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Analytical solution for creeping channel flow of non-Newtonian compressible fluid subject to wall slip HANSONG TANG, Dept. of Civil Eng., City College, City Univ. of New York, DIHAN KALYON, Highly Filled Material Inst., Stevens Inst Tech — Creeping channel flows of compressible viscoplastic fluids subject to wall slip are important in many industries as well as presenting significant academic challenges. Here we present analytical solutions for pressure-driven steady flows of viscoplastic fluids within planar and circular channels. Herschel-Bulkley constitutive equation is employed in conjunction with constant or pressure dependent wall slip coefficients. Simplifications of the Hershel-Bulkley fluid provide other generalized Newtonian fluids including power law and Newtonian fluids. Under the assumption that pressure only changes in the flow direction and its gradient deviates slightly from a constant, explicit solutions are derived for distributions of pressure, velocity, and slip velocity within the channels. The analytical solutions are compared against numerical solutions as well as experimental data collected using rectangular slit dies. The effects of compressibility and wall slip on the flows are elucidated. A distinctive feature of such a flow is that, when the slip coefficient is considered to be inversely proportional to pressure, the slip velocity increases rapidly in the flow direction and the flow can evolve into a pure plug flow at the exit, removing the stress singularity that is presumed to exist in the transition from the channel flow into a free surface flow at the exit.

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