Contribution ID: **101** Type: **Oral 20 Minutes**

Flow of Yield Stress and Carreau fluids through Rough-Walled Rock Fractures and Packed Beads: prediction and experiments

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Many natural phenomena in geophysics and hydrogeology involve the flow of non-Newtonian fluids through natural rough-walled fractures and unconsolidated granular porous media. Therefore, there is considerable interest in predicting the pressure drop generated by complex flow in these media under a given set of boundary conditions. However, this task is markedly more challenging than the Newtonian case given the coupling of geometrical and rheological parameters in the flow law. Indeed, although recent advances have been made, obtaining a macroscopic law to predict pressure drop as a function of flow rate has proved to be a stumbling-block. In particular, extending Darcy's and Forchheimer's laws to the case of non-Newtonian fluids flow poses a considerable challenge. The main contribution of this work is to propose a simple method to predict the flow of commonly used Carreau and yield stress fluids through fractures and packs of spherical beads. To do so, a characteristic shear rate of the flow through the porous media is rigorously defined and an expression relating the "in-situ"shear viscosity of the fluid to the bulk shear-viscosity parameters is subsequently obtained. Then, this "in-situ"viscosity is entered in the macroscopic laws to predict the flow rate-pressure gradient relations. Experiments with yield stress and Carreau fluids were conducted using two replicas of natural fractures and 5 packs of beads and covering a wide range of injection flow rates. The results of these experiments are compared to the predictions of the proposed method, showing that the use of a constant shift parameter to relate "in-situ"and bulk shear viscosity is no longer valid in the presence of a yield stress or a plateau viscosity. This means that the relationship between characteristic shear rate in the porous medium and flow rate is not linear at low flow rates for these types of fluids. Consequently, properly representing the dependence of the shift parameter on the flow rate is crucial to obtain accurate predictions. The proposed method predicts the pressure drop in rough-walled fractures and packed beds at a given injection flow rate by only using the shear rheology of the fluid and the porosity and permeability of the medium as inputs. Our results can be included in computational studies of large-scale nonlinear flow in fractured rocks and unconsolidated granular media, which should result in improved predictions providing valuable information for management and decision making.

References

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