6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

# Numerical simulations of immiscible generalised Newtonian fluids

**Knut Sverdrup[1*], Nikolaos Nikiforakis[1] and Ann Almgren[2]**

[1]Cavendish Laboratory, University of Cambridge, CB3 0HE, UK
[2]Lawrence Berkeley National Laboratory, CA 94720, USA

**Keywords**: *Fluid-Fluid Displacement, Non-Newtonian Yield Stress Fluids, High Performance Computing*

We present a numerical methodology for three-dimensional large-scale simulations of two-fluid flow for generalised Newtonian fluids exhibiting non-Newtonian behaviour such as a non-zero yield stress and power-law dependency on strain-rate. The incompressible Navier-Stokes equations are solved using a computational framework initially developed at Lawrence Berkeley National Laboratory. The solver uses second-order Godunov methodology for the advective terms and semi-implicit diffusion in the context of an approximate projection method to evolve the system in time. We have extended the algorithm to enable the simulation of Herschel-Bulkley fluids by means of a mathematical regularisation of the constitutive equation which describes the fluid rheology. Additionally, interfaces between fluids with different properties are treated using a passively advected indicator function. The performance of the software is validated for two-dimensional displacement flow and tested on a three-dimensional viscoplastic dambreak.

## REFERENCES

[1] A. S. Almgren, J. B. Bell, P. Colella, L. H. Howell and M. L. Welcome, A conservative adaptive projection method for the variable density incompressible Navier-Stokes equations. *J. Comp. Phys.*, Vol. **142**, pp. 1–46, 1998.

[2] K. Sverdrup, N. Nikiforakis and A. Almgren, Time-dependent viscoplastic fluid flow simulations in two and three dimensions. *arXiv preprint arXiv:1803.00417*, 2018.

[3] K. Wielage-Burchard and I. Frigaard, Static wall layers in plane channel displacement flows. *J. Non-Newt. Fluid Mech.*, Vol. **166**, pp. 245–261, 2011.

[4] Y. Liu, N. J. Balmforth, S. Hormozi and D. R. Hewitt, Two-dimensional viscoplastic dambreaks. *J. Non-Newt. Fluid Mech.*, Vol. **238**, pp. 65–79, 2016.

*Presenter at conference and corresponding author: ksk38@cam.ac.uk