ABSTRACT

An analysis of the yielding and flow behavior of a model yield-stress fluid, 0.2 wt% Carbopol gel, in a capillary with slip at the wall has been carried out in the present work. For this, a study of the flow kinematics in a capillary rheometer was performed with a two-dimensional particle image velocimetry (PIV) system. Besides, a stress-controlled rotational rheometer with a vane rotor was used as an independent way to measure the yield stress. The results in this work show that in the limit of resolution of the PIV technique, the flow behavior agrees with the existence of a yield stress, but there is a smooth solid–liquid transition in the capillary flow curve, which complicates the determination of the yield stress from rheometrical data. This complication, however, is overcome by using the solely velocity profiles and the measured wall shear stresses, from which the yield-stress value is reliably determined. The main details of the kinematics in the presence of slip were all captured during the experiments, namely, a purely plug flow before yielding, the solid–liquid transition, as well as the behavior under flow, respectively. Finally, it was found that the slip velocity increases in a power-law way with the shear stress.

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