Contribution ID: **18** Type: **Poster Presentation**

Experimental evaluation of dynamic seepage in tight/shale reservoirs under the coupling of matrix fractures based on NMR

Tuesday, 14 May 2024 09:25 (1h 30m)

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The imbibition and displacement between fractures and matrix have a significant effect on the development of tight/shale reservoirs, a combination of dynamic displacement and imbibition online physical simulation method was established by integrating nuclear magnetic resonance (NMR) and CT scanning. Through real-time dynamic monitoring of multiphase flow and migration behavior of crude oil in each stage of dynamic imbibition, the development effect of dynamic imbibition and the micro-production mechanism of pore throats with different sizes of tight/shale oil were quantitatively studied. The effects of displacement pressure, permeability, and fractures on the dynamic imbibition effect and pore crude oil production were analyzed. On this basis, the dynamic seepage process of fracking-soaking-backflow-production integration was simulated, which reveals the dynamic production characteristics of different development stages and their contribution to enhancing oil recovery (EOR). The results show that the dynamic imbibition process of tight/shale oil water flooding can be divided into three stages: strong displacement and weak imbibition stage of rapid production of large pores and fractures under displacement action; weak displacement and strong imbibition stage of slow production of small pores and fractures under counter-current imbibition action and dynamic equilibrium stage of weak displacement and weak imbibition. The greater the displacement pressure, the lower the degree of imbibition recovery and the stronger the contribution of displacement, but it is easy to produce water channeling, leading to an early breakthrough, as a result, the recovery increases and then decreases. The higher the permeability and the better the pore throat connectivity, the greater the degree of both imbibition and displacement recovery, and the shorter the percolation equilibrium time and the greater the recovery. Fractures can effectively increase the imbibition contact area between the matrix and water, reduce the resistance of oil and water seepage, and increase the rate of matrix oil release and total recovery. There are differences in dynamic production characteristics and the degree of contribution to recovery at different development stages. Conducting a soaking program after fracturing is beneficial for fully utilizing the effects of fluid imbibition, displacement, and energy storage; also, the key to EOR is to effectively utilize the carrying effect of the backflow fluid and the displacement during the production stage. This study provides theoretical support for the efficient development of tight/shale oil.

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Presenter: Dr DU, Meng

Session Classification: Poster

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media