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Study on Microscopic Imbibition process in Variable Diameter Capillary Tubes

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Spontaneous imbibition plays an important role in water injection development of tight reservoirs. At present, few research focused on micro-imbibition law considering capillary diameter change in liquid-liquid system. In this study, based on Poiseuille's law and imbibition theory, the theoretical formula of spontaneous imbibition in variable diameter capillary under liquid-liquid system was derived. A new theoretical model of imbibition considering capillary structure and viscosity ratio was established, and the imbibition behavior of liquid-liquid system in multi-stage expanding-shrinking capillary was revealed. It was found that the capillary geometry is the main factor affecting the imbibition process of the variable diameter section. The end time of liquid imbibition is much longer than that in gas-liquid system. With the increase of the variable diameter section, the imbibition curve presents a convex curve. The viscosity ratio has a great influence on the end time of imbibition in liquid-liquid system. In gas-liquid system, the increase of gas phase viscosity has little influence on the end time of imbibition, and it is better to fit the previous numerical simulation and analytical results. On this basis, the multi-stage expansion-shrinkage equivalent capillary model is obtained. Compared with the traditional BCLW imbibition model, the prediction deviation is smaller, the coincidence rate is higher. The model can quickly and accurately predict the imbibition process in the variable diameter capillary, and provide a theoretical basis for optimizing the water injection development strategy of tight reservoirs.

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Participation

Online

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