Contribution ID: **342** Type: **Oral Presentation**

Postitive feedback effects in 2D creeping flow of viscoelastic fluids through porous media amplify preferential flow paths

Monday, 31 May 2021 11:10 (15 minutes)

The flow of dilute polymer solution in model porous media consisting of an array of cylinder is considered. Numerical [1] and experimental [2] studies show that such flows are subject to the intensification of preferential flow paths. These pathways tend to favour shear stress and thus increase viscous dissipation and decrease permeability.
We seek to study the mechanisms of reinforcement of these preferential flow paths which are crucial to the understanding of these flows. We consider here the Oldroyd-B model of dilute polymer solutions.
The equations of the model are solved using a time prediction-correction scheme and MAC discretization in finite volume in space.
The flow around two cylinders in a channel is first studied. As experimentally observed in [3], preferential flows appear, depending on the gap between the cylinders.
We show that the reinforcement mechanism of the preferential flow paths is linked to the appearance of elastic membranes which will interact with the flow. Like gates, they will guide the flow to areas where the velocity is initially high.
We then show how this mechanism works in the flow through an array of cylindres and study its impact on the flow and its macroscopic properties.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

[1] S. De, J.A.M Kuipers, E.A.J.F Peters, and J.T Padding. Viscoelastic flow simulations in random porous media. Journal of Non-Newtonian Fluid Mechanics, 248 :50–61, 2017.

[2] D.M. Walkama, N. Waisbord, and J.S. Guasto. Disorder suppresses chaos in viscoelastic flows. Phys. Rev. Lett., 124 :164501, Apr 2020.

[3] C.C. Hopkins, S.J. Haward, and A.Q. Shen. Tristability in viscoelastic flow past side-by-side microcylinders. Phys. Rev. Lett., 126 :054501, Feb 2021.

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Session Classification: MS21

Track Classification: (MS21) Non-linear effects in flow and transport through porous media