Le Marec, C.; Guérin, R.; Haldenwang, P.
Collocation method for convective flow induced by directional solidification in a cylinder.
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We present a Chebyshev-Fourier collocation method for solving the unsteady three-dimensional Navier-Stokes equations in a cylindrical domain. The numerical scheme uses primitive variables, and the incompressibility constraint is satisfied by applying iteratively a correction to the pressure field. Several tests are carried out in Cartesian geometries, then a comparison is performed in a cylindrical domain with two different sets of radial collocation nodes: Gauss-Lobatto nodes and Gauss-Radau points.

We present an application to the study of thermosolutal convection induced by unidirectional solidification of a binary alloy. The latter grows from a Pb-30% Tl liquid phase in a cylindrical crucible corresponding to the vertical Bridgman upward configuration. We study the influence of the flow patterns on the crystal composition.

MSC:
76M25 Other numerical methods (fluid mechanics) (MSC2010)
76R10 Free convection
76T99 Multiphase and multicomponent flows
80A22 Stefan problems, phase changes, etc.

Keywords:
generalized Stokes problem; Chebyshev-Fourier collocation method; unsteady three-dimensional Navier-Stokes equations; cylindrical domain; primitive variables; Gauss-Lobatto nodes; Gauss-Radau points; thermosolutal convection; binary alloy; Pb-30% Tl liquid phase; vertical Bridgman upward configuration

Full Text: DOI

References:

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