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# The Influence of Viscosity and Wettability on Immiscible Fluid Displacements in Porous Media

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We study the synergistic impact of wettability and viscosity on immiscible fluid displacements in heterogeneous porous media. Direct Numerical Simulations are performed for viscosity ratio M (of invading vs defending fluid) ranging several orders of magnitude and contact angles ranging from very small to very large i.e. from completely wetting to completely non-wetting. The capillary number is kept constant at ⊠⊠=1×10−6 for all the investigations.

We notice different fluid displacement patterns such as fingering and compact displacements when the Ca is maintained low and by varying the viscosity ratios and the contact angles. For viscosity ratios greater than 1, the morphology of the displacement patterns is observed to be compact and is hardly affected by the wettability. On the other hand, at viscosity ratios lower than 0.1, we observe viscous fingering during imbibition and drainage. When the viscosity ratio moves towards 1, capillary fingering emerges. This intriguing observation suggests that one cannot use the knowledge about the displacement patterns to comment on the wettability states of the porous medium.

We further quantify the pore occupancy by the invading fluid during imbibition and drainage. Though we notice similar displacement patterns that occur at lower (M<1) and higher viscosity ratios (M>1), we notice differences in the pore filling mechanisms by the invading fluid. For M>1, the 'co-operative pore filling'is prominent irrespective of the wettability state. For M<1, we notice the dominant pore invasion mechanism during drainage is 'channelling'whereas for imbibition, the wetting phase propagates over the surface of the solid grains gradually.

## Participation

In-Person

## References

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