



ENOS Project: injectivity changes produced by the alternate injection of CO₂ and brine

CSLF and CO₂GeoNet Workshop «CO₂ storage stories: learning by doing»

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Outline



1.- ENOS Project

2.- Hontomín TDP

3.- Alternate injection of CO₂ and brine

4.- First results

5.- Discussion

6.- References



1.- ENOS Project



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WP1 Progress “Ensuring safe storage operations”

Task 1.1 "Reliable CO2 Injection procedures in carbonates"

- Design and execution of injections
- Modelling, interpretation and history matching



GOALS

- To demonstrate safe and environmentally sound on-shore injection using experiences from Hontomín pilot operation
- Innovative injection strategies for a later industrial deployment



WP1 Consortium

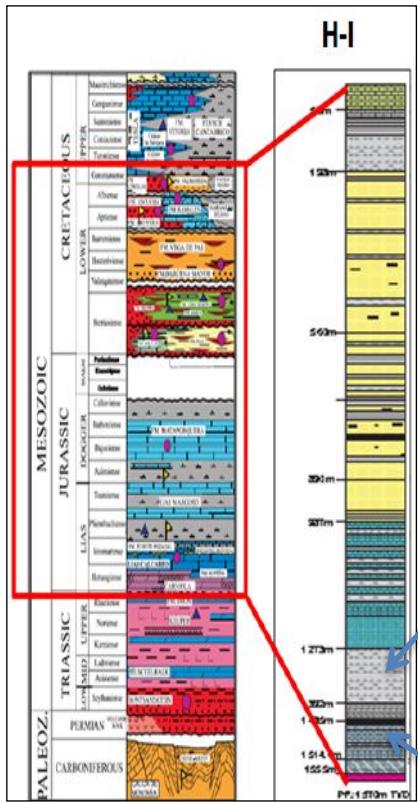
2.-Hontomín TDP



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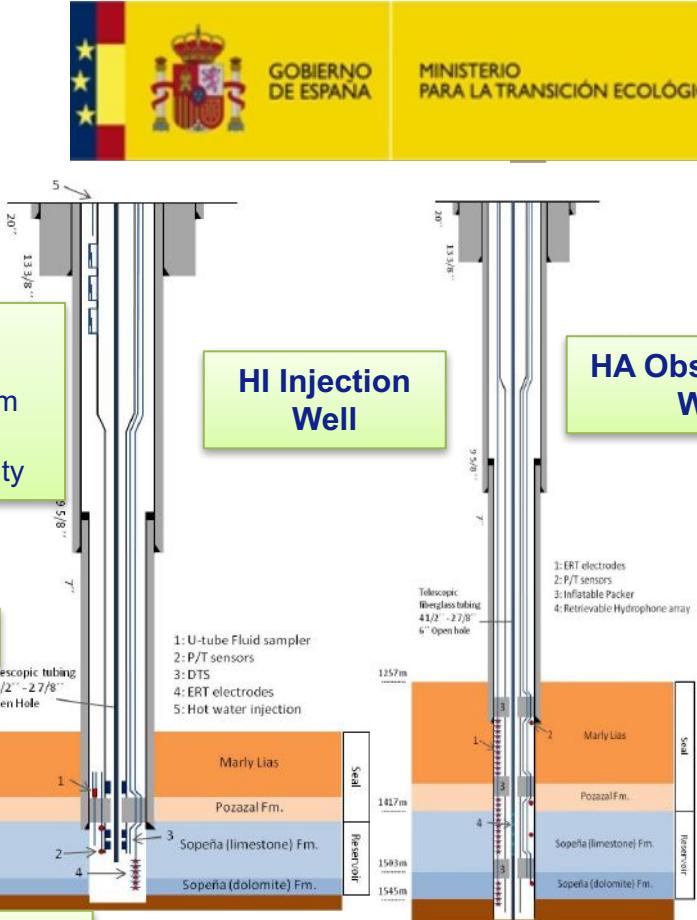
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Deep saline aquifer
Seal-Marly Lias
Reservoir-Sopeña Fm
Fractured carbonates
with low matrix porosity

