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Monitoring low permeable two-phase fluid flow experiments by NMR

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Abstract

Nuclear magnetic resonance (NMR) is a well established laboratory / borehole method to characterize the storage and transport properties of rocks due to its direct sensitivity to the corresponding pore fluid (water / oil), pore sizes and saturation. Usually, the accuracy of these properties strongly depends on the calibration of the pore model with other experimental data (e.g. high pressure mercury injection). In this contribution we will present a novel inversion approach that uses an angular pore model and different levels of saturation to directly determine the pore size distribution of the sample without the need of calibration.
We present results of state-of-the-art two-phase fluid flow experiments in a high-pressure NMR flow cell carried out on tight gas sandstones. The initially fully water saturated samples are installed at high confining pressures of 150 bar. Subsequently, the samples are drained with nitrogen by step-wise increasing the differential pressures across the sample. After gas flow is established effective (relative) gas permeabilities are measured. With increasing pressure difference gas permeability increases due to the decreasing water saturation. The entire drainage process is monitored by NMR relaxation measurements to continuously determine the water saturation of the sample. This allows for a direct estimation of saturation dependent relative permeability, a key parameter when estimating production rates of reservoir rocks.