Polymer Rheology and its Importance to Injection Molding

A Newtonian fluid is described as a fluid whose viscosity is not influenced by the shear rate being applied to it. The viscosity remains constant as the shear changes. Example: Water. A non-Newtonian fluid, is a fluid whose viscosity changes with the change in the shear rate. The viscosity does not remain constant as the shear changes. Example: paints. Rheology is the study of such non-Newtonian Fluids.

All plastics exhibit a combination of non-Newtonian and Newtonian behavior. At lower shear rates, the plastic is non-Newtonian but as the shear rate increases, the plastic tends to exhibit a Newtonian behavior. This happens because with increasing shear rate, the polymer molecules start to untangle from each other and start to align themselves in the direction of flow.

Importance to Injection Molding:

During Injection Molding, the material is subjected to large amount of shear forces during the cavity filling stage. The shear rate is proportional to the injection speed. If the shear rates are in the non-Newtonian region of the curve, small variations in the shear rate will cause a large shift in the viscosity. This will make the mold filling inconsistent resulting in shot to shot inconsistency. It is therefore important to find the Newtonian region of the curve and set the injection speed (therefore shear rate) in this region. The viscosity curve can be generated at the molding machine for any given mold. The term ‘In-Mold Rheology’ is another term used for developing the viscosity curve.