonlinear partial differential equations: conservation of mass, momentum, energy, and concentration equation. The dimensionless transformed governing equations subject to the given boundary conditions have been solved directly by the Runge-Kutta Fehlberg fourth- fifth-order method followed by the shooting technique. Graphical results relative to the interaction effects of dynamic thermo-physical dimensionless parameters such as Richardson parameter, Dufour number, Soret number, Prandtl number, temperature ratio parameter, nondimensional activation energy, chemical reaction parameter and velocity ratio parameter controlling the flow, heat and mass transfer features are presented and analyzed. It can be seen, from the study, that the skin friction due to angular velocity reduces with increase in size of the needle and it upsurges due to the increase in material parameter. The obtained numerical results revealed that the augmented Richardson parameter is in favor of a greater heat transfer enhancement. The obtained results show a better agreement of this model with the previously published results. © 2019, Società Italiana di Fisica and Springer-Verlag GmbH Germany, part of Springer Nature.

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