Asymptotic Analysis of the Polymer Fluid Flow through a Porous Medium

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Abstract.

By its simplicity, as well as its importance in the problems of fluid mechanics, Newton's model comes first and it postulates linear relationship between the viscous stress tensor and the symmetrized gradient of the velocity. In certain cases however, this model is not adequate because the viscosity simply isn't constant, but changes significantly with the increased shear stress.
Of all these so-called nonnewtonian or quasinewtonian fluids, we turn to the ones obeying the power-law, more precisely the polymer fluids. We observe the flow through a porous domain, seen as a periodic structure made of the fluid parts and the impermeable parts. The assumption of the periodic nature on the microscale level is fundamental to the asymptotic method called homogenization, whose main task is to determine the global filtration law. This procedure enables for the cumulative effect of the impermeable micro obstacles slowing down the fluid to be described by the effective equations given on the homogeneous domain, obstacle-free.
We show that the results depend on the asymptotic behaviour of one small parameter, the size of the impermeable part, during the homogenization process when number of cells tend to infinity and their size to zero. The precise filtration laws are low volume fraction limit for small size obstacles and nonlinear Brinkman's law in case of the critical obstacle size.