

Couple Stress Fluid Flow with Variable Properties: A Second Law Analysis

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Abstract: The present work examines the combined influence of variable thermal conductivity and viscosity on the irreversibility rate in couple stress fluid flow in between asymmetrically heated parallel plates. The dimensionless fluid equations are solved by using homotopy analysis method (HAM) and validated with Runge-Kutta shooting method (RKSM). The convergent series solution is then used for the irreversibility analysis in the flow domain. The effects of thermal conductivity and viscosity variation parameters, couple stress parameter, Reynolds number, Grashof number, Hartmann number on the velocity profile, temperature distribution, entropy production, and heat irreversibility ratio are presented through graphs, and salient features of the solutions are discussed. The computations show that the entropy production rate decreases with increased magnetic field and thermal conductivity parameters, whereas it rises with increasing values of couple stress parameter, Brinkman number, viscosity variation parameter, and Grashof number. The study is relevant to lubrication theory.

Key words: Bejan number, entropy generation number, homotopy analysis method, mixed convection, variable thermal conductivity, variable viscosity