Impact of CO_2 injection speed on two-phase flow and the bulk physical parameters of porous sandstone

CO_2 storage Div.

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Abstract

We present a comprehensive experimental study on the effect of CO_2 flow and injection rate (represented by the capillary number C_a) on CO_2 saturation (S_{CO_2}), CO_2 distribution, and differential pore pressure (ΔP) in porous Berea sandstone. We measured two independent geophysical parameters, P wave velocity (V_p) and electrical resistivity (ρ^*), to monitor the two-phase flow. Our experimental results clearly indicate that S_{CO_2} and ΔP increased slightly with increasing C_a under low-C_a flow conditions ($\log_{10} C_a < -7.14$), but increased rapidly under higher-C_a flow conditions. The geophysical parameters suggest that the flow pattern changes with increasing C_a. The V_p-S_{CO_2} relation indicates that the characteristic size of connected CO_2 volumes decreases with increasing C_a, whereas the ρ^*-S_{CO_2} relation demonstrates increased CO_2 penetration with increasing C_a. These results indicate that, with increased flow rate, the injected CO_2 formed pathways and replaced brine (increasing ΔP and S_{CO_2}) by progressively invading contiguous (smaller) CO_2-free pores.