Extended finite element method for flow inside twin-screw extruders

Sarhangi Fard Arash, Hulsen Martien A., Meijer Han E.H., Anderson Patrick D.

Determining the velocity field in twin-screw extruders operating in realistic conditions is still very challenging despite all progress made in simulations during last years. There are two main difficulties that arise when solving the balance equations. The first is that we have to deal with moving geometries, the screws, in a fixed barrel and the gap widths are extremely small and change in time during rotation. Obtaining a velocity field and its derivative very close to the moving screws is not trivial, but essential for further particle tracking analysis. A second challenge is to deal with the viscosity that is a function of position, shear rate and temperature, and can change orders of magnitude. In this paper we present an extended finite element method (XFEM) to model non-Newtonian Stokes flow inside the twin-screw extruder and demonstrate its accuracy and efficiency by systematically refining the mesh and compare with boundary-fitted results. Two-dimensional cross-sectional results for velocity and pressure are compared with full three-dimensional simulations. In addition we discuss strategies to speed up particle tracking in these moving grid simulations without compromizing accuracy. Residence time distributions are compared for various screw designs.