Geochemical impact of renewable natural gas (biomethane) in aquifer storage in the Paris Basin, France

Context and objectives

Biomethane is one of the main renewable gases available today to offset fossil gas and decarbonize the energy system. According to the REPowerEU plan (2022), renewable natural gas production should reach 35 billion cubic meters per year by 2030. Biomethane production in Europe increased by 20% in 2022 compared with the previous year. Before biomethane is injected into the gas network, O_2 is added to desulfurize the gas. In contrast to natural gas, the oxygen content in the gas blend can reach up to 10,000 ppm at times.

In this context, Storengy needs to better understand the geochemical impact of injecting biomethane into its underground natural gas aquifer storage facilities. In particular, these studies will aim to define the oxygen concentration limit as part of pre-normative investigation. The potential risks are corrosion of the facilities' metal components from a technological point of view, and local acidification of the aquifer water from an environmental point of view.

The overall aim of this postdoctoral project is to assess the resilience of deep aquifers to the injection of biomethane and natural gas blend up to the maximum O_2 and CO_2 content. A first multiphase reactive transport model (Banc et al., 2023, Sin et al. 2023) has been developed to simulate the changes in gas and water quality, mineral phases, and petrophysical properties as a result of acidification and oxidation of the system. This research will extend the model to other gas contents and mixtures (CO_2, H_2S) and other reaction processes (microbial kinetics). The study will also enrich the engineering component of the model by integrating the heterogeneity and geometric complexity of storage reservoirs, as well as multi-well systems and various injection/production cycle scenarios.

Centre for Geosciences, Mines Paris – PSL, has been developing the HYTEC reactive transport code that couples geochemical reactions to flow and advective/dispersive transport in porous media. HYTEC can also simulate the flow, diffusion, and reactivity of a gas mixture in a porous medium (Sin et al., 2017) over a wide range of pressures and temperatures (Sin et al., 2019). The geochemical module of HYTEC allows for the full range of water-gas-rock interaction processes in the aquifer but also simulates bacterial growth and kinetics.

The results will be published (at least one scientific publication) and presented at international conferences or workshops.

Banc, C., Sin, I., De Windt, L., Petite, A. (2023). Evaluation of the geochemical impact of biomethane and natural gas mix injection in sandstone aquifer storage. EGU conference (Vienna) and paper submitted.

Sin, I., De Windt, L., Banc, C., Goblet, P., and Dequidt, D. (2023). Assessment of the oxygen reactivity in a gas storage facility by multiphase reactive transport modeling of field data for air injection into a sandstone reservoir in the Paris Basin, France. Science of The Total Environment 869, 161657.

Sin, I., and Corvisier, J. (2019). Multiphase multicomponent reactive transport and flow modeling. In Reactive Transport in Natural and Engineered Systems, J. Druhan and C. Tournassat, Eds., Mineralogical Society of America ed., vol. 85. Reviews in Mineralogy and Geochemistry, Ch. 6, pp. 143–195.

Sin, I., Lagneau, V., Corvisier, J. (2017). Integrating a compressible multicomponent two-phase flow into an existing reactive transport simulator. Advances in Water Resources 100, 62-77.

Skills

- Doctorate (Ph.D) degree (or engineer with a first experience);
- Experience in geochemical, multiphase flow or reactive transport modelling;
- Strong motivation for team work with the industrial partners;
- High level in English, intermediate level in French is desirable.

Workplace and contract

This project is part of a collaboration between Centre for Geosciences of Mines Paris - PSL and Storengy. Centre for Geosciences conducts projects with major economic and societal implications, such as sustainable supply of primary resources, underground storage of energy and waste, and environmental impacts on water resources. Storengy is the leading storage operator in France and the second largest producer of bio-methane via Engie-Bioz.

The position will be based at Centre for Geosciences in Fontainebleau (77), with regular travel to STORENGY's premises in Bois-Colombes (92).

Duration: 24-month fixed-term contract at Mines Paris - PSL.

Starting date: from the first semester 2024.

Contacts

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