MASTER 2 INTERNSHIP PROPOSAL

Numerical modelling of condensation in porous media

Context

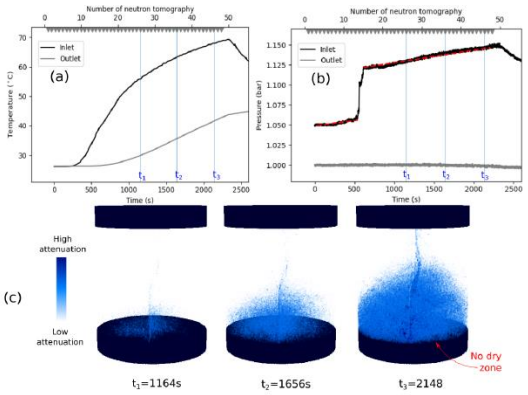
Fluid flow and heat transfer in porous media has been studied for decades, and their theories and physical models have been well developed. However, when phase change in porous media is involved, additional complexities are added to the two-phase flow so that the heat transfer between the porous matrix and the fluids determines the phase change and the fraction of each phase. Among the processes with phase change, condensation remains fairly under-explored despite its various applications including durability and performance of concrete structures, porous fabrics and insulations, underground contamination removal by steam, steam-based gas and oil recovery methods, heat pipes wicks, and geothermal reservoirs.

Currently 3SR laboratory, ESRF and LEGI laboratory are engaged in a project aiming at better understanding the vapor condensation in such media. A key feature is to understand how the porous media heterogeneities (through porosity spatial distribution or the existence of a more localized porous fracture network) affect this process. Those investigations involve experimental work as well as numerical work.

On the experimental side, original set of data have been already gathered using fast neutron imaging at ILL on several configurations (porous media with or without fractures). Those new data are supplemented with calibration experiments as well as sample characterizations, that allows to perform a quantitative analysis of the condensation and water content evolution in the samples.

Subject

This master internship will mainly deal with the numerical part of the project. Following a thorough investigation of literature, a first model based on simplifying assumption (saturated vapor) and applied to simple configurations (1D, homogeneous porous media), has been developed and implemented with OpenFoam©. During this internship, this 1D-model will be assessed on simple configurations that can be compared with existing literature results. On a second step, this model will be extended to more 2D or 3D complex configurations namely those studied in the experiments performed in ILL.



Example fast neutron imaging and corresponding results gathered at ILL (ref [1]

As a first task, it is intended to investigate the ability of the model to quantitatively represent the behavior observed in the porous sample without the crack. If successful, a parametric study will be performed to assess the influence of the porous media characteristic, especially its heterogeneity through the porosity spatial distribution. Depending on the work progress, some development aiming to include the crack will be optionally performed.

Candidate profile

We seek for an enthusiastic candidate enrolled in a Master's program in earth sciences, fluid mechanics, physics, or any other related topic (M2). The candidate should have strong interest in modelling and numerical studies. Any previous experience in flow in porous media,thermodynamics and/or numerical simulations are highly appreciated. The internship is located at *LEGI* laboratory at *University Grenoble Alpes*. It is expected to last for 5 to 6 months starting from early February 2023

Contact

Please send you CV and motivation letter to:

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Ref

[1] A. Nemati, B. Lukic, A. Tengattini, R Gupta, M Briffaut & P Séchet, Rapid In Situ Neutron Tomography and X-ray Imaging of Vapor Condensation in Fractured Sandstone, Transport in Porous Media, https://doi.org/10.1007/s11242-023-02014-3, (2023)

[2] Gupta, R. et al. (2022). 'Experimental characterisation of transient condensed water vapour migration through cracked concrete as revealed by neutron and x-ray imaging: Effect of initial saturation'. In: Cement and Concrete Research 162, p. 106987.

[3] Bergins, C., Sven Crone and Karl Strauss (2005). 'Multiphase flow in porous media with phase change. Part II: Analytical solutions and
experimental verification for constant pressure steam injection'. In: Transport in Porous Media 60.3, pp. 275–300