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Finite element methods for a mesoscopic constitutive model of blood

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Recent advances in Constitutive Models for viscoelastic fluids along with numerical techniques for solving their equations have allowed for higher level of detail in the simulations of viscoelastic flows. An application occurs in the modeling of blood flows in the smaller blood vessels. In such geometries, the clustering of red blood cells into aggregates called rouleaux begins to affect the flow patterns. Mathematically this is represented as an Oldroyd-B model for the elastic extra-stress tensor (due to the red blood cells), whose relaxation time is a function of the local average rouleaux size. In turn the elastic stress contribution of the red blood cells affects the fluid flow, which in turn affects via the local shear the average rouleaux size. This coupling results in a system that is capable of reproducing many interesting rheological properties of blood. The aim of this work is to implement the model in nontrivial geometries using the Finite Element Method, in particular the Discrete Elastic-Viscous Stress Split formulation for the Viscoelastic Navier–Stokes equations.

KeyWords : haemorheology, Stabilized Finite Elements.