Wettability in porous rocks, from macroscopical measurements to pore scale characterization

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Abstract

Wettability refers to the relative preference of a solid material for one fluid in a diphasic or multiphasic system. As this property greatly affects the distribution of fluids in the pore space, it has a critical influence on the oil recovery [1] [2] [3] . Despite the great importance of wettability for the oil industry, the understanding its experimental characterization and its exact impact at the pore scale remains poorly known. The wettability of a reservoir rock is generally determined on centimeter-sized samples through volumetric measurements recovered fluids and expressed by a parameter such as the Amott index. The current study aims at establishing a correlation between such macroscopic measurements and physical characteristics at the pore scale. We focus on a Bentheimer outcrop sandstone, saturated with brine and oil. Two twin samples with equal length but different diameter are subjected to the classical Amott procedure: a sample of $36mm$ in diameter diameter enables to obtain the Amott index by volumetric measurement of the produced fluids [4], while a sample of around $5mm$ in diameter enables direct observation of the distribution of the fluids inside the sample's pore space. This observation is done by acquiring tomographic scans with a typical resolution around $2\mu m$ to $3\mu m$. As both samples are subject to the same constraints, we impose the same capillary pressure, and should obtain the same saturation state at each phase of the test. For time considerations, and as we are mostly interested in Amott Indexes, we only record saturation states at the endpoints, i.e. after primary drainage, spontaneous imbibition, forced imbibition, spontaneous drainage, and forced drainage. When equilibrium is reached, we perform X-ray computed tomography on the small sample. The bulk part of this work focuses on the adaptation and validation of the Amott procedure on the small sample. We first applied this methodology to extremely water wet cases, i.e. Bentheimer "as received". The indexes calculated by means of recovered volume on the centimeter-scale and through saturation profile in the millimeter-scale sample proved to be consistent. Moreover, a good agreement was found between the observed behavior of the fluids in the rocks, the expectations from the literature, and the macroscopically measured Amott Index. Future work will focus on moderately water wet to oil wet cases.

Keywords: *Wettability, Xray microcomputed tomography, Porous medium, pore scale*

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