PREDICTION OF BLOOD DAMAGE WITHIN BIOMEDICAL BLOOD-WETTED DEVICES DUE TO MECHANICAL ACTION

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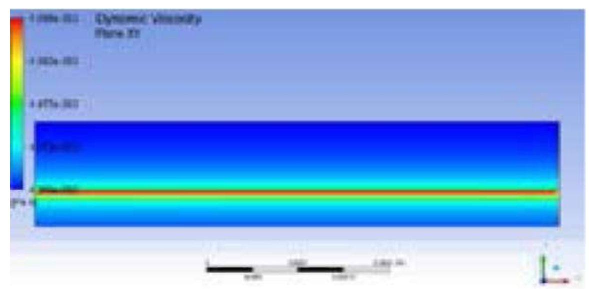
Introduction. The goal of this project is to develop a CFD model of blood to predict hemolysis due to mechanical action in biomedical blood-wetted devices. Most of the current models approximate blood as a Newtonian fluid at high shear rates. Our work is based on numerical model developed in [1] that modeled blood as a multiphase fluid with constant viscosity. Although successful in capturing phase segregation (Fahraeus-Lindqvist effect), it still did not reach acceptable agreement with experimental data in terms of damage. Gijsen et al. [2] reported significant differences between flow fields obtained by Newtonian and non-Newtonian models of blood. The goal of this study is to introduce non-Newtonian blood rheology to the base model and validate it with existing experimental data.

Methodology. The base model is a 3D Eulerian-Eulerian multiphase model implemented in CFD platform. Blood is modelled to consist of disperse (red blood and platelet cells) and continuum (plasma) phases. Garon and Farinas [3] used blood damage transport model to calculate hemolysis caused by shear stress. To simulate non-Newtonian rheology of blood we used Quemada model which was proven to accurately reproduce blood behavior by several authors [4,5]. Validation of the proposed model will be done by applying it to stenotic connectors of different geometry and surface roughness.

Results/Discussion. This research work is still in early-stage development. We implemented Quemada model for viscosity in plane Couette-Poiseuille flow and observed shear-thinning behavior of blood (Fig. 1). Later this viscosity model will be applied to the multiphase model which will account for the local hematocrit at each point of the domain and adjust the viscosity correspondingly.



Conclusions. It is anticipated that introduction of a more realistic rheology to the model will improve agreement of numerical results with experimental data on blood damage.

References

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