Analytical and Numerical Solutions of a Generalized Hyperbolic Non-Newtonian Fluid Flow

Mehmet Pakdemirli[a], Pınar Sarı[b], and Bekir Solmaz[b]

[a] Department of Mechanical Engineering, Celal Bayar University, 45140 Muradiye, Manisa, Turkey
[b] Department of Civil Engineering, Celal Bayar University, 45140 Muradiye, Manisa, Turkey

Reprint requests to Fax: +90.236.2412143; E-mail: mpak@bayar.edu.tr; pinar.sari@bayar.edu.tr; bekir.solmaz@bayar.edu.tr

The generalized hyperbolic non-Newtonian fluid model first proposed by Al-Zahrani [J. Petroleum Sci. Eng. **17**, 211 (1997)] is considered. This model was successfully applied to some drilling fluids with a better performance in relating shear stress and velocity gradient compared to power-law and the Hershel-Bulkley model. Special flow geometries namely pipe flow, parallel plate flow, and flow between two rotating cylinders are treated. For the first two cases, analytical solutions of velocity profiles and discharges in the form of integrals are presented. These quantities are calculated by numerically evaluating the integrals. For the flow between two rotating cylinders, the differential equation is solved by the Runge-Kutta method combined with shooting. For all problems, the power-law approximation of the model is compared with the generalized hyperbolic model, too.

Key words: Generalized Hyperbolic Non-Newtonian Fluid; Pipe Flow; Parallel Plate Flow; Flow Between Rotating Cylinders.