The use of high-density polyethylene pipes has thrived over the last decades. This has been possible because these pipes are lightweight, corrosion resistant, unlikely to have leaks, and are low cost. The molecular characteristics of the polymer and the manufacturing affect the pipe’s performance. A new generation of high density polyethylene resins has improved the performance of the pipes, but brought new challenges to their testing and characterization. There is a need to understand the flow characteristics of the resins and their properties as a finished pipe. The flow behavior of the resins was studied to characterize their molecular characteristics. Geometries that induced simple flow allowed studying the viscous response of the molten resins. The higher molecular weight resin showed increased viscosity and a more propensity to deviate from ideal behavior. The flow characteristics of the resins let one model certain aspects of the manufacturing process. The flow channels during processing end up in low velocities, but the molecular characteristics of the resins cause high processing stresses. Using a different size die had a larger impact in processing compared to changing the resin. The flow of a fluid through a pipe causes constant stress, which makes the pipe fail. Tests that characterize the service lifetime of pipes take long times and are expensive. Transient and oscillatory tests allow characterizing the pipes and get functions that predict the pipes’ accelerated behavior.