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Non-Newtonian flow in macroscopic heterogeneous porous media: from power-law fluids to rheology with change of behavior

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Many natural or industrial fluids exhibit non-Newtonian behavior. Non-Newtonian fluids can therefore be found in different applications related to porous or fractured media such as mud flows, oil recovery, hydraulic fracturing or foam injection clean-up.
Although there are many different non-Newtonian fluids, we focus in this work on fluids that exhibit a change in regime: for low shear-rate, their viscosity is constant (Newtonian) but it becomes shear-thinning (or shear-thickening) at higher shear rate.
And we are interested in understanding the flow of these fluids in large scale heterogeneous porous media, and particularly in the coupling between flow heterogeneity and the rheology.

Since the local viscosity changes above a certain velocity threshold, the flow field depends drastically on the mean flow rate or the applied pressure drop. In particular, one expects that the flow condition affects drastically the velocity field inhomogeneity, which is an important feature to understand the transport of species. We will show that, if the flow presents two asymptotic regimes of low and high flow rate corresponding to power-law fluids, the transition between these two regimes characterizes the heterogeneity of the permeability field. And, similarly to the case of yield stress fluids, the flow field presents interesting geometrical characteristics in this transitional regime, such as criticality and multi-scale (fractal) properties which will be analyzed.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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