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格子ボルツマン法を用いた層流流量変化
Lattice Boltzmann simulation for flux change under oscillating boundary condition

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The amount of oil production in the world is decreasing recently and it is of importance to seek the technological development for enhanced oil recovery (EOR) in place in the subsurface. Seismic stimulation is known as one of the methods of EOR. Recently, many laboratory experiments and field tests have been performed such as water, gas, chemical, or thermal injections to attempt the enhancement of oil production. Numerous observations show that seismic stimulation of oil reservoir may improve oil production. To use seismic EOR efficiently, we need to understand the mechanisms of macroscopic phenomena: flux increment, pore-water pressure increment and relative permeability improvement, in particular in terms of seismic frequency and amplitude, to improve oil production. In this study, we attempt to demonstrate the flux change in viscous laminar flow under oscillating boundary condition with various frequencies and amplitudes for the simulation of interstitial flow. We discuss five characteristics: amplitude, frequency, angle, aspect ratio of pore length to pore width, and scale. All characteristics are largely related with the amount of flux change. The flux increases under cases with large amplitude, high frequency, large angle of incident to the wall, large aspect ratio or large scale. The angle is one of the most important characteristics for the flux change. So, vertically oscillating wall has smaller effect even if the other characteristics satisfy the condition to cause the flux increment. Our numerical results imply: i) the flow resistance increases by the velocity difference between the wall and the center of flow, ii) fluid extrusion is generated by partial pressure gradient near the wall, and iii) the oscillating boundary may cause pressure loss. We then discuss the possibility of flux change in terms of pore scales or shapes under the oscillating boundary condition with LBM. Finally, we try to enhance our simulations to include two-phase flow. We confirm that the oscillating boundary conditions could generate the reduction of interfacial tension to improve the relative permeability of oil droplets.

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