

Numerical simulation of the heat transport and flow problems with phase change

Alekseev V.N., Vasilieva M.V.

Abstract

In this paper, we consider the heat transfer and flow problems in perforated domains with phase change [1]. Mathematical model contains convection-diffusion equation for the temperature and Stokes or Darcy equation for the flow. Heat transport with phase change described by the Stefan model [2, 3]. For simulation of flow with moving phase change boundary, we use fictitious domain method. For approximation by space of the equation we use the finite element method. For solution of such problem main difficulty related to the convection-diffusion equations in the case when the convective term dominates over diffusion. The standard approximation using the classical Galerkin method can lead to oscillations in the solution of the problem at high Peclet numbers. For a stable solution of this problem, SUPG is used. For approximation of flow problem, we use Taylor-Hood finite elements for Stokes flow and mixed finite element method for Darcy flow [4]. We present the numerical results for model problem in perforated domain in two-dimensional and three-dimensional formulations.

The work was supported by the mega-grant. The Government of the Russian Federation No. 14.Y26.31.0013.

References

- [1] *Chung E. T. et al* Generalized multiscale finite element methods for problems in perforated heterogeneous domains // *Applicable Analysis*. - 2016. - T. 95. - No. 10. - C. 2254-2279.
- [2] *Samarskii, A., Vabishchevich, P. N., Iliev, O. P., and Churbanov, A. G.* Numerical simulation of convection/diffusion phase change problems—a review. *International journal of heat and mass transfer*, 36(17), 4095-4106, 1993.
- [3] *Samarskii A. A., Vabishchevich P. N.* *Computational Heat Transfer* (Editorial URSS, Moscow, 2003) // *Google Scholar*. – 2009.
- [4] *Brezzi F., Fortin M.* *Mixed and hybrid finite element methods*. – Springer Science and Business Media, 2012. - T. 15.