Solution Mining Research Institute Spring 2021 Virtual Technical Conference
19-22 APRIL 2021

Effect of carbon dioxide dissolution into the brine on the storage conditions

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Abstract

In the current energy transition context, the Power-to-Gas process appears as one of the most promising technological solutions to store energy, but it still faces the problem of carbon dioxide supply. For this reason, ongoing projects are working on the possibility to temporarily store this product, in particular in underground facilities such as salt caverns.

However, the solubility of carbon dioxide is known to be much higher than that of other commonly stored products like natural gas or hydrogen, for which the phenomenon of dissolution during the storage is neglected. An experimental investigation was conducted in laboratory to show how the carbon dioxide dissolution impacts the thermodynamic conditions in the cavity and to verify the validity of the assumption neglecting this particular phenomenon: carbon dioxide was brought into contact with the brine phase within a hermetically closed isochoric PVT-cell. The system was then left to stand until reaching its equilibrium, similarly to a storage in salt cavern. The same experiment was conducted with a reference product (namely methane) to compare both storage behaviors. It was showed that the dissolution phenomenon induces a drop in the gas pressure, which for carbon dioxide, in addition to being stronger, is kinetically faster than for natural gas. A Fickian model was adjusted to describe the pressure drop, depending on the salinity of the brine. This pressure drop has to be accurately characterized at the cavern scale to avoid any confusion with pressure drops induced by leakage anomalies in practice, especially at the beginning of the leaching phase, as the whole amount of carbon dioxide injected is lower than the amount required to reach the gas concentration at saturation and thus tends to dissolve quickly.

Key words: Gas Storage, Thermodynamic Behavior, Mass Transfer in Brine, Kinetics of Dissolution