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THE INFLUENCE OF RHEOLOGICAL MODELING ON VISCOUS HEATING IN EXTRUDER FLOWS

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In the analysis of process engineering applications like polymer melt flows in extruders, the use of generalized non-newtonian models is a popular choice. They model the viscosity as a function of a generalized shear rate. Therefore, results of a basic rheometrical characterization can be implemented easily in a simulation. In this way only shear thinning is considered. Strain hardening, normal stress differences, and transient evolution of stress are neglected. However, all of these effects can be described by nonlinear maxwell type models e. g. the exponential form of the Phan-Thien Tanner model (EPTT). But the disadvantage of these models is, that they are hard to handle numerically and parameter identification is always an issue.

One field that is influenced mostly by the choice of the rheological model is viscous dissipation, since it is a product of stress and the velocity gradient. As a source term of the energy equation it influences the temperature field. For analysis of flows in extruders this is important, since overheating of the melt, caused by dissipation, can damage the polymer chains. Hence this is subject of this contribution.

A comparison study for the EPTT and a generalized non-newtonian model based on an interpolation table is carried out. This table contains the shear viscosity curve of the EPTT model, consequently its shear behavior is imitated exactly. In this way the error in the velocity and temperature field, caused by modeling the real viscoelastic behavior instead of considering the shear thinning viscosity, can be quantified.

The considered flow is a simplified model for a single screw extruder, based on the unwounded flow channel enabling calculations in a relative system cf. [1]. Field studies are carried out varying important process parameters evaluating the maximum occurring temperature. The framework of OpenFOAM is used to perform these calculations [2]. For stabilization of the viscoelastic model the log-conformation reformulation is applied[3].

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