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Heat and mass transfer analysis in natural convection flow of nanofluid over a vertical cone with chemical reaction
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Abstract
Purpose - In recent years, nanofluids are being widely used in many thermal systems because of their higher thermal conductivity and heat transfer rate. The higher thermal conductivity depends on many parameters such as size, shape and volume and the Brownian motion and thermophoresis of added nanoparticles. The purpose of this paper is to analyze the influence of the Brownian motion and thermophoresis on natural convection heat and mass transfer boundary layer flow of nanofluids over a vertical cone with radiation. Design/methodology/approach - Using similarity variables, the non-linear partial differential equations, which represent momentum, energy and diffusion, are transformed into ordinary differential equations. The transformed conservation equations are solved numerically subject to the boundary conditions by using versatile, extensively validated, variational finite-element method. Findings - The sway of significant parameters such as magnetic field (M), buoyancy ratio parameter (Nr), Brownian motion parameter (Nb), thermophoresis parameter (Nt), thermal radiation (R), Lewis number (Le) and chemical reaction parameter (Cr) on velocity, temperature and concentration evaluation in the boundary layer region is examined in detail. The results are compared with previously published work and are found to be in agreement. The velocity distributions are reduced, while temperature and concentration profiles elevate with a higher (M). With the improving values of (R), the velocity and temperature sketches improve, while concentration distributions are lowered in the boundary layer region. The temperature and concentration profiles are elevated in the boundary layer region for higher values of (Nt). With the increasing values of (Nb), temperature profiles are enhanced, whereas concentration profiles get depreciated in the flow region. Social implications - In recent years, it has been found that magneto-nanofluids are significant in many areas of science and technology. It has applications in optical modulators, magnetooptical wavelength filters, tunable optical fiber filters and optical switches. Magnetic nanoparticles are especially useful in biomedicine, sink float separation, cancer therapy, etc. Specific biomedical applications involving nanofluids include hyperthermia, magnetic cell separation, drug delivery and contrast enhancement in magnetic resonance imaging. Originality/value - To the best of the authors' knowledge, no studies have assessed the impact of the two slip effects, namely, Brownian motion and thermophoresis, on the natural convection of electrically conducted heat and mass transfer to the nanofluid boundary layer flow over a vertical cone in the presence of radiation and chemical reaction; therefore, this problem has been addressed in this study. Comparison of the results of this study's with those of previously published work was found to be in good agreement. © 2017 Emerald Publishing Limited.

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