



Experimental determination of H₂ solubility in saline solutions under reservoir conditions

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Emitting huge amounts of carbon dioxide, the burning of fossil energy sources are considered the driving force for global warming. The German energy transition therefore aims at switching from fossil to renewable energy sources and the future energy system will differ notably from the current. The increasing share of renewable energy in the system leads to a highly fluctuating and somewhat unpredictable energy supply. To balance energy supply and demand and to further increase the amount of renewable energy while maintaining security of supply, innovative technologies for large-scale energy storage are needed. One possible solution are power-to-gas techniques, which uses surplus energy of e.g. wind power to produce synthetic gases like hydrogen. These gases can then be flexibly stored in the subsurface at required scale.

Contrary to geological storage of natural gas, which is a mature technology since decades, geological storage of hydrogen is only done at very few places worldwide and is still in its initial stage of development. As for natural gas, hydrogen storage options include salt caverns and porous rocks. For a reliable assessment of the different storage options, fundamental data like hydrogen solubility in formation fluids or hydrogen diffusion rates for the different reservoir and cap rocks at the respective pressure and temperature conditions are needed but to a large extend are still lacking.

Within the running projects Energy System 2050 and H₂_ReacT, laboratory experiments have been performed to derive internally consistent data on H₂ solubility in saline solutions under reservoir conditions. The experiment were performed in an autoclave capable of high pressures and temperatures and covered conditions from 25 to 150 °C, pressure up to 200 bar and salinities up to salt saturation within the KCl- and NaCl-H₂O systems. The gained results are compared with theoretical solubility models based on available thermodynamic data. The comparison clearly shows that the so far available thermodynamic data and models are not capable to reproduce the experimental results. The newly derived solubility data will be used to update and improve the thermodynamic data bases and also for subsequent modelling.

Further investigations will study potential fluid-rock interactions of mineral separates as well as rock samples with hydrogen and brine. A new experimental set-up including hydrogen tight diffusion cells is drafted to study and determine permeability and diffusion rates of hydrogen through potential cap rocks like salt rock or claystone.