Increasing the temperature of the canister surface to 150°C: effect on thermo-hydraulic processes in the bentonite barrier

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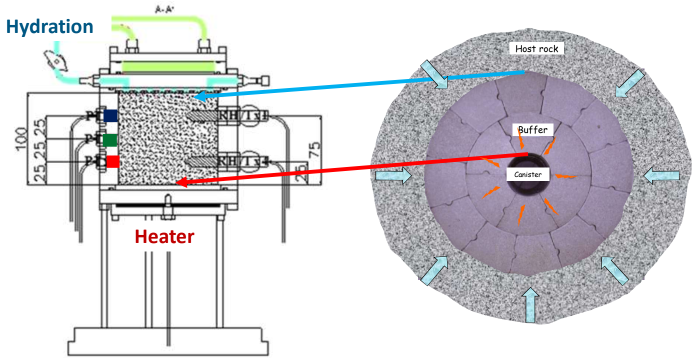
○ INTRODUCTION

Thermo-hydraulic tests in laboratory cells make it possible to reproduce the conditions that compacted bentonite – an essential barrier in deep geological repositories for radioactive waste - will experience during service. These tests provide both real-time and postmortem data, which are crucial for validating models that predict the thermo-hydro-mechanical (THM) behaviour and evolution of the bentonite barrier.

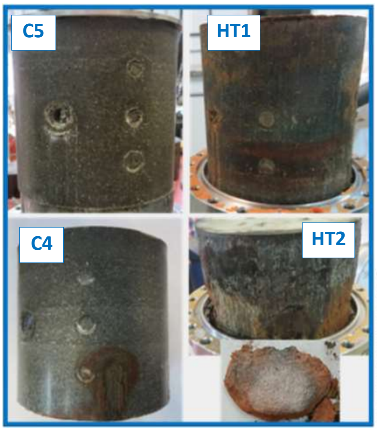


○ METHODOLOGY

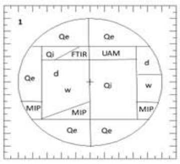
- Blocks of compacted Wyoming-type bentonite (dry density: 1.57 g/cm^3, water content=17%).
- Four tests were performed in stainless steel instrumented cells (temperature, pressure, relative humidity), using two heater temperatures and two different hydration waters.
- The tests consisted of an initial short heating phase and a heating+hydration phase.

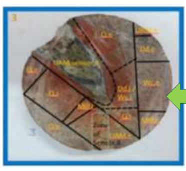
Test	HT1	HT2	C5	C4
Heater T (°C)	150	150	110	110
Hydration solution	Glacial	Saline*	Glacial	Saline*

*with a high concentration of chloride, sodium and sulfate



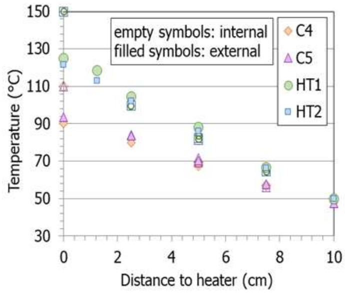
After 2.5 years of operation, the cells were dismantled and the bentonite was sampled for detailed analysis by sections located at different positions along the block.



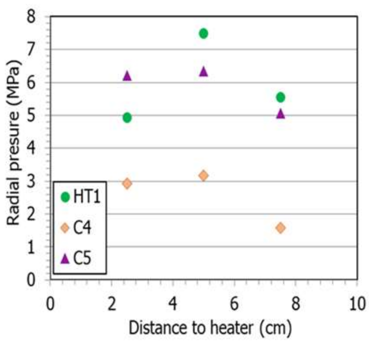


○ RESULTS

The temperature gradient along the blocks was linear. Water vapour movement was more intense in the cells with heater at 150°C: by the end of the heating phase, the relative humidity in the upper half of the blocks was higher in cells HT1 and HT2.

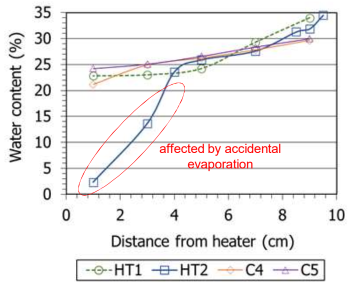


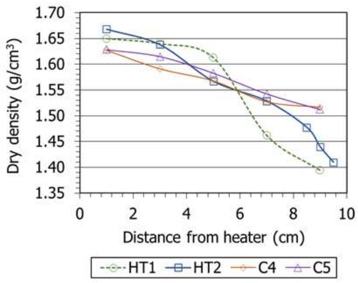
At the beginning of hydration, the water intake rate was very similar in both sets of tests, but the relative humidity in the middle and bottom part of the bentonite blocks increased more quickly in the tests at higher temperature.



As a result of hydration, radial pressure developed initially faster in the tests hydrated with glacial water. For a given water salinity, pressure build-up was faster at higher temperature and reached higher values.

The final degree of saturation was high in all cells, except HT2 (experimental artefact), although saturation was more difficult in the areas submitted to temperature >100°C.





○ CONCLUSIONS

The increase of temperature to values in the bentonite higher than 100°C does not hinder saturation, neither the development of swelling pressure to the same values expected for lower temperatures. However, the final inhomogeneity of the barrier can be enhanced by saturation under higher temperature.

Corrosion and alteration processes could be more intense under higher temperature, but this will have to be confirmed by the postmortem chemical and mineralogical analyses.