Research Topic 24 for the ParisTech/CSC PhD Program

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:
ali.siadat@ensam.eu AND yvon.velot@ensam.eu

Subfield: Computational Fluid Dynamics and Experimental Fluid Mechanics in Porous Media.

ParisTech School: Ecole Nationale Supérieure d'Arts et Métiers.

Title: Computational and Experimental study of non-Newtonian flow through Porous and Fractured Media.

Advisor(s): Dr. Giovanni RADILLA,
giovanni.radilla@ensam.eu,
www.researchgate.net/profile/Giovanni_Radilla
Dr. Antonio RODRIGUEZ DE CASTRIO
antonio.rodriguezdecastro@ensam.eu
www.researchgate.net/profile/Antonio_Rodriguez_De_Castro

Short description of possible research topics for a PhD:

Complex fluids are extensively used in petroleum engineering and soil remediation to improve the microscopic sweep efficiency of the reservoir through stabilization of the injection front. Also, many natural phenomena in geophysics and hydrogeology involve the flow of non-Newtonian fluids through porous and fractured media, which has become a field of great research interest. In particular, the amount of trapped oil and the size of the trapped blobs depend on a variety of parameters including transport properties of porous media and the physical and chemical properties of the displacing and displaced fluid. However, such dependency is still unclear in the case of complex fluids. Also, obtaining a macroscopic law to predict pressure drop as a function of flow rate when complex fluids are injected in porous and fractured media has proved to be a stumbling-block. The objective of this PhD thesis is to present a method to predict the pressure losses and the residual oil saturation generated during single-phase and two-phase immiscible flow of non-Newtonian fluids in porous and fractured media of known geometry. This method will be based on the results of numerical simulations using a realistic model for the fluid's rheology. The predictions will then be validated by laboratory experiments using real and model porous media.

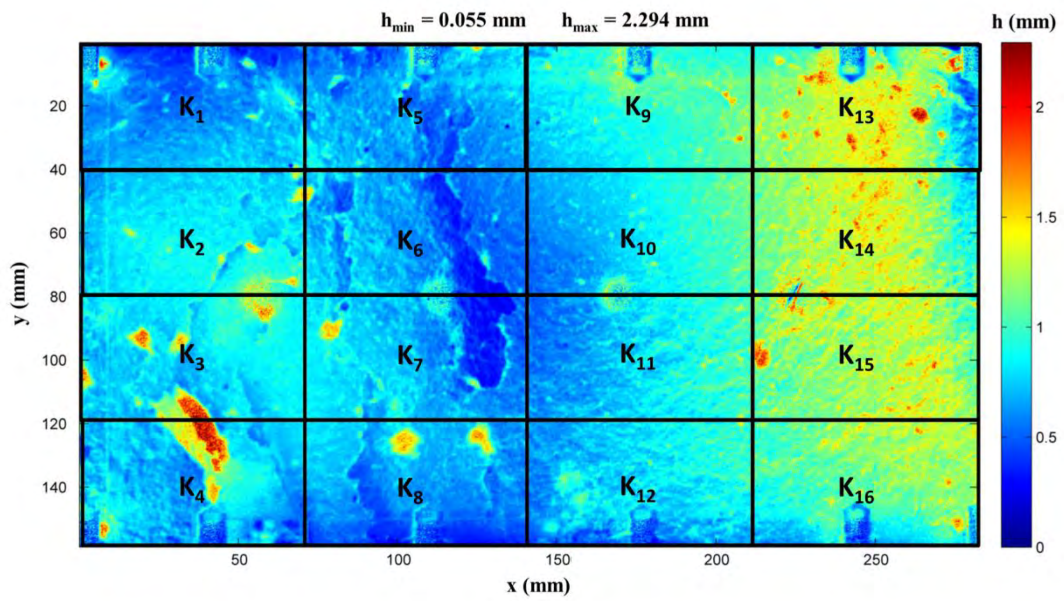

Figure 1 Aperture map of the Vosges sandstone fracture. K_i with (i=1…12) represent averaged permeabilities which may be used to compute pressure drops through the fracture.

Required background of the student: A solid theoretical and experimental understanding of the fundamentals of fluid mechanics is required. The principles of Computational Fluid Dynamics must be known. Performing experiments requires dexterity, autonomy and meticulousness.

A list of 5 (max.) representative publications of the group:

Rodríguez de Castro, A., Radilla, G., Flow of yield stress and Carreau fluids through rough-walled rock fractures: Prediction and experiments, Water Resour. Res. 53 (2017), 6197–6217. http://dx.doi.org/10.1002/2017WR020520.

Rodríguez de Castro, A., Radilla, G., Non-Darcian flow of shear-thinning fluids through packed beads: Experiments and predictions using Forchheimer's law and Ergun's equation, Advances in Water Resources 100 (2017), 35-47. http://dx.doi.org/10.1016/j.advwatres.2016.12.009

Rodríguez de Castro, A., Radilla, G., Non-Darcian flow experiments of shear-thinning fluids through rough-walled rock fractures, Water Resources Research 52 (2016), 9020-9035. http://dx.doi.org/10.1002/2016WR019406

Radilla, G., Nowamooz, A., Fourar M., Modeling non-Darcian single- and two-phase flow in transparent replicas of rough-walled rock fractures, Transport in Porous Media 98 (2013), 401-426. http://dx.doi.org/10.1007/s11242-013-0150-1.

Fourar, M., Radilla, G., Lenormand, R., Moyne, C., On the non-linear behavior of a laminar single-phase flow through two and three-dimensional porous media, Advances in Water Resources 27, (2004), 669-677. http://dx.doi.org/10.1016/j.advwatres.2004.02.021.