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Is salt precipitation an issue during geological storage of hydrogen in saline aquifers? from thermodynamic perspective using PC-SAFT EoS

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During the Underground Hydrogen Storage (UHS) process, hydrogen gas must be transported from the production site to the storage site, be injected into the storage repository (depleted hydrocarbon reservoir, aquifer, or salt cavern), and finally the stored hydrogen needs to be released from the storage site and be transported to the distribution points. During this long journey, hydrogen molecules can encounter a wide range of pressure and temperature and most likely be exposed to other fluids such as reservoir fluids, impurities, cushion gas, etc. In order to plan and perform risk analysis of UHS projects, it is necessary to model the phase behavior of hydrogen mixtures and accurately determine the distribution of hydrogen among different phases. Hydrogen gas (H2) has an ideal symmetrical structure and the phase behavior of pure H2 gas can be usually handled with Henry's law. Although, when H2 is injected to a depleted hydrocarbon reservoir or a saline aquifer or it is imposed to impurities during transportation, a more complex approach might be required to model the phase behavior of the mixture due to highly non-ideal intermolecular interactions, such as association (hydrogen bonding), polarity, ionic bonds, and chain forming reactions. In this work, we used PC-SAFT equation of state for this aim and added association, electrolyte, and polar contributions to the Helmholtz energy. We benchmarked the model against experimental data. A major advantage of the model is that it can be used for a wide range of pressures and temperatures, can handle non-ideal molecular interactions, especially when impurities are involved, and can apply to the entire chain of UHS.
Additionally, we have done a primary assessment of mutual solubility of H2 and brine to examine the possibility of dry out effect and salt formation during UHS in saline aquifers. The results show that the risk of salt precipitation is very low compared to CO2 storage in saline aquifers.

Participation

In-Person

References

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