Seal-Marly Lias

Reservoir-Sopeña Fm



3.-Alternate injection of CO₂ and brine

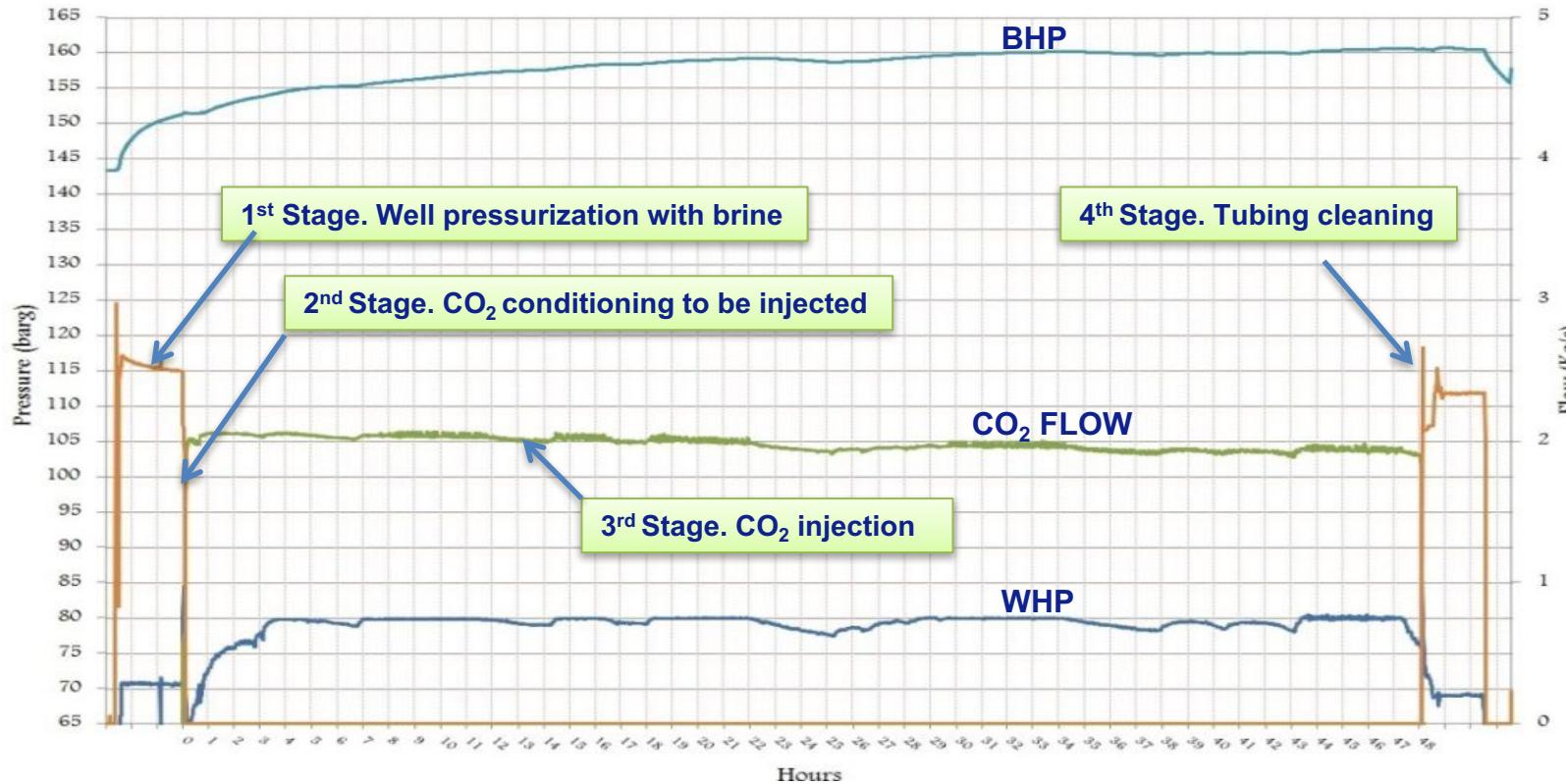


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Spanish Industrial Patent ES-2580880_A1



Tubing choke installed at the depth of 1000 m for avoiding high bottom hole overpressure (de Dios et al, 2017)

