

Research Topic for the Arts et Métiers ParisTech - CSC PhD Program

Subfield: Fluid mechanics in porous and fractured media.

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

Title: Experimental study and modelling of tracer dispersion and multiphase flow of Newtonian and shear-thinning fluids in 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: (10 lines in English + optional figure)

Multiphase flow of Newtonian and shear-thinning fluids and tracer transport in porous media and fractures have several industrial applications: chemical engineering, petroleum engineering, hydrology, environmental engineering and geothermal energy production among many others.

Empirical models describing multiphase flow and tracer transport in such media are strongly linked to the media geometric properties (surface roughness, pore-size distribution, pore network connectivity...).

Numerical simulations and experiments are both required in order to build new reliable models and also to find and quantify relevant parameters describing the physics of the flow.

Our expertise focuses on experimental set-ups involving classical pressure and flow measurements combined with image processing techniques which allow to observe different flow regimes and to measure accurately phase saturation under multiphase flow conditions.

Required background of the student: (Which should be the main field of study of the applicant before applying)

A solid theoretical and experimental understanding of the fundamentals of fluid mechanics is required. The principles of signal and image processing must be known.

Performing experiments requires dexterity, autonomy and meticulousness.

2-3 representative publications of the group: (Related to the research topic)

Nowamooz A., **Radilla G.**, Fourar M. and Berkowitz B. (2013). Non-Fickian transport in transparent replicas of rough-walled rock fractures. *Transport in Porous Media* (98)3, pp. 651-682, DOI: 10.1007/s11242-013-0165-7.

Radilla G., Nowamooz A. and Fourar M. (2013). Modeling non-Darcian single- and two-phase flow in transparent replicas of rough-walled rock fractures. *Transport in Porous Media* (98)2, pp. 401-426, DOI: 10.1007/s11242-013-0150-1.

Radilla G., Sausse J., Fourar M. and Sanjuan B. (2012). Interpreting tracer tests in the enhanced geothermal system (EGS) of Soultz-sous-Forêts using the equivalent stratified medium approach. *Geothermics* (44), pp. 43–51. DOI: 10.1016/j.geothermics.2012.07.001.

Radilla G., Kacem M., Lombard J.M. and Fourar M. (2010). Transport properties of Lavoux Limestone at various stages of CO₂ like acid-rock alteration. *Oil & Gas Science and Technology*. DOI: 