A COMBINDED BOUNDARY-CONFORMING – CUT CELL FINITE ELEMENT METHOD WITH APPLICATION TO FLOW INSIDE TWIN-SCREW EXTRUDERS

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An extruder is a machine commonly used in the polymer-related industries. Its main component is a screw, which rotates inside a cylinder. In this work, we consider co-rotating twin-screw extruders (TSE), i.e. an extruder which has two overlapping cylinders and two screws. These screws are composed of two types of screw elements – conveying and kneading elements. The design of a conveying element is based on a sweep of a 2D cross section. The geometry can be considered smooth in longitudinal direction. Kneading elements instead feature geometrical discontinuities in longitudinal direction. These discontinuities, the small gap size between screw and cylinder, and in addition the intermeshing of the two screws, leads to several challenges when trying to apply numerical analysis to TSE.

The aim of the underlying work is to develop a boundary-conforming finite element method, enhanced with a Nitsche approach, with which the flow and the temperature distribution in the TSE can be computed. Here, the mainly boundary-conforming nature of the method stands in contrast to the commonly employed interface capturing methods [1].

The boundary-conforming part of the method has been especially developed for the conveying elements: We termed it Snapping Reference Mesh Update Method (SRMUM). Every mesh point is updated through algebraic operations without solving an additional PDE. This makes the method computationally very efficient. However, it cannot handle the discontinuities of two non-matching cross-sections in kneading elements. Therefore, we couple these interfaces using the Nitsche cut method presented in [2]. The advantage of the presented method is that the coupling is broken down to 2D cross sections in 3D, which simplifies the computation of cut cells and avoids difficulties with degenerated polyhedrons. The capabilities of the method will be shown for flow of plastic melt inside TSEs under consideration of thermal effects.

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