Laboratory CO₂ injection in Utrillas Sandstone (Cretaceous): Analysis of changes in porous media using Hg porosimetry

R. Campos Egea (1)
(1) CIEMAT, Petrophysics Laboratory - Environmental Department
Av. Complutense 40, 28040 Madrid - Spain
Tel: +34 91 346634, E-mail: r Campos@ciemat.es

Deep geological storage of CO₂ is a promising option to mitigate greenhouse gas emissions in the atmosphere. The most favourable sites for the definitive storage of CO₂ in the Iberian Peninsula are deep saline aquifers and the Utrillas Formation in the Mesozoic basement of the Duero Basin (central Spain), where a promising rock formation for CO₂ storage is present.

Porosity and CO₂ trapping mechanisms project

The aim of this project is the characterisation of the Utrillas porous system before and after CO₂ injection to understand the trapping mechanisms.

1. Evaluate this system as a potential CO₂ storage formation.
2. Estimate the storage capacity of these systems.
3. Assess the retention mechanisms and changes after injection of CO₂.

Changes in the pore space microstructure can not only significantly modify the storage capacity but also change the pattern and velocity of movement or the fluid through a rock.

The goal of this study is to determine variations in pore space microstructure caused by the injection of CO₂ in supercritical state in two samples of sandstone of almost identical composition and different texture. We want to remark the key role of the initial rock texture in determining variations in the pore space and trapping mechanisms.

The Utrillas Sandstone is a sedimentary sandstone formation whose age is located at the Lower-Lower limit of the Cretaceous. The lithological and formation characteristics of Utrillas sandstones make it a favourable geological formation for CO₂ injection and storage. Borehole CSO-01 was carried out in the CD-SO-01 borehole to 35.5 and 62.45 m in depth in a fine and medium-coarse grain facies respectively.

The Injection experiment was performed using a core sample resized to 38 mm and 100 mm length. The sample was saturated in synthetic saline water (brine), before being put into the CO₂ injection cell. The synthetic water was prepared specifically for this experiment by MOSSA-Aqua. The hydrogeochemical code PHREEQC, developed by the U.S. Geological Survey (USGS), was used to model the water chemistry.

The results of the test showed that the soaking of the sample under CO₂ pressure and the dissolution of the sample led to the release of CO₂. The results were confirmed by TGA analysis.

Following the test, significant changes in the porosity were observed, which correspond to variations in the storage capacity and CO₂ flow pattern through the rock. The reduction in porosity affected a large volume of the sample, leading to a decrease in the size of mesopores in the sandstone. A moderate increase of porosity, along with a reduction in the size of the smallest pores was observed in the thick granite sandstone sample.

A decrease in the BET and microarea was observed in the two samples of sandstone before and after the CO₂ injection.

To carry out the experiment, a thermo-resistant cover was put on the dry sample. Then, both were put inside a Viton cylinder with high elasticity, high resistance to aggressive fluids and high temperatures. After, the sample in the Viton was placed inside the injection cell. The injection cell was built for this type of test for the Petrophysical Institute Foundation, with which we have collaborated on the project. Once the sample was saturated with brine, the injection cell was connected to a supercritical carbon dioxide separator with the injection and evacuation or production valves opened. This way, production or injection of CO₂ is controlled. Once the sample with CO₂ was saturated, the cell remained closed for two months with pressure (8Mpa) and temperature conditions (32°C) controlled daily.

The most plausible cause for the mesopore loss is mineral precipitation in the pores of smaller size. The reduction of porosity and consequent reduction of their effective storage capacity after CO₂ injection should be taken into account when assessing the potential formations for geological CO₂ storage.