New Numerical Approach for Solving the Oseen Problem in a Convection Form in Non-convex Domain

Viktor A. Rukavishnikov[1], Alexey V. Rukavishnikov[2]

[1] *Computing Center of Far-Eastern Branch, Russian Academy of Sciences, Khabarovsk, Russia*

vark0102@mail.ru

[2] *Institute of Applied Mathematics of Far-Eastern Branch, Russian Academy of Sciences, Khabarovsk, Russia*

78321a@mail.ru

Abstract: An essential class of problems describes physical processes occurring in non-convex domains containing a corner greater than π on the boundary. The solution in the neighborhood of a reentrant corner is singular and its finding using classical approaches entails a loss of accuracy. In the report, we consider stationary, linearized by Picard's iterations, Navier-Stokes equations governing the flow of a incompressible viscous fluid in the convection form in non-convex polygonal domain containing one reentrant corner on its boundary. An R_ν-generalized solution of the problem in special sets of weighted spaces is defined. A weighted finite element method to find an approximate R_ν-generalized solution is constructed. The degree of the weight function, as well as the parameter ν in the definition of an R_ν-generalized solution, and a radius of a neighborhood of the singularity point are free parameters of the method. Earlier, using the proposed method, the Stokes problem and Oseen system in a rotation form were numerically studied in [1-3]. A specially selected combination of them leads to increase the convergence rate of an approximate solution to the exact one in relation to the classical approaches. The convergence rate is equal to one by the grid step in the norm of the weighted Sobolev space and does not depend on the value of the reentrant corner.

Keywords: Oseen problem with singularity, weighted finite element method

2010 Mathematics Subject Classification: 65N30, 35Q30

References

[1] V.A. Rukavishnikov, A.V. Rukavishnikov, Weighted finite element method for the Stokes problem with corner singularity, Journal of Computational and Applied Mathematics, vol. 341, 144–156, 2018.

[2] V.A. Rukavishnikov, A.V. Rukavishnikov, New approximate method for solving the Stokes problem in a domain with corner singularity, Bull. South Ural State Univ., Ser. Math. Model. Program. Comput. Software , vol. 11, no 1, 95–108, 2018.

[3] V.A. Rukavishnikov, A.V. Rukavishnikov, New numerical method for the rotation form of the Oseen problem with corner singularity, Symmetry , vol. 11, no 1, (54) 1–17, 2019.