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CONVECTION PROBLEM IN TWO-DIMENSIONAL ARBITRARY REGIONS

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Phase transition modelling with explicit tracking of interfaces [1] leads to convection problem in arbitrary regions. Numerical method with primitive variables and non-staggered grids [2] can be used in this case. This work presents the method for solving convection problem in two-dimensional arbitrary regions on non-staggered grids.

The classical formulation of convection problem with primitive variables in arbitrary region Ω can be written in the form

$$\frac{\partial \mathbf{v}}{\partial t} + C(\mathbf{v})\mathbf{v} + \operatorname{grad} p = \nu \Delta \mathbf{v} + \beta \mathbf{g} T, \qquad \operatorname{div} \mathbf{v} = 0,$$

$$\frac{\partial T}{\partial t} + C(\mathbf{v})T = k\Delta T, \quad x \in \Omega, \quad 0 < t \leq t_0.$$

The numerical method of solving is based on the idea of transition to a curvilinear non-orthogonal coordinate system (ξ, η). Such transformation leads to the following presentation of differential operators

$$\operatorname{div} \mathbf{v} = \frac{1}{|J^{-1}|}\left[(y_\eta u)_\xi - (y_\xi u)_\eta - (x_\eta v)_\xi + (x_\xi v)_\eta\right], \quad \operatorname{grad} p = \frac{1}{|J^{-1}|}\left(y_\eta u_\xi - y_\xi u_\eta, -x_\eta v_\xi + x_\xi v_\eta\right),$$

$$\Delta u = \operatorname{div} \operatorname{grad} u, \quad C(\mathbf{v})u = \frac{1}{2}\left((\mathbf{v} \cdot \operatorname{grad})\, u + \operatorname{div}(\mathbf{v}u)\right).$$

The results of computational experiment for modeling convection processes in regions with arbitrary shapes are given.

REFERENCES

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