Numerical and experimental study of the thermodynamic behavior of hydrogen storage in salt cavities

The intermittency problem that usually characterizes the renewable energy led to vast storage techniques in the last few decades. The storage of Hydrogen in the salt caverns is one of the suggested solutions.

In this context, a precise prediction of the cavern thermodynamic state is needed. Besides, such a thermodynamic response requires to be fully coupled with the thermo-hydro-mechanical behavior of the rock mass surrounding the cavern.

Most of the recent available researches with regard to gas storage in salt caverns depend on numerical tools that assume a uniform cavern thermodynamic state. Thus, they ignore the spatial variations of the cavern thermodynamic variables as well as the flow nature (laminar/turbulent). These numerical approaches allow fast and low-cost simulations to be carried out, however, a question arises about their validity during fast cycling operation in the cavern.

This proposed PhD thesis is dedicated to investigating the integrity of salt cavern mechanical and thermodynamic behaviors during fast and slow cycling while addressing the entire complexity of the Computational Fluid Dynamics (CFD) problem, i.e. the full discretization of the cavern, the cavern gas velocity field, the thermodynamic variables spatial variations, the nature of flow and the 3D thermo-hydro-mechanical behavior of salt. Moreover, the problem of H_2 storage in salt caverns is particular compared to other gases. This is attributed to the large mobility of hydrogen induced by its very small molecular length and its potential reactivity with other chemical species that can be present in the storage environment. We aspire that this PhD thesis would shed a light on the phenomenon of hydrogen seepage into the salt rock.