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Experimental evidence for use of Non-Newtonian fluids for pore structure characterization

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Recent advancements in non-Newtonian fluids research have led to the theoretical development of new method for pore structure characterization. Given the complexity of the developed framework, a numerical solver, referred to as "AAPP method", was built to accommodate a wide range of possible fluid properties and experimental conditions. Using this solver, numerical evaluations revealed promising utility for complementing the use of water in saturated infiltration experiments with different (N-1) non-Newtonian fluids to obtain N different effective pore radii and their contribution to total flow. The method was then tested with synthetic porous media composed of different combinations of capillary tubes showing the ability of the N-1 non-Newtonian fluids to predict with acceptable accuracy the distribution of the pore structure. The numerical evaluations and the experimentation with simple synthetic porous media revealed promising potential out of this method: an ability to predict pore structure that is far beyond the ability of what a similar or even larger number of Newtonian fluids alone can do. To demonstrate the ability on real soils, a series of one-dimensional column experiments was conducted with varying porous medium packings, including a range of Accusands and a polydisperse sand/glass bead mixture. For each packing, distilled water and three concentrations each of guar gum and xanthan gum were injected at a range of flow rates, and the resulting pressure was measured. Data collected from the column experiments were used as inputs for the "AAPP method" to calculate representative pore radii for each media. The model output for varying fluid/flow rate permutations were combined to produce a distribution of pore radii. Independently, the pore radii were determined by x-ray micro-computed tomography (microCT) and these results were compared with results obtained from the new method, and were found to be in good agreement.