Influence of Thermal Radiation and Heat Absorption of a Third-Grade Fluid in Wire Coating Analysis Through a Porous Medium

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Abstract In the present study, the influence of porous matrix, thermal radiation, and internal heat absorption on wire coating using third-grade fluid like melt polymer in the presence of constant as well as temperature-dependent viscosity has been analyzed. The governing equations are solved numerically by employing fourth-order Runge-Kutta method. Models such as third-grade fluid model, Reynolds model, and Vogel's model have been used. The results for the velocity and temperature are displayed and discussed in detail. Porous matrix has remarkable contributions in escalating the temperature whereas the effect of thermal radiation is diametrically opposite to that of porous matrix in the flow region within the die. Velocity profiles disparaged because of resistive force from medium porosity, and thereby, momentum boundary layer shrinks. Heat absorption in thermal boundary layer leads to decrease in temperature, and then, the associated thermal boundary layer thickness shrinks.

List of Symbols

R_w	Radius of the wire (m)
$\frac{D}{Dt}$	Substantial derivative
U_w	Wire velocity (m s^{-1})
p	Pressure (N m^{-2})
θ_w	Wire temperature (K)
F	Viscous force per unit volume (N m^{-3})
L	Length of die (m)
R_d	Radius of die (m)
k	Thermal conductivity (W m^{-1} K^{-1})
C_p	Specific heat at constant pressure (J kg^{-1} K^{-1})
q_r	Radiative heat flux (W m^{-2})
θ_d	Die temperature (K)

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