Simulating Twin-Screw Extruders with Boundary Conforming Space-Time Finite Elements

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ABSTRACT

Co-rotating twin-screw extruders (TSE) are extremely important devices within polymer-producing industries. Reasons are their versatility as processing, mixing and reaction machines. The accuracy of the analysis of mixing as well as of reaction processes within a TSE strongly depends on the accuracy of the flow field prediction. However, its computation is quite challenging due to interlocking screws and very small gap sizes.

We use boundary conforming finite elements based on the Deforming Spatial Domain/Stabilized Space-Time (DSD/SST) method. The rotating screws require an update of the computational mesh within every time step. This can be done using mesh deformation techniques like Radial Basis Functions (RBF) or the elastic mesh update method (EMUM). However, these methods result in mesh tangling after few time steps due to the complex movement of the rotating screws. This makes re-meshing necessary, which can be very time-consuming and tedious for such complex domains.

Therefore, we propose a different method, that is still boundary conforming but does not require constant re-meshing, the Snapping Reference Mesh Update Method (SRMUM). It is based on a background mesh that constantly adapts to the current geometry. Every mesh point is updated through algebraic operations without solving an additional PDE. This allows to compute the deformation of the mesh at a fraction of the cost of the flow simulation. The method has been tested for conveying screw elements with convex 2D cross sections. The functioning and advantages of the SRMUM – also for other applications involving deforming domains – will be shown for 2D and 3D flow simulations of TSE's. Additionally, more complex flow considering shear heating effects will be presented.