Thermo-dependent Non-Newtonian Fluid Simulation for Injection Molding using the MPS_TKB Method

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The MPS method was originally proposed for simulating purely Newtonian [1], without any kind of dependency to common physical phenomena such as shear stress or temperature, including common fluids such as water or oils. Additionally, the method was not designed for high viscosity fluids, for which problems can rapidly arise. In order to accurately simulate processes such as injection molding, which can use fluids like thermoplastics, complex viscosity models have to be used for more realistic behavior.

However, such models can't be directly implemented in the MPS method, as they show increasing error with simulation time [3]. Consequently, the MPS_TKB method [3] was developed based on improvements of the MPS method by Khayyer and Gotoh [4] and Tanaka and Masunaga [5]. Briefly, the pressure source terms of both improvements are combined to form a new one, with an alternative formulation for the Laplacian and gradient terms.

Using the MPS_TKB method, a temperature and shear rate dependent Cross-WLF viscosity model is implemented and compared to a FEM model for verification in a Poiseuille flow. A 2D simulation of thermoplastic injection molding is then done and discussed.

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