Preliminary Data for Slip Flow in Shear and Elongational Flow through a Semi-Hyperbolically Converging Die

All data presented was taken with Polypropylene-3854 in standard Rheometrics rheometers at 220 degrees Celsius. Shear data was taken on a cone and plate device, and elongational data was taken using the semi-hyperbolically converging dies with Hencky strain values of 4, 5, 6, and 7. Stearic acid was added some of the polymer samples at strengths of 1, 2, and 5 wt% to study the effects of slip flow on the polymer in the various flow geometries.

In the first figure, we examine the effects of the stearic acid additive on the shear viscosity in a pure homogeneous shear flow. This data was taken on an ARES rheometer with a cone-and-plate geometry. Data shows a shear stress reduction of almost 50% once stearic acid is added to the polymer, and that the degree of this reduction is relatively insensitive to the stearic acid concentration once a critical amount has been added.
In the following figures, data is presented for the elongational viscosity as measured in the four Hencky dies of strain values 4, 5, 6, and 7. In all cases the viscosity reduction due to the stearic acid additive is much less than for shear flow, indicating that the polypropylene without additive was experiencing a greater degree of slip flow in this geometry than in the shear flow. Notice that as the Hencky value of the die increases, i.e., as the die becomes less tube-like, more slip in the pure sample is evident.