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Measuring fluid-solid interfacial area during multiphase flow in a porous medium at different wetting and flow conditions

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Wetting a porous solid with a fluid is one of the most fundamental phenomena governing the multiphase flow in a porous medium for applications such as CO2 or H2 storage in geological reservoirs or oil and gas reservoirs. Quantifying wettability using contact angle is limiting due to the scale and heterogeneity of these reservoirs. Capturing the effect of flow and surface roughness while measuring the contact angle is difficult. In this study, we demonstrate a tracer method to directly measure the wetted area of the solid by a liquid during multiphase flow in a sand-pack. The wetted area is a function of the contact angle; therefore, measuring the wetted area can quantify the wettability of the porous solid. We use multiphase flow experiments in the sand-pack at different wetting conditions of the sand tested by floatation test and capillary rise experiments. We do tracers tests at different fluid phase saturations (i) organic phase is at residual saturation (ii) both the organic and the aqueous phases are moving. When the organic phase is at the residual saturation for water-wet sand, we observe that increasing the flow rate does is not change the residual saturation significantly. However, the contact area of the aqueous phase with the porous solid increases with an increase in the water flow rate. This is because of the increased capillary number and different pore-scale fluid distributions at rising water flow rates. For oil-wet sand, we observe that the water saturation increases with the flow rate; however, the water-solid contact area first decreases and then increases when we increase the water flow rate. This is because of the considerable alteration in matrix dissolution at various water-flow rates. In other words, the topology of individual trapped oil globules changes at different water flow rates. When both phases move, we see that the contact area and phase saturations are correlated. We obtain a monotonic increasing behaviour of the water-saturation and water-solid interfacial area, increasing the water flow rate in the porous medium during all wetting conditions.

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References

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Time Block Preference

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

Participation

Online

Primary authors: Ms SINGH, Deepshikha (Indian Institute of Technology Delhi); Prof. PHIRANI, Jyoti (University of Strathclyde)

Presenter: Ms SINGH, Deepshikha (Indian Institute of Technology Delhi)

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