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Mesh Immersion Technique for 3D Moving Domain Calculation and Applications to Twin-screw Extrusion and Mixing

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This work is concerned with the development of numerical techniques devoted to the simulation of the flow of a polymer melt in mixing processes such as twin-screw extrusion. In mixing or twin extrusion process simulation, the absence of symmetry of the moving boundaries (the screws) implies that their rigid body motion has to be taken into account by using a special treatment. In this study, we introduce a new technique called Mesh Immersion Technique (MIT), which consists in : a) using a P1+/P1-based (MINI-element) mixed finite element method for solving the velocity-pressure problem, b) solving the problem in the whole barrel cavity and imposing a rigid motion (rotation) to nodes found located inside the so called immersed domain. In contrast to the fictitious domain technique, each subdomain (screw) is represented by a volumic mesh (or its mathematical equation in simple cases). The independent meshes are immersed into a unique backgound computational mesh with the help of a projection technique and intersections of meshes are accounted for, allowing to compute to a fill factor usable as for the VOF methodology. This technique, combined with the use of parallel computing, allows to compute the flow of generalized Newtonian fluids in a complex system such as a twin screw extruder, including moving free surfaces. Moreover, the multidomain approach makes possible the computation of the thermomechanic problem, including heat conduction inside the screws.