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Characterization Of Capillary Driven Flow In Layered Porous Reservoirs

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For gas storage in the geological reservoirs, it is important to understand fluid flow behaviour when capillary forces are dominant i.e. after the gas injection stops. In this work, we use numerical simulations to understand the capillary driven flow in layered porous reservoirs at Darcy scale. Using our model we want to predict if capillary breakthrough is possible in the cap rock based on the properties of the layers. We used MATLAB Reservoir Simulation Tool (MRST) for unidirectional capillary driven flow assuming horizontal displacement in co-current mode. The core dimensions of 5 m x 1 m x 1 m are used for two-layered reservoirs. We placed an additional grid cell of pore volume ten times to that of the core at one end of the setup which acts as a water tank. The boundary conditions in simulation are controlled using the wells. We positioned one injector well in the water tank and one production well at the other side of the core with pressures of both the wells being the same to allow for capillary driven flow. For a single layered, homogeneous system, we compared the obtained saturation profiles from the simulation with the analytical solution published in the literature. Comparisons are provided for three different wettability states for oil-water systems. For mixed wet case, the numerical solution shows a good match with the analytical solution. We validated our simulation model using several cases of the homogeneous reservoirs of different petrophysical properties, relative permeability, capillary pressure - saturation curves, and varying mobility ratios. Using our model for layered porous media, we observed that the fluids propagate with different velocity in each layer and wetting fluid (i.e., water for strong water-wet) reaches farther through the low permeability layer due to high capillary forces. The solution obtained can be used to study the influence of wettability, predicting saturation profiles and breakthrough characteristics. The simulation study undertaken can be used to understand the flow of wetting and non-wetting fluids in a geological layered reservoir, for example in CO2 sequestration when CO2 injection has stopped. Using this model we can estimate the required properties of the caprock for no leakage of CO2.

Participation

In-Person

References

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