Experimental Setup and Application of High-Precision Fiber Bragg Grating Sensors for Laboratory Core Flooding Monitoring

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The fiber optical sensing (FOS) data from CO_2/brine flooding experiments are of great significance for geophysicists and reservoir engineers to better understand their experimental phenomenon, numerical simulation and field applications in the Carbon Capture, Utilization and Storage (CCUS) projects. The state-of-the-art high-resolution laboratory core flooding apparatus has been designed for CO_2 geological storage and acid gas injection in the Institute of Rock and Soil Mechanics, the Chinese Academy of Sciences, Wuhan, China. This apparatus couples three monitoring techniques of acoustic emission probes, strain gauge and fiber optical sensors into typical sedimentary rocks in core-scale CO_2/brine flooding experiments under simulated in-situ P-T conditions. The main objective of this apparatus is to continuously seize the front of CO_2 plume migration during the coupled process of scCO_2 displacing brine in brine-saturated sedimentary core samples.

In this presentation, firstly we figured out the experimental setup of high-resolution fiber Bragg grating (FBG) Sensors in the laboratory core flooding experimental apparatus. Then, we conducted a series of deionization water and free-CO_2 core flooding experiments on saturated sandstone core specimens under various reservoir conditions. We dynamically monitored the strain responses during the water and CO_2 displacement processes by using three FBG sensor arrays along the axial and radial directions. Finally, we found that the relative strain increased throughout the experiment with the increase in the confining pressure or pore pressure. For the water flooding experiment, the proportions due to the rise of the sequestration pressures were different in each scenario and FBG arrays, and they showed generally positive increases, which can be ascribed to the effective pressure. Meanwhile, the initial arrival time of the precisely characterized strain histories revealed the fronts of the injected water as well as the detailed implications of the CO_2 plume migration during the core-scale flooding processes.

References

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