Minisymposium 8 - Homogenisierung und Anwendungen

Viscous fluid flow in bifurcating pipes

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We consider the flow of a viscous Newtonian fluid in a bifurcation of thin three-dimensional pipes with a diameter-to-length ratio of order $O(\epsilon)$. The model is based on the steady-state Navier-Stokes equations with pressure conditions on the outflow boundaries. Our aim is to construct an asymptotic expansion in powers of the diameter ϵ and a Reynolds number Re_ϵ, representing the assumption of small data. This approximation is based on Poiseuille flow in the pipes which is matched to the solution of a local Stokes problem in the junction. In this way we are able to include the influence of the bifurcation geometry on the fluid flow. We show that the solution of the junction problem decays exponentially to Poiseuille flow in the pipes and derive error estimates in powers of ϵ and Re_ϵ. The obtained results generalize and improve the existing ones in literature. In particular, our results show that Kirchhoff's law of the balancing fluxes has to be corrected in $O(\epsilon)$ in order to obtain an adequate error estimate for the gradient of velocity.