

STUDY OF IMMISCIBLE VISCOUS FINGERING IN POROUS MEDIA USING COMSOL MULTIPHYSICS

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This study presents a computational investigation of immiscible viscous fingering in a two-dimensional homogeneous porous medium using COMSOL Multiphysics 5.5. The phenomenon was modeled by injecting a low-viscosity fluid (water-glycerin mixture) into a high-viscosity fluid (crude oil), leading to hydrodynamic instability known as viscous fingering at the fluid interface due to the viscosity contrast between the two fluids. The simulation framework was developed using Darcy's law to describe flow in porous media, coupled with a phase-field method to capture the immiscible fluid interface of the water-glycerin mixture displaces oil in a homogeneous porous medium. The results revealed the dynamic evolution of these structures and provide insight into displacement efficiency and interface morphology in immiscible fluid systems within porous media. The difference in how the water-glycerin mixture and oil move through the medium was characterised by their mobilities, and this difference was described by the log mobility ratio. In this scenario, the water-glycerin mixture flows more easily than the oil, which quantifies how easily one fluid moves in relation to the other. Influence of the variation of the speed of the water-glycerin mixture on the shape and growth of the fingers were also studied. Understanding these effects helps to improve processes such as enhanced oil recovery, where injecting fluid to push out oil is common.

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