Overview

Understanding the relationship between the materials' microstructure, processing and final performance is the ultimate goal of materials science. In this framework, having an advanced controlled processing system is essential to understanding this relationship and for process optimization. Extrusion is one of the most important and widespread operation for polymer melt processing and it is used extensively in out lab for testing the flow behavior/processability of new materials, i.e. composites, foods. The extrusion system is capable of providing inline viscosity measurements based on mechanical pressure readings. However, viscosity alone accounts only for one shear component of the extra-stress tensor associated to polymeric materials. For a more thorough understanding of the effects of polymer chain dynamics and polymer-filler and filler-filler interactions a more complete description of the extra-stress tensor needs to be determined.

Project summary

The master project’s main goal is to test the possibility of determine the first and possibly the second normal stress differences via the 'hole effect'. Errors in pressure measurements for polymeric liquids, were known for decades to occur for offset positioned transducer with respect to the capillary walls. This effect can be put to good use to determine the first and, in some cases, the second normal stress difference. The 'hole effect' refers to the streamline curvature induced due to the offset positioning of a transducer, e.g. see (4) below, in which case the normal components of the stress tensor are no longer aligned with the principal channel axes. Thus, based on the pressure difference between (3) and (4) it is possible to estimate normal stress differences. The project will include (i) testing commercial polyethylene, (ii) optimizing the positioning of the transducers and (iii) possibly improving the data acquisition and processing system for a superior signal-to-noise ratio. By developing the normal stress differences module, the project’s final goal is to create an outstanding experimental setup for future manufacturing pilot programs.

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Schematic overview of the experimental setup: (1) single-screw extruder, (2) slit die, (3), (4) pressure transducers, (5) temperature transducer and (6) conveyor belt.