REDUCED ORDER MODELING OF TIME-DEPENDENT PURELY VISCOUS NON-NEWTONIAN FLUID FLOWS

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Abstract. This work numerically evaluates the accuracy and performance of a stabilized finite element Reduced Order Modelling (ROM) approach designed to simulate time-dependent generalized Newtonian fluid flows. The method estimates off-trained parametric scenarios not included in the training data set composing the ROM basis and can adopt arbitrary values from other specific fluid and flow conditions. Also, a mesh-based hyper-reduction technique is included [1].

The numerical testing includes approximating well- established benchmark solutions of shear-thinning and shear-thickening fluid flows to demonstrate the method's robustness. Furthermore, the application of the method in two engineering problems related to hemodynamic and conjugate thermally coupled flows is presented [2,3].

Numerical results evidence the method's capability, accuracy, and performance to approximate complex flow conditions of generalized Newtonian fluids.

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Keywords: Stabilized Finite Element Metods, Variational Multiscale Method, Non-Newtonian Fluids, Reducer Order Modelling.

References

[1] R. Reyes, O. Ruz, C. Bayona-Roa, E. Castillo and A. Tello. Reduced order modeling for parametrized generalized Newtonian fluid flows. *Journal of Computational Physics*, 484: 112086, 2023.

[2] N. Espinoza, C. Bayona-Roa, E. Castillo, T. Gandara and N.O. Moraga. Hyperreduced-order modeling of thermally coupled flows. *Applied Mathematical Modeling*, 125(Part A): 59-81, 2024.

[3] C Farías, C Bayona-Roa, E Castillo, RC Cabrales, R Reyes. Reduced order modeling of parametrized pulsatile blood flows: Hematocrit percentage and heart rate. *International Journal of Engineering Science*, 193: 103943, 2023.

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