Effects of variable viscosity and thermal conductivity on the Brinkman model for mixed convection flow past a horizontal circular cylinder in a porous medium

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Abstract:

This work presents a performance analysis of mixed convection boundary layer flow past a horizontal circular cylinder embedded in a fluid-saturated porous medium in a vertical stream flow using the Darcy-Brinkman model. The surface temperature is assumed to be constant. The fluid viscosity and thermal conductivity are assumed to vary as a linear function of temperature. Both cases of a heated (assisting flow) and a cooled (opposing flow) cylinder are considered. The governing equations reduce to the similar Darcy’s model, while it becomes nonsimilar for the Darcy-Brinkman model, and they are solved numerically employing the finite difference method. The effects of the Darcy-Brinkman parameter $\Gamma$, mixed convection parameter $\lambda$, viscosity parameter $\nu$, and thermal conductivity parameter $\kappa$ are studied. It is found that cooling the cylinder ($\lambda < 0$) delays the separation of the boundary layer and can suppress it completely for large values ($\lambda > 0$). Results for the details of the velocity and temperature fields as well as skin friction and rate of heat transfer at the wall are presented. Results are compared with previously published work and are found to be in excellent agreement.

Keywords:

Brinkman Model, Stagnation flow, Finite difference, Nonsimilar solutions

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