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Magnesium alloys are increasingly used in automotive, aeronautic and electronic applications to produce high performance, light weight parts. In the thixomolding process the semi-solid slurry is injected into a mold at controlled temperature such that the melt has specific flow behavior. This allows the fabrication of near net shape components with controlled microstructure and good mechanical properties. This paper presents a 3D numerical solution algorithm for the simulation of the injection molding of semi-solid magnesium alloys. The methodology deals with the shear thinning, temperature dependent viscosity behavior and is able to accurately solve the high velocity free surface flows encountered during semi-solid magnesium molding. A segregated algorithm is used to solve the Navier-Stokes, energy and front tracking equations [1]. The position of the flow front in the mold cavity is computed using a level set approach. Equations are integrated in time using an implicit Euler scheme and solved by stabilized finite element methods. The viscosity is described using a generalized Newtonian model. Two sets of data are used representing the apparent viscosity as measured by two separate experiments.

The approach is applied to the molding of a tensile bar and the results compared with experimental data. Numerical solutions indicate that the material forms a jet at the exit of the gate and then a swirling flow is formed as the material advances along the first larger diameter section. The wall regions are filled first, leaving a void inside. This agrees very well with the experimental observation. The first larger section remains hollow during the filling of the central smaller diameter section. In the simulation using a lower viscosity, the void continues along the center of the smaller diameter section and the material flows along the walls in a spiral motion. This experimentally observed void is not present in the simulation with higher viscosity. The solution algorithm is able to tackle the high Reynolds number, high shear rate flow and to predict jetting, recirculating flow and formation of voids.

References

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