3.-Alternate injection of CO₂ and brine



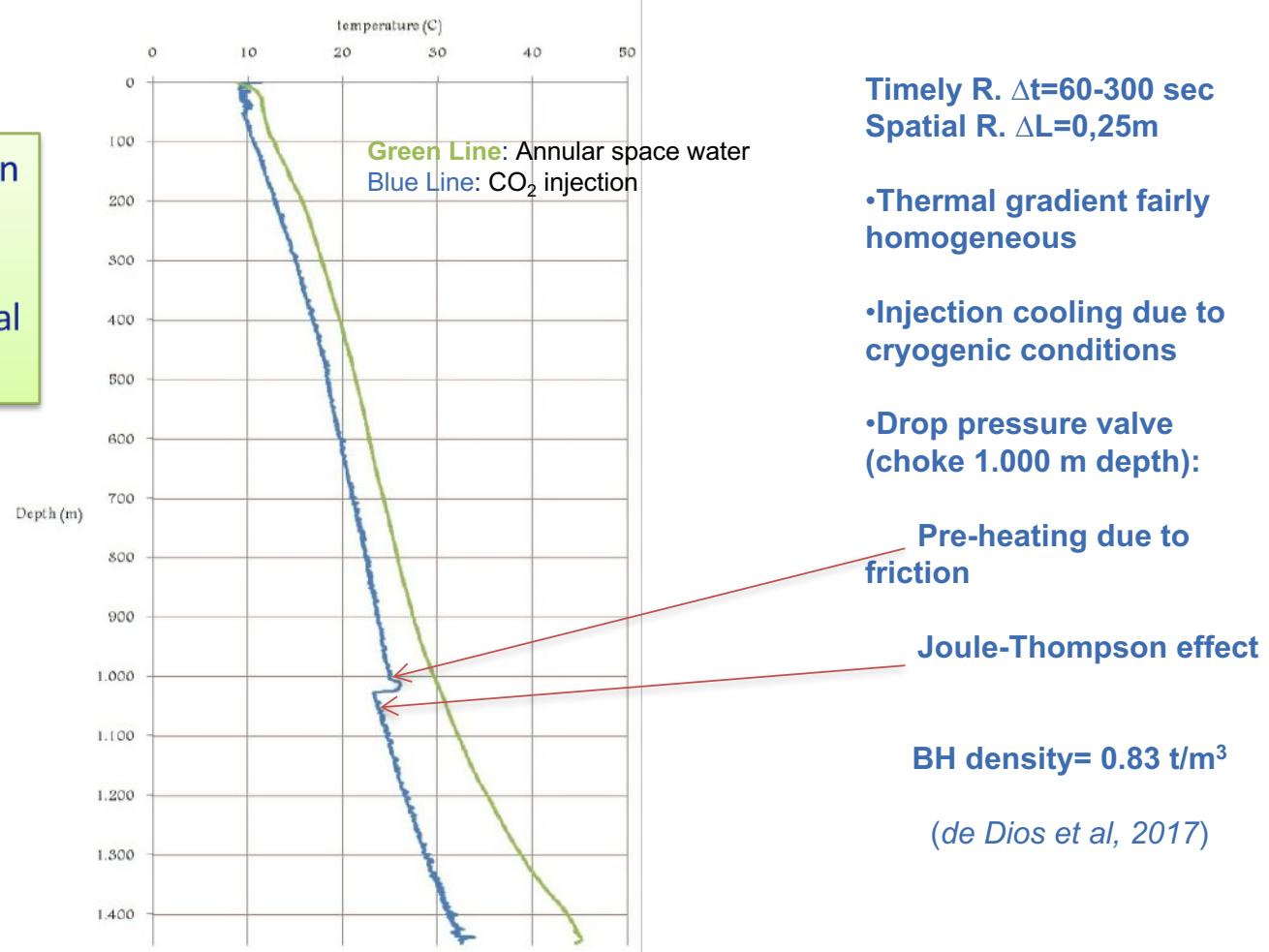
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Distributed temperature measurements along the injection tubing

- CO₂ injection performed in liquid phase
- Trapped CO₂ in supercritical phase



4.- First Results



Task 1.1. “Reliable CO₂ injections in carbonates”

Deliverable 1.1 “Design of CO₂ injection tests” (*J. Carlos de Dios and Yann Le Gallo*)

Injection Strategies:

Discontinuous strategies: Focusing on knowledge increase to improve the hydrodynamic stability at the fractured reservoir.

Continuous strategies: Managing the operational parameters to control storage integrity in long term injection.

Alternative strategies. Cold injection will be designed and tested, with the aim of finding the most efficient operation parameters.

Injection campaigns have started on March 2017 at HontomínTDP



4.- First Results



Discontinuous Injection Tests

Type of Test	Control Parameter	Set-Point	Variable to monitor
Pressure Control Mode	WHP	≥ 75 bar	Flow Rate
Flow rate Control Mode	Flow Rate	1-2 kg/s	WHP/BHP



