Bilag 17: Konklusionen fra 'Analysis of CO2 Migration in Horizontal Saline Aquifers during Carbon Capture and Storage Process'

By mathematical modelling horizontal aquifer, the authors evaluated the storing possibilities of industrial CO2. The analysis performed in this work demonstrates that many factors pose potential risks to the process of CO2 sequestration and its sustainability, with the mobility of CO2 being one of the main ones; it is of interest to have a higher mobility of CO2 since it guarantees larger storage capacities but a higher mobility would increase the chances of CO2 escaping the storage and returning into the atmosphere.

Storage durability depends on the type of aquifer and its characteristics. Knowledge of the evolution of storage processes in a particular aquifer is not deterministic, rather we can talk about estimates and the probability of some outcomes in the sequestration process. It is certain, however, that the porosity of the material forming the aquifer, as well as the CO2 permeability, have a considerable impact on CO2 migration. The porosity of aquifer brines can vary from 10% to about 20%, and for a given range the evolution of plume and its radial distance can vary up to 30%. This is an important factor because it determines mobility and capacity at the same time in inverse proportionality. Saline water viscosity is the second most important parameter and can vary in range (0.1–0.4) mPa/s.

For a given variation of water viscosity, the radial distance of plume can be doubled in range from 5 to 10 km for 30 years injection period. In such a way, the brine formed after injection period will continue to evolve and have diffusion and convection migrations until reaching some equilibrium state. This research showed that, depending on the parameters of the aquifer, brine can evolve into a stadium for which the maximal radial distance can be up to several tens of kilometres from the injection point in worst-case scenarios for injection periods of 30 years. For long injection periods and large injection rates, the radial migration of CO2 can be even larger.

Long injection periods and high injection rates can, however, increase the radial migration of CO2 and leakage becomes probable when CO2 finds an upward path inside the aquifer. The results of this work showed that in the worst-case scenarios, where breaches occurred at open or poorly sealed abundant wells, leakage of the CO2 can occur after a very short period, which can be measured in months and years. For millennium-lasting projects, this is quite a small time.

Poor seals can have high permeability, and in the long-term trapping of CO2 it will allow considerable brine leakage out of the formation vertically upwards. The paper has demonstrated that upward force, buoyancy force, and the pressure gradient are equal in magnitude. The issue in modelling CO2 lies in transport equations which depend on small-scale parameters, the solutions of which are only found in large-scale domains. The problem can be simplified, however, by introducing an effective density for CO2, which then determines the convective velocity. This transfers the problem from compressible to incompressible fluids, the solutions of which can be analytically derived.

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