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Flow behaviors characterization of CO_2 flow through a 3D rough fracture based on Lattice Boltzmann simulations

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In order to enhance energy harvesting from geothermal reservoirs, the technology using CO_2 as the working fluid has been developed. This study presents a detailed investigation on the effects of CO_2 properties on flow behaviours through a 3D rough fracture based on Lattice Boltzmann method (LBM) simulations. The properties of CO_2 are highly pressure and temperature dependent, and vary between liquid and supercritical states in deep reservoirs. A 3D LBM code was developed for the simulations of liquid and supercritical CO_2 flow through a single fracture with rough surfaces. The influences of pressure differences between the injecting and discharging surfaces of the fracture were also taken into consideration. The simulation results were examined through comparisons between different scales of the fracture size. Simulation results showed that the average flow velocity of CO_2 flow changed considerably with temperatures and pressures. The streamlines distributions revealed the changes of flow tortuosity under different temperature and pressure conditions, which followed a similar trend to that of the average velocity. A detailed analysis of the effects of the temperature, pressure and upscaling velocity on tortuosity was conducted based on the relevant curves and streamlines distributions. It can be concluded that the values of tortuosity have a close relationship with the kinematic viscosity that depends on temperature and pressure.