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Investigation of water film rupture time in entrapped oil recovery during high pressure gas injection at different miscibility conditions

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In wet water media, a continuous thin water film exists on the surface of pores and pore throats in the reservoir rock. As water saturation increases during water flooding, this film coalesces into a water layer, which isolates the residual oil behind the oil bank in the form of more massive ganglia. When the tertiary gas injection process is applied to such a system, direct contact between the oil and gas phases will be impossible due to the presence of the water barrier formed previously. This phenomenon is referred to as water blocking or the water shielding effect. In the current survey, the time required in rupturing the water film shielding the oil as a result of oil swelling caused by the diffusion of dissolved gas in the water phase and trapped oil behind it has been investigated in porous medium at high pressure and temperature. To study the active mechanisms, the experiments have been conducted with two different types of injectants: carbon dioxide and methane (with different solubility in water), under different miscibility conditions at equal reduced pressures. The results show that water film reduces the performance of oil recovery by limiting the interface of oil and gas phase. Under such a condition, the best scenario is the miscible gas injection because the gas can effectively swell the oil and rip the water shield. At miscible and near-miscible conditions, the time required for wiping out the water film increases as the injectant solubility in water decreases; however, there is a negligible difference at the immiscible regime. The trend of oil recovery curves after rupture of the water film shows that oil swelling is one of the main mechanisms involved in water-trapped oil recovery. These results suggest practical guidelines on the effect of water shielding phenomenon in the field of tertiary gas injection.

Recent Publications

1. Mirazimi S, Rostami B, Ghazanfari M H and Khosravi M (2017) Water film rupture in blocked oil recovery by gas injection experimental and modeling study. Chemical Engineering Science 161:288–298.
2. Zeinabadi D, Rostami B and Khosravi M (2016) Effect of petro physical matrix properties on bypassed oil recovery from a matrix-fracture system during CO2 near-miscible injection: experimental investigation. International Journal of Multiphase Flow 85:123–131.
3. Kazemi K, Rostami B, Khosravi M and Zeinabadi D (2015) Effect of initial water saturation on bypassed oil recovery during CO2 injection at different miscibility conditions. Energy & Fuels. 29(7):4114–4121.
4. Khostavi M, Rostami B, Emadi M and Roayaie E (2015) Marangoni flow: an unknown mechanism of oil recovery during near-miscible CO2 injection. Journal of Petroleum Science and Engineering 125:263–268.
5. Fatollahi A and Rostami B (2014) Carbonated water injection: effects of silica nano-particles and operating pressure. The Canadian Journal of Chemical Engineering 93(11):1949–1956.

Biography

Behzad Rostami is an Associate Professor of Petroleum Engineering at the Institute of Petroleum Engineering (IPE) at University of Tehran. His research interests include gas injection-based methods for enhanced oil recovery, foam injection and carbonated water injection, CO2 sequestration in saline aquifers and depleted hydrocarbon reservoirs, gravity drainage and multi block interaction in fractured media. He authored more than 40 technical papers in international journals and also supervised more than 30 graduate students.

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