



Contribution ID: 830

Type: Poster

Observation and Evaluation of Multiphase Flow in Heterogeneous Porous Media of Tight Gas Reservoir with Super-normally Saturated Water

Monday 14 May 2018 17:15 (15 minutes)

The phenomena of tight gas reservoirs with super-normally saturated water, which exhibit the unique combination of very high initial water saturation combined with low to very low permeability (permeability of less than 0.1 mD) exist extensively in a number of regional sedimentary basins. Traditionally, multiphase flow of natural gas and connate water is evaluated in laboratory by conducting flow experiments. However, due to the lack of sufficient insight vision, this traditional method only reflects the macroscopic phenomena but fails to reveal some important microscopic behaviors inside the cores of different type of reservoir during multiphase flow process. In this paper, a new method, which combined the multiphase flow experiment and nuclear magnetic resonance experiment, was introduced to effectively observe and characterize the water flow to various multiphase flow scenarios in different types of rocks. First of all, a series of core displacement experiments were carried out. Then, based on the displacement experiments, the pore size distribution of rock samples is converted by NMR T2 spectrum by T2 spectrum experiment. The distribution of the remaining water under different water saturation of different cores was analyzed and the water production mechanisms of tight high water saturation reservoir were revealed. Finally, we prove the relationship between gas & water production and pore structure using effective flow formula. Through theoretical analysis and calculation, the physical significance and the value of two main parameters in gas production formula are made clear. This experiment and evaluation methods provided a valuable tool in the evaluation of whether given pay zones in an ultra-tight gas reservoir situation are worthy of completion and what kind of pressure should be provided for production. It also provides information on how this new method can be used in the exploitation of this ever increasing area of tight gas reservoir production.

References

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Session Classification: Poster 1

Track Classification: MS 2.01: Pore-Scale Modeling and Experiments on Multiphase Flow in Porous Media