HySTORAGE: Preliminary investigations of possible hydrogen losses with focus on a planned hydrogen storage field test in Bierwang

G. Strobel[1], C. Kosack[1], P. Bombach[2], A. Fischer[2], B. Hagemann[3], S. Hogeweg[3]

[1]Uniper Energy Storage GmbH, Düsseldorf, Germany, [2]Isodetect GmbH, Leipzig, Germany, [3]TU Clausthal, Institute of Subsurface Energy Systems, Clausthal-Zellerfeld, Germany

As part of the commitment archiving net zero by 2030, the interest in storing hydrogen in the subsurface has risen strongly. In order to conclude the technical feasibility of storing hydrogen in porous storage, a field trial is planned, where different hydrogen concentrations are mixed into a natural gas stream and stored in a porous formation. The three different concentrations (5%, 10%, 25% H_2) lead to three different sub-tests, each containing an injection, storage, and withdrawal phase and each sub-test with a total duration of ca. four months. Consequently, the field test is scheduled for at least 12 months. In detail, 150,000 m^3 of natural-gas hydrogen mixture is injected, and withdrawn via the same well per one sub-test. In order to conclude the hydrogen recovery during the withdrawal phase and the overall operation of hydrogen storage, the existing operational monitoring is complemented by online gas composition measurement. During the preparation and execution of the field test, safe operation is ensured through implemented technical and organizational measures.

Besides the primary field test, accompanying and partly preliminary studies are performed to investigate and predict hydrogen losses, focusing on hydro-dynamical and microbiological effects. The complete research consists of experimental investigations before and during the field test, tracer tests, and reservoir simulations, including microbial conversion and mixing behavior.

Based on the literature, potential microbial metabolisms leading to a conversion of hydrogen are sulfate-reduction, methanation, and acetogenesis. To study the reactions, microbial growth experiments are performed before and during the field test. The pre-experiments with the formation water and the hydrogen-natural gas mixture show a significant hydrogen reduction in the reactors. Further, additional experiments are conducted with deuterium as a tracer to test its feasibility for a growth indicator in the reservoir.

As the first growth tests indicate a possible conversion of hydrogen, a change of hydrogen concentration during the field test can not be directly linked to the mixing of injected and the initial gas because microbial and mixing effects could overlap. Therefore it is planned to add a defined amount of helium to the injected gas mixture. As helium acts as an inert tracer, its concentration changes can be used to study the mixing behavior in the reservoir.

Based on the growth experiments and changes in gas composition, reservoir simulations are performed, which coupled the microbial activity with diffusion and dispersion effects. In the first step, a dynamic model is implemented to predict those effects and the performance of the field test.