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Fluid flow in a curved thin pipe

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ABSTRACT

We consider an injection of incompressible viscous fluid in a curved pipe with a smooth central curve γ. The 1-dimensional model is obtained via singular perturbation of the Navier-Stokes system as ε, the ratio between cross section area and the length of the pipe, tends to 0. In case of shear-dependent viscosity (quasi-Newtonian flow) we us the two-scale convergence to find the effective equations. The first approximation of the effective flow depends only on the tangential injection along the central curve γ of the pipe and the velocity as well as the pressure drop are in the tangential direction. For stationary Newtonian flow an asymptotic expansion of the flow in powers of ε is computed. The second term contains the effects of the curvature (flexion) of γ in the direction of the tangent while in the direction of the normal and the binormal to γ the effects of torsion appear. The boundary layers at the ends of the pipe are studied. The error estimate is proved.

Keywords: *thin domains, lower-dimensional model, asymptotic analysis, Navier-Stokes system*

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