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HyUSPRe

Hydrogen **U**nderground **S**torage in **P**orous **Re**servoirs

Data set of effective binary diffusion coefficients, mechanical dispersivities and relative permeability curves

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Executive summary

In working package 4 of the HyUSPRe project three different laboratory measuring methods were used to investigate the flow behavior of hydrogen in underground pore storages. The first experimental series investigated the molecular diffusion for a binary H_2-CH_4 system in reservoir rocks. Based on the measurement results effective diffusion coefficients were determined. The second experimental series investigated the mechanical dispersion also for a H_2-CH_4 system. Here, longitudinal dispersivities were determined. The third experimental series investigated unsteady state relative permeabilities for H_2-brine systems. Based on this two-phase relative permeability curves were determined under drainage conditions. The measurements were conducted at a range of temperatures, pressures, salinities and with different storage rock samples.

The data set available here allows the reinterpretation and further use of the experimental data. It contains in total 29 molecular diffusion, 13 mechanical dispersion and 9 relative permeability measurements.

About HyUSPRe

Hydrogen **U**nderground **S**torage in **P**orous **Re**servoirs

The HyUSPRe project researches the feasibility and potential of implementing large-scale underground geological storage for renewable hydrogen in Europe. This includes the identification of suitable porous reservoirs for hydrogen storage, and technical and economic assessments of the feasibility of implementing large-scale storage in these reservoirs to support the European energy transition to net zero emissions by 2050. The project will address specific technical issues and risks regarding storage in porous reservoirs and conduct an economic analysis to facilitate the decision-making process regarding the development of a portfolio of potential field pilots. A techno-economic assessment, accompanied by environmental, social, and regulatory perspectives on implementation will allow for the development of a roadmap for widespread hydrogen storage by 2050, indicating the role of large-scale hydrogen storage in achieving a zero-emissions energy system in the EU by 2050.

This project has two specific objectives. Objective 1 concerns the assessment of the technical feasibility, associated risks, and the potential of large-scale underground hydrogen storage in porous reservoirs for Europe. HyUSPRe will establish the important geochemical, microbiological, flow, and transport processes in porous reservoirs in the presence of hydrogen via a combination of laboratory-scale experiments and integrated modelling; and establish more accurate cost estimates to identify the potential business case for hydrogen storage in porous reservoirs. Suitable storage sites will be identified, and their hydrogen storage potential will be assessed. Objective 2 concerns the development of a roadmap for the deployment of geological hydrogen storage up to 2050. The proximity of storage sites to large renewable energy infrastructure and the amount of renewable energy that can be buffered versus time varying demands will be evaluated. This will form a basis for developing future scenario roadmaps and preparing for demonstrations.

Document information, revision history, approval status

Document information

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1 Introduction

In the HyUSPRe project three different laboratory measuring methods were used to investigate the flow behavior of hydrogen in underground pore storages. The first experimental series investigated the molecular diffusion for a binary H_2-CH_4 system in reservoir rocks. Based on the measurement results effective diffusion coefficients were determined. The second experimental series investigated the mechanical dispersion also for a H_2-CH_4 system. Here, longitudinal dispersivities were determined. The third experimental series investigated unsteady state relative permeabilities for H_2-brine systems. Based on this two-phase relative permeability curves were determined under drainage conditions. The measurements were conducted at a range of temperatures, pressures, salinities and with different storage rock samples.
The available data set (Michelsen et al., 2023a) allows the reinterpretation and further use of the experimental data. It contains in total 29 molecular diffusion, 13 mechanical dispersion and 9 relative permeability measurements.
The data are publicly available at https://doi.org/10.25625/7XCCL8.
Further details on the methods, measurement conditions and an interpretation of the results can be found in Michelsen et al. (2023b).

2 Data set description

The dataset D4.3 consists of three parts: molecular diffusion, mechanical dispersion and relative permeability measurements. For each part there are tables (in .CSV format) containing the experimental results. An overview of the main results of each experimental series can be found within the corresponding folder.

2.1 Molecular diffusion

29 experiments with various pressures, temperatures and rock samples were conducted. For each experiment the measurement results are listed in a table with two columns. One column contains the time and the other one contains the measured H_2 mole fraction.

2.2 Mechanical dispersion

13 experiments with different pressures, temperatures and flow rates were carried out. The results contain the time and the measured concentration of H_2 and CH_4.

2.3 Relative permeabilities

Nine experiments with different rock samples, salinities and pressures were conducted. The temperature was set at 80°C in all experiments. Each experiment shows the relative permeability of the gas phase (K_{rg}) and the brine (K_{rw}) dependent on the gas saturation (S_g).

3 References

Michelsen, J., Thaysen, E. M., Hogeweg, S., Hagemann, B., Hassanpouryouzband, A., Langanke, N., Edlmann, K., & Ganzer, L. (2023a). *Data for: HyUSPRe—WP4—Hydrogen reservoir flow behaviour: Measurements of molecular diffusion, mechanical dispersion and relative permeability*. GRO.data. https://doi.org/10.25625/7XCCL8.

Michelsen, J., Thaysen, E. M., Hogeweg, S., Hagemann, B., Hassanpouryouzband, A., Langanke, N., Edlmann, K., & Ganzer, L. (2023b). *Hydrogen reservoir flow behaviour: Measurements of molecular diffusion, mechanical dispersion and relative permeability* [H2020 HyUSPRe project report D4.4].