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Effect of grain circularity on the temporal evolution of interfacial area

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Multi-phase flow is controlled by the pore geometry of the porous domain, which is formed by the grain morphology. Grain morphology not only influences fluid behavior and transport but also affects the development of interfacial area over time. One quantitative measure of grain morphology is circularity, i.e., how closely a grain resembles a perfect sphere. The objective of this work is to quantify how grain circularity affects the temporal development of interfacial area during multi-phase flow through porous media. A multi-phase lattice Boltzmann method (Guntensen et al., 1991; Reis and Phillips, 2007) is used to simulate oil-water drainage and imbibition in an ensemble of two-dimensional porous media samples (Mollon and Zhao, 2012). We conducted multi-phase simulations on 3 groups of porous media which involved: 20 realizations of spherical grain shapes, 20 realizations of intermediate grain shape, and 20 realizations of elongated grain shapes. Interfacial area was periodically monitored during drainage and imbibition simulations in 60 samples, until the samples acquired steady-state fluid saturations. During drainage and imbibition, the interfacial area increases with time, acquires a peak value, and then decreases before reaching a plateau at steady-state. All three groups of porous media showed the same temporal trend, with no major differences. However, the domains with highly circular groups showed an average 16 percent residual water saturation at the end of drainage, while only a 10 percent average residual water saturation was observed in the other two groups. The results indicate that grain circularity does not strongly affect the temporal evolution of interfacial area but influences the residual fluid volumes in the system. This implies that in case of oil spills in groundwater, spherical grains would be expected to have more water residual than an elongated grain system. Therefore, the results of this work can help understand oil contamination in groundwater and improve soil remediation efforts.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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Primary authors: Ms ZAHID, Fizza (University of South Florida); CUNNINGHAM, Jeffrey (University of South Florida)

Presenter: Ms ZAHID, Fizza (University of South Florida)

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