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Spontaneous imbibition in dual permeable media using dynamic pore network model

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Understanding preferential flow in porous media holds substantial theoretical significance on the design and optimization of hydrocarbon exploitation in shale reservoir. Previous researches discussed the competition of imbibition front in layered porous media while the underlining mechanism for interfacial dynamics and induced displacement efficiency of multiphase flow remains ambiguous. In this paper, we investigate the spontaneous imbibition in dual permeable media and analyze the flux exchange between the neighboring porous zones with permeability contrast using dynamic pore network model. The impact of fluid viscosity ratio and permeability contrast on the spontaneous imbibition preference have been addressed, and finally a phase diagram for displacement efficiency has been obtained. The results revealed that the dual permeable structure enhanced the invasion rate of wetting fluid in the low-permeable zone and induced unstable displacement patterns, leading to reduction of the long-term displacement efficiency. The interfacial pattern transition from stable displacement to unstable pattern in dual permeable media could be ascribed into the flux exchange between dual permeable zones, which shows a contrary impact on the fluid flow within the low-permeable zone under favorable and unfavorable viscosity ratios. The permeability contrast in dual permeable media intensifies this impact during spontaneous imbibition. These results help us to understand the occurrence and mutual interaction of multiphase flow in layered porous media, and provide a theoretical guidance for the hydrocarbon exploitation in shale reservoir.

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