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Energy Storage in Unconventional Formations

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Objective:
The success of large-scale geological storage of gases requires proper understanding of the interfacial behavior among the participating phase. In this work a systematic study on the impact of pressure and brine salinity on the interfacial tension (IFT) of binary H2-brine systems as well as wettability within ternary systems comprising H2-brine-shale are investigated. Furthermore, the shale adsorption capacity of H2 is measured at elevated pressures up to 30 MPa. The conversion of the organic matter at elevated temperatures and elevated pressures under H2 atmosphere has also been examined to understand the role of hydrogenation in upgrading shale oil products.
Methods:
A high-pressure high-temperature view cell with a Pmax of 69 MPa and a Tmax of 200 ℃ (Eurotechnica GmbH,Germany) was employed to measure the IFT using the pendant drop method. The view cell was also employed to measure the wettability using the sessile drop method. A magnetic suspension balance (MSB) with Pmax of 40 MPa, Tmax of 150 ℃ (Rubotherm GmbH, Germany) was used to measure the adsorption of H2 on shale based on the gravimetric method. Thermal gravimetric analysis (TGA) was conducted using an MSB with Pmax of 15 MPa and 400 ℃ (IsoSORP, Waters TA instruments, Germany). The products of the TGA were analyzed using Nuclear Magnetic resonance (NMR) (Avance III 600 MHz-Bruker, Czech Republic) and Gas Chromatography (GC) (Varian 320-Agilent, United States).
Results, Conclusions:
The reduction in IFT upon increasing the pressure was insignificant. Further on, wetting tests suggest that the system is water wet under all experimental conditions. Both these findings guarantee the structural storage integrity of the shale. It is also found that adsorption plays a role in H2 storage within the shales. The NMR and GC analyses reveal that aliphatic compounds are excessively present in comparison to aromatics and olefinic compounds. In an H2 environment, it was observed that aromatic substitution by aliphatic hydrocarbons took place.
Novelty:
This work presents information on H2 wettability and H2 adsorption capacity of shale at conditions relevant to gas storage which are severely lacking in the literature. Furthermore, and up to the best of the author's knowledge, the conversion of organic matter at H2 pressures relevant to gas-storage is introduced for the first time.

Participation

In-Person

References

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