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Pore-scale Assessment of Spontaneous Imbibition from Layer to Layer

Tuesday, 31 May 2022 17:00 (15 minutes)

Spontaneous imbibition is a fundamental flow mechanism that plays a significant role in oil extraction from subsurface reservoirs. Understanding the imbibition behavior, which is driven by capillarity relative to the interfacial forces between the immiscible fluids within the porous media, is essential for designing and optimizing IOR/EOR recovery schemes. Conventional lab experiments with Amott cell, which is commonly used to quantify the oil recovery behavior from a core plug, do not replicate the actual field conditions, where imbibition occurs within the porous media, i.e., from layer to layer. The poor representation of field case conditions may underestimate the full potential of the imbibition mechanism. In this study, we propose a new method to complement the conventional method by providing insights on the spontaneous imbibition behavior from layer to layer, mimicking cross-flow between reservoir layers. The concept is based on placing two different layers of glass beads, with different mesh sizes, in contact with each other in a closed-cell and observing the change in saturation and the cross-flow pattern at the pore-scale level, driven by capillarity and wettability difference. The fluid change will be only in the water-oil distribution, where water initially placed in one glass beads layer is expected to imbibe the other layer and vice-versa for the oil, i.e., counter-current flow. Computed Tomography Scan (CT scan) equipment was employed for this purpose. High-resolution time-lapse images were captured and reconstructed to represent the whole volume of the two layers. The imbibition front movement and the redistribution of the saturation were qualitatively analyzed and discussed. We were able to offer an understanding of the effects of heterogeneity and pore size distribution on the imbibition and cross-flow between the layers at the pore-scale level. X-ray attenuation, which is affected by the sample's density and atomic number, was used to quantify the change in saturation with time and construct the production curves. Results were used to enhance the obtained conventional spontaneous imbibition by Amott cell and provide a new concept about the imbibition mechanism across the contact of the two rocks. We also identified areas of preferred production sites as evidence of the wettability heterogeneity within the rock. The novelty of this work, which is the first of its kind, is that it provides a deep understanding of the pattern of the spontaneous imbibition that happened in the subsurface. The new method should complement the current Amott cell method to enhance the construction of the production curves. The use of micro-CT and time-lapse in-situ imaging facilitates visualizing and quantifying rock-to-rock imbibition within heterogeneous porous media, which cannot be achieved with the conventional methods.

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References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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