Shuai Li et al., Expert Opin Environ Biol 2018, Volume 7
DOI: 10.4172/2325-9655-C4-029

6th International Conference on
GREEN ENERGY AND EXPO
August 29-31, 2018 | Toronto, Canada

Aqueous phase migration and water-block remove during hydraulic fracturing shut-ins

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To investigate the aqueous phase migration and water block remove during hydraulic fracturing, in this paper, a physical and numerical model was built to simulate well shut-ins after hydraulic fracturing. We injected 0.15 PV water into tight and shale samples, wrapped the rock surfaces using resin glue and measured the transverse relaxation time (T2) spectrum at different shut-ins time using a nuclear magnetic resonance (NMR) methods. What's more, a 1D 2-phase countercurrent imbibition model was developed to simulate well shut-ins numerically. After Mattax and Kyte's time dimensionless and after spatial discretization and time integration, water saturation profiles were given. NMR results showed that aqueous phase mainly distributes in intervals of 10-100 ms at the beginning of water invasion. After the different length of shut-ins, T2 spectrum shifted towards intervals of 5-50 ms. In addition, the T2 amplitude in smaller intervals increased while amplitude at large intervals decreased, indicating that during the shut-ins period, water redistributes and migrate from large pore spaces to smaller pore spaces. Via the water migration, near fracture water-block can be weakened or removed and this is the direct reason for rock permeability enhancement and hydrocarbon increase after good shut-ins. Numerical simulation showed that water saturation moves slowly to the deeper distances during good shut-ins. Variables of NB-1 (ratio of capillary force and gravity) shows that capillary is the dominant force for imbibition during tight formation shut-ins, while capillary number (Nc) indicating both wetting phase and non-wetting phase recovery decreased with higher capillary pressure in flow-back section.

Biography

Shuai Li is now a senior engineer at Research Institute of Petroleum E. & D., PetroChina, he holds a Ph.D. degree, master's degree and bachelor's degree at China University of Petroleum, major in petroleum engineering. He has also been a visiting scholar at Pennsylvania State University from 2016 to 2017.

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