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Applications of Pore Network Modeling in Tight Oil Migration

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The oil migration process controls the oil/water distribution and the scale of oil accumulation, which is important for the evaluation and exploitation of reservoirs. The migration of expelled oil in an unconventional tight reservoir is subject to different pore-scale fluid transport mechanisms as opposed to a conventional counterpart. In our present work, a two-phase pore network model (PNM) with consideration of the boundary layer effect is developed to study the oil migration process in tight formations. The accuracy of the established model is validated with well-designed oil charging experiments using different natural core samples. The agreement between the predicted and experimental results is encouraging. Using the validated model, three critical factors including the radius of pores, the coordination number, and the wettability of pore surface are studied to evaluate their influences on the tight oil migration process. The simulation results show that, with the decrease of pore radius, the resistance forces for oil migration increase dramatically while the terminal oil saturation at the irreducible water condition decreases either. The coordination number and wettability condition show little influence on the terminal oil saturation results. However, the required charging pressure for the terminal condition increases with the decrease of connectivity and contact angle. All the involved factors show influences on the oil/water relative permeability results. The predicted oil relative permeability decreases with the increasing pore radius, coordination number or the decreasing contact angle. The model and simulation results in this work provide valuable insights for understanding and quantitatively analyzing the oil migration in tight oil reservoirs.