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Microfluidic Visualization and Modeling of Polymer Induced End-Point Relative Permeability Damage

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After polymer injection, the end-point relative permeability of porous medium to other fluids often drops significantly and is not the same as that prior to polymer injection. To understand the hydrodynamic mechanism of this change, we conducted microfluidic experiments. We discovered that polymer solutions were mostly found in pores that are aligned with the direction of mean flow. At the end-points, to flow around the polymers, oil / water needed to use channels that are not aligned. Their flow pathways hence became more tortuous. To quantify the effect of pathway tortuosity, orientation distributions of fluids in the microfluidic porous medium were measured. They were then coarsened into four bins consisting of channels 0, 30, 60, and 90 degrees relative to the direction of mean flow. By treating the microfluidic porous medium as a superposition of two inter-penetrating honeycombs, we show that the observed distributions of fluids at the end-points could largely explain the changes in the end-point relative permeabilities, proving the tortuosity of the flow was indeed a significant contributor to end-point relative permeability damage.

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