4.- First Results

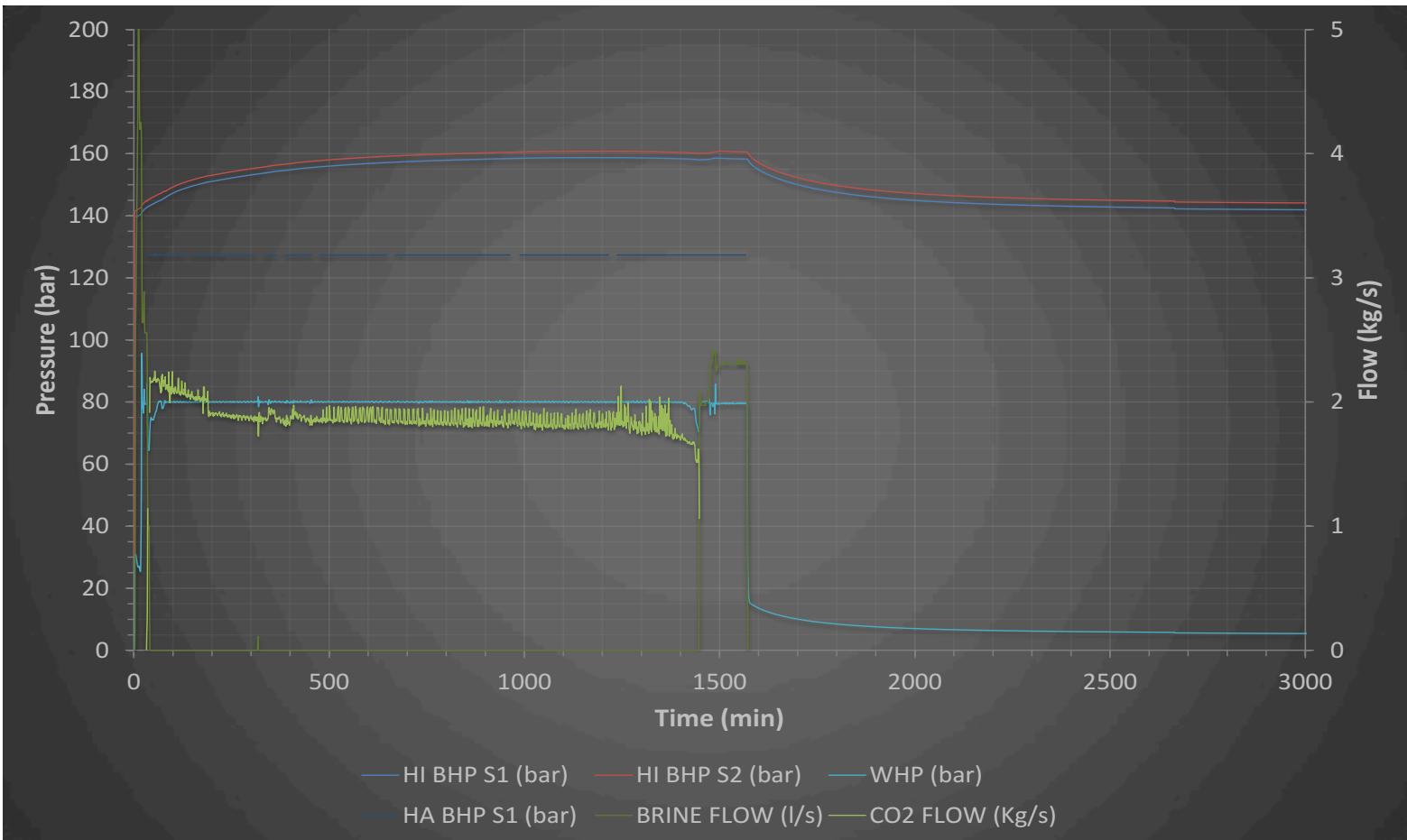


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Operating parameters from the twenty-four hour CO₂ injection in pressure control mode (80 bar WHP)
(de Dios et al, 2019)



