6 months internship for 2nd year master students

Impact of atmospheric carbonatation on hydrodynamic properties of concrete in the context of nuclear waste storage.

LMTE

France, nuclear waste is managed by CIGEO, a deep geological storage site emphasizing reversibility over its 150-year lifespan. Material selection, notably concrete, is carefully chosen for its durability. Concrete's pH protects steel reinforcement from corrosion, but factors like atmospheric carbonatation can accelerate corrosion. It is important to maintain a low corrosion rate to ensure the mechanical stability of reinforced concrete and prevent its deterioration.

Atmospheric carbonatation of concrete occurs when atmospheric CO_2(g) diffuses into its porosity, leading to acidification of pore water through CO_2(aq) solubilization (FIgure 1). Dissolution of cement hydrates, like calcium hydroxide $Ca(OH)_2$, buffers this acidification and forms secondary minerals, such as calcium carbonates $CaCO_3$. The rate of carbonatation front propagation depends on concrete's specific characteristics (e.g., porosity, permeability, initial water content, hydrate content) and environmental factors like CO_2(g) concentration and atmospheric humidity.

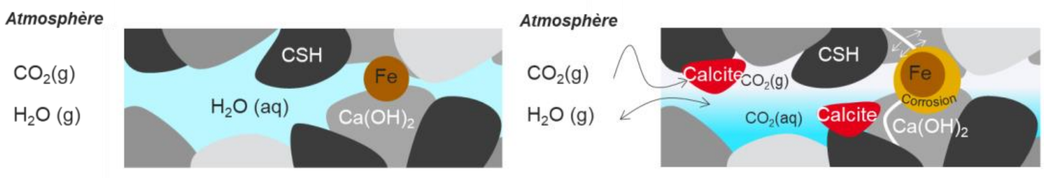

Figure 1: Schematic representation of the atmospheric carbonatation process in concrete. Left: concrete completely saturated with water, limiting CO_2(g) penetration. Right: concrete with a liquid saturation of less than 1, allowing CO_2(g) to penetrate and solubilize in water.

The intern will conduct modeling work aimed at evaluating, at different time scales (from years to hundreds of years) and spatial scales (meso- and macroscopic scales), the impact of storage scenarios on the physical and chemical quality of concrete. The modeling work should also allow for the decoupling of the various mechanisms resulting from concrete carbonatation through a sensitivity study. The results will be used to (i) improve the fundamental understanding of the mechanisms underlying concrete carbonatation and (ii) provide an in-depth understanding of the long-term durability of containers, thereby providing decision-making tools for structure design.

Tasks and responsibilities

In collaboration with the supervisory team, the trainee will define storage scenarios and carry out the corresponding calculations. Sensitivity studies will be carried out on these calculations in relation to the various parameters chosen beforehand. The intern will play an active role in processing, analyzing and interpreting the results, which will then be recorded in an internship report and scientific article.

Supervision and contact

The internship is scheduled to last **6 months** and will be based at the Cadarache site (Bouches-du-Rhône, 13). The selected student will be co-supervised by **Camille BANC (camille.banc@cea.fr, 06-19-95-78-39)**, Pascal THOUVENOT and Jean-Eric LARTIGUE (research engineers).

Remuneration and accommodation

The internship will give rise to remuneration of around €700 gross/month. Missions (field visits, meetings outside the Cadarache site) will be reimbursed if the trainee uses his/her personal vehicle. The trainee will be based at CEA Cadarache FRANCE (13). The student may request accommodation in the student residence located in the immediate vicinity of the Cadarache site. Financial assistance may be provided for accommodation. Acceptance of the applicant will be subject to the outcome of the security survey conducted by CEA.

Candidate profile

Currently enrolled in a Master 2 or equivalent engineering school in environmental sciences, hydrogeology or geochemistry, the candidate should have a keen interest in modeling and data processing. Practical skills in reactive transport modeling in porous media will be appreciated.