

PROJECTION METHOD FOR FLOWS WITH LARGE DENSITY VARIATIONS

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Numerical models of solidification including a mushy zone are notoriously inefficient; most of them are based on formulations that require the coupled solution of the velocity components in the momentum equation greatly restricting the range of applicability of the models. There are only two models known to the authors that have used a projection or fractional step formulation [1-2], but none of these were used to model problems of any significant size. A third model [3] was only applied to a partial mushy zone with no all-fluid region.

Our initial attempts at modeling directional solidification in the presence of a developing mushy zone using a projection formulation encountered very serious difficulties once solidification starts. These difficulties were traced to the inability of the method to deal with large local density differences in the vicinity of the fluid-mush interface [4]. As a result, a modified formulation of the projection method has been developed, that maintains the coupling between the body force and the pressure gradient and is presented in this work.

The new formulation is shown to be robust and efficient, and can be applied to problems involving very large meshes. This is illustrated in this work through its application to simulations involving Pb-Sb and Pb-Sn alloys.

References

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