Assessment of oxygen reactivity in underground bio-methane storage by multiphase reactive transport modeling

Context and objectives

Embracing the transition to sustainable energy leads to growing share of bio-methane produced in France. This energy sector has a significant potential and will continuously increase to achieve the carbon neutrality. Bio-methane is injected into the gas distribution network introducing oxygen (O_2) in underground gas storage facilities. In this context, Storengy aims to give a better understanding of the geochemical impact of the injected O_2 into storage sites in shallow and deep aquifers. This study will support a pre-normative research on the admissible oxygen concentration. Two potential risks are identified: corrosion of steel components of the installations from a technological point of view and local acidification of the natural groundwater from an environmental point of view.

The first objective of the postdoc study is to identify the key reactions occurring in the aquifer after the injection of bio-methane with 100 ppm O_2 by means of batch geochemical modeling and the literature review. The natural gas in place will be also considered in the model to study the impact of CO_2 and H_2S present in the storage. In the medium term, the objective is to develop a two-phase reactive transport model (gas/water/rock) in a representative geometry for a full injection and withdrawal cycle (circa one year). Variations of pressure, temperature, O_2 partial pressure, and the presence or lack of key minerals such as calcite and pyrite impact on reactional chain. A sensitivity analysis will then be needed. In the long term, an alternative injection will be studied. Reactive transport models will rely on site data of two storage sites operated by Storengy: a first site at medium depth (47 bar, 30°C, a limestone-cemented sandstone) and a second deeper site (116 bar, 54°C, a clay-cemented sandstone).

Modeling will be done with the HYTEC code that has been developed at MINES ParisTech for about twenty years. HYTEC couples geochemical reactions with flow and advective/dispersive/diffusive transfer in porous media. In HYTEC, the multiphase reactive transport employs an equation of state approach to calculate the vapor-liquid equilibria of complex mixtures over a wide range of pressure and temperature.

This project will be the subject of at least one scientific publication and one presentation at international conferences or workshops.

Workplace

The present project is part of a collaboration between the Geosciences Department at MINES ParisTech and STORENGY. MINES ParisTech is one of the oldest French engineering schools. At the Geosciences Department, main research areas focus on sustainable supply of mineral resources, underground storage of energy and wastes, as well as environmental impact on water resources and soils. STORENGY is the number one for gas storage in Europe, and the second biomethane producer in France via Engie Bioz.

The work will take place in the labs of MINES ParisTech in Fontainebleau (South of Paris), with frequent exchanges with the specialists in gas storage and hydrogeology from STORENGY (Bois-Colombe, near Paris).

Skills

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

Contract

Fixed-term work contract for a duration of 12 months (renewable once). Salary: approx. €2200 net per month including healthcare cover. The postdoc can start from September 2021.

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