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A Method for Fluid-Structure Interaction Problems with Non-Newtonian Fluid

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This paper represents a numerical method to solve fluid-structure interaction (FSI) problems where the fluid exhibits a non-Newtonian Viscoelastic behaviour. A number of applications may rise where there is a non-Newtonian fluid interacting with a deforming structure. For instance, there is a growing interest in numerical solution of blood flow inside deformable vessels in human arterial system.

A semi-implicit partitioned FSI method is developed which separates the fluid pressure term and strongly couples it to the structure, while the remaining fluid terms are only loosely coupled. Strong coupling of the pressure term guarantees the stability of the method while loose coupling of the remaining terms reduces the computational cost [1]. Thus the method is capable of solving FSI problems with strong added-mass effect.

Oldroyd-B constitutive equations is used to model the Viscoelastic behaviour of the fluid and it is coupled with the flow equations. The convective term in the constitutive equation is discretized using an upwind scheme. Log-conformation representation stabilization approaches is used to overcome the high Weissenberg number problem (HWNP) [2].

Numerical tests are conducted on a case of Viscoelastic fluid inside a lid-driven cavity where the bottom wall is deformable. Different values of Weissenberg number of Viscoelastic fluid are tested. Numerical results of velocity magnitude inside of the domain and time evolution of deformation of the bottom wall are extracted and compared with the results regarding the Newtonian fluid. A discussion is made on the results.

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