EGU24-9509, updated on 23 Jan 2025
https://doi.org/10.5194/egusphere-egu24-9509
EGU General Assembly 2024

Quantifying flow reduction during injection of CO2 into legacy hydrocarbon reservoirs for CCUS

Qian Wang, Glover Paul, and Lorinczi Piroska
China University of Mining and Technology, School of Resources and Geosciences, China (wq5635137@163.com)

In the development of hydrocarbon fields, it is becoming known that CO_2 injection (which is sometimes done to improve hydrocarbon production) can cause pore blockage and wettability alteration by the promotion of asphaltene deposition. In hydrocarbon reservoirs, the result is poor oil recovery performance during carbon dioxide (CO_2) injection. If CO_2 is being injected into a legacy hydrocarbon reservoir (i.e., one that still contains residual oil) the same process will occur. Once again, the ability of fluid (this time supercritical CO_2) to flow will be impeded, but it is also possible that asphaltene deposition will also reduce the overall pore volumes in which CO_2 could otherwise be stored. In this work, the residual oil distribution and the permeability decline caused by organic and inorganic precipitation after miscible CO_2 flooding and water-alternating-CO_2 (CO_2-WAG) flooding have been studied by carrying out core-flooding experiments at high pressures and temperatures in an artificial three layer system. For simple CO_2 injection during CCUS operations, flooding experimental results indicate that the low-permeability layers retain a large oil production potential even in the late stages of production, which could impede CO_2 emplacement and provide significant heterogeneity, while the permeability decline due to asphaltene precipitation is more significant in high-permeability rocks. In contrast, we found that CO_2-WAG can reduce the influence of heterogeneity on the oil production, but it results in more serious reservoir damage, with permeability decline caused by CO_2–brine–rock interactions becoming significant. In addition, miscible CO_2 flooding has been carried out for rocks with similar permeabilities but different wettabilities and different pore-throat microstructures in order to study the effects of wettability and pore-throat microstructure on formation damage. Reservoir rocks with smaller pore-throat sizes and more heterogeneous pore-throat microstructures were found to be more sensitive to asphaltene precipitation, making these less attractive for CCUS reservoirs. However, rocks with larger, more connected pore-throat microstructures became less water wet due to asphaltene precipitation to pore surfaces, ultimately leading to a lower pore volume in which CO_2 can be stored. Taken together, there may be a case for not simply injecting CO_2 in CCUS operations, but alternating the CO_2 injection with injection of water in order to stabilise CO_2 flow and reduce formation damage by asphaltene precipitation.