4.- First Results

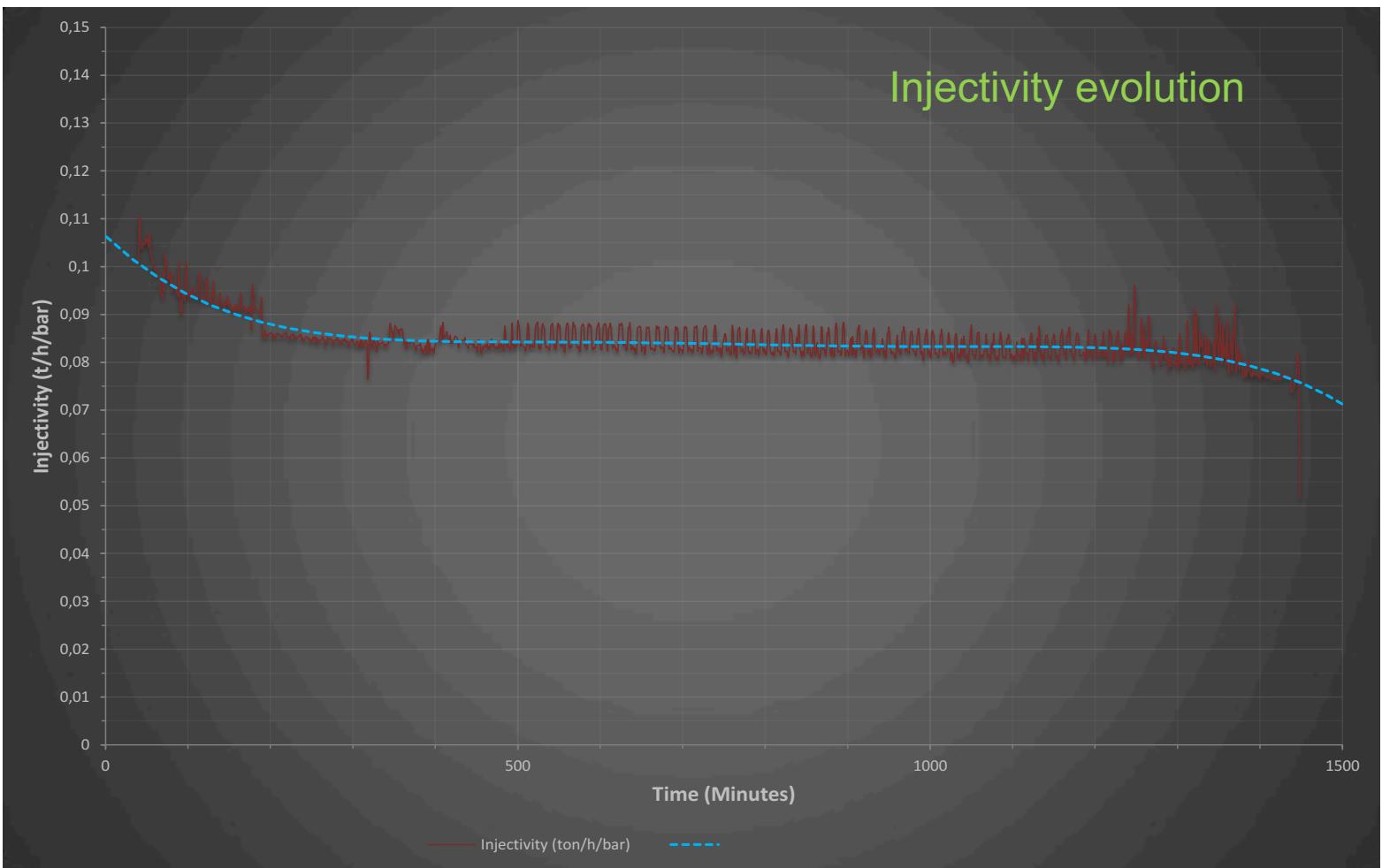


Operating parameters from the twenty-four hour CO₂ injection in pressure control mode (80 bar WHP)
(de Dios et al, 2019)

Parameter	Initial value	Final value (24 h)
WHP	80 bar	80 bar
HI BHP (S2)	142 bar	160 bar
WHT	10° C	10° C
Flow rate	2.2 kg/s	1.7 kg/s



4.- First Results



5.-Discussion



- *Gahfarokhi et al (2018)* studied the injectivity changes due to WAG in porous medium at SACROC EOR project in Texas (USA)
- The injection conducted at Hontomín was in liquid phase (BH Density 0.83 t/m³)
- Tests conducted in pressure control mode reveal the decrease of injected flow to hold constant the WHP value
- Brine and CO₂ alternate injection produces multiphase flow hysteresis in the fracture network. Is this fact the reason for injectivity decrease?
- Discussion is focused on whether these results correspond to wellbore effects in the short-term, or they set a trend on long-term behavior of pair seal-reservoir
- New injections conducted in similar conditions during several days are planned to be performed at Hontomín in ENOS project, in order to give proper solutions to the injectivity changes, BHP recovery term and BHP/T evolution, inter alia operating parameters.



6.-References



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- ENOS Deliverable 1.1 “*Design of CO₂ injection tests*” (de Dios, J.C. and Le Gallo, Y.)
- de Dios, J.C.; Le Gallo, Y.; Marín, J.A. *Innovative CO₂ Injection Strategies in Carbonates and Advanced Modeling for Numerical Investigation*. Fluids 2019, 4(1), 52. Available online: //doi.org/10.3390/fluids4010052





Thank you for your attention

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