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TOWARDS A REALISTIC MODEL OF BLOOD VISCOSITY AND COAGULATION IN MEMBRANE OXYGENATORS

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Modelling blood flow and shear induced coagulation in membrane oxygenators (MO) is challenging. The relevant geometry of oxygenator fibers (OF) and chaining threads is complex and spans several length scales. In relevant scales and regimes blood shows several significant non-Newtonian effects [1]. Existing models are only capable of accounting for some, but not all relevant effects. Additionally, coagulation processes are influencing fluid properties and geometry significantly. Due to the enormous size of the discretised geometries highly detailed viscosity and coagulations models are not applicable. Our goal is to develop a model for combined viscosity and coagulation properties of blood flow in MOs. First step is to find a geometry dependent viscosity representation on basis of parametric micro channel experiments with anti-coagulated blood. Next step is a statistic coagulation model, based on micro channel experiments with human (re-calcified citrated) whole blood and evaluation of clinically used oxygenators. Since shear rate dependent (i.e. viscosity dependent) coagulation in return influences the viscosity, a combined model with suitable implementation in a RANS framework is necessary. Towards this end, micro channel experiments with new and used single OFs triggering coagulation are performed. Structures of multimeric von Willebrand fibers (vWF), as indicator for shear induced coagulation, are compared to computed and measured flow conditions, using using immunofluorescence microscopy, RANS-computations and μPIV, respectively. Preliminary examinations in clinically used MOs show good agreement between occurring structures of vWF, cell deposits and computed flow patterns (geometry from μCT-Scans). However, computed shear rates might be to low to actually trigger activation of vWF. The complex geometry of MOs results in huge meshes, which makes RANS with statistical modelling of viscosity and coagulation a reasonable approach. Towards this end, experimental data on micro channel level with evaluation on real application level is crucial. Especially regarding clotting processes, micro fluidic experiments are a powerful research tool [2].

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