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Microfluidic study for investigating migration and residual phenomena of supercritical CO_2 in porous media

Gyuryeong Park (1), Sookyun Wang (1), Minhee Lee (2), Jeong-Gi Um (1), and Seon-Ok Kim (1)

(1) Department of Energy Resources Engineering, Pukyung National University, Busan, Republic Of Korea(rbfud4773@hanmail.net), (2) Department of Earth Environmental Science, Pukyung National University, Busan, Republic Of Korea

The storage of CO_2 in underground geological formation such as deep saline aquifers or depleted oil and gas reservoirs is one of the most promising technologies for reducing the atmospheric CO_2 release. The processes in geological CO_2 storage involves injection of supercritical CO_2 ($scCO_2$) into porous formations saturated with brine and initiates CO_2 flooding with immiscible displacement. The CO_2 migration and porewater displacement within geological formations, and , consequentially, the storage efficiency are governed by the interaction of fluid and rock properties and are affected by the interfacial tension, capillarity, and wettability in supercritical CO_2-brine-mineral systems.

This study aims to observe the displacement pattern and estimate storage efficiency by using micromodels. This study aims to conduct $scCO_2$ injection experiments for visualization of distribution of injected $scCO_2$ and residual porewater in transparent pore networks on microfluidic chips under high pressure and high temperature conditions. In order to quantitatively analyze the porewater displacement by $scCO_2$ injection under geological CO_2 storage conditions, the images of invasion patterns and distribution of CO_2 in the pore network are acquired through a imaging system with a microscope. The results from image analysis were applied in quantitatively investigating the effects of major environmental factors and $scCO_2$ injection methods on porewater displacement process by $scCO_2$ and storage efficiency. The experimental observation results could provide important fundamental information on capillary characteristics of reservoirs and improve our understanding of CO_2 sequestration progress.