Reduced-order modeling of generalized Newtonian fluids including engineering applications

Ernesto Castillo[1] and Camilo Bayona[2]

[1] Universidad de Santiago de Chile, Av Libertador Bernardo O'Higgins 3363, Santiago, Chile,
ernesto.castillode@usach.cl

[2] Centro de Ingeniería Avanzada, Investigación y Desarrollo, Bogotá, Colombia, cbayona@ciaid.co

Key Words: *Generalized Newtonian Fluids, Reduced Order Modeling, VMS- Methods.*

We present a projection-based model reduction approach to solving generalized Newtonian fluids in this work. We develop our formulation using three ingredients: a standard offline--online setting for the model reduction based on a proper orthogonal decomposition approach, the finite element method for the discretization of the domain, and the variational multiscale approach, and a stabilization technique for both the full and reduced-order models [1,2]. As a novelty, in this work, we propose a POD-like algorithm that includes more than one parameter in the basis construction, allowing us to solve problems outside the training set. We test the method using the power-law index of the fluid and the Reynolds number as parameters. The numerical results include 2d and 3d solutions related to hemodynamic flows and thermally coupled flows of conjugate problems.

REFERENCES

[1] E. Castillo and R. Codina, Dynamic term-by-term stabilized finite element formulation using orthogonal subgrid-scales for the incompressible Navier–Stokes problem. *Computer Methods in Applied Mechanics and Engineering*, Vol. **349**, pp. 701−721, 2019.

[2] R. Reyes and R. Codina, Projection-based reduced order models for flow problems: A variational multiscale approach. *Computer Methods in Applied Mechanics and Engineering*, Vol. **363**, 112844, 2020.