Numerical Simulation of Generalized Newtonian and Oldroyd-B Fluids in Stenotic Channel

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Abstract

Presented work deals with numerical simulation of generalized Newtonian and Oldroyd-B fluids. Newtonian fluids are described by the system of conservation laws of mass and momentum. In the generalized case of Newtonian fluids, the viscosity function is specified to describe shear-thinning behaviour of the fluid.

In the case of Oldroyd-B fluids the extra stress tensor is decomposed into Newtonian and elastic part. The later part is described by the Oldroyd-B model. When one considers generalized Oldroyd-B fluid, the modified Cross model is used to capture shear-thinnig behaviour of the flowing liquid.

Steady numerical solution of incompressible generalized Newtonian and Oldroyd-B flows is sought in the geometry of stenotic channel in 3D. An artificial compressibility method is used in numerical solution. In this case one can use marching in time to find steady solution with steady boundary conditions in the same manner as in the case of compressible flow. The system of governing equations is discretized by the finite volume method in space. The viscous fluxes are computed using dual finite volumes cells of the diamond type. The convective fluxes are discretized in a central manner. The resulting system of ordinary differential equations is then solved by the three-stage Runge-Kutta method. The comparison of Newtonian, generalized Newtonian, Oldroyd-B and generalized Oldroyd-B flows is presented in the geometry of stenotic channel.

References

1. T.Bodnar and A.Sequeira and M.Prosi . On the shear-thinning and viscoelastic effects of blood flow under various flow rates. Applied Mathematics and Computations 217, 2011, p. 5055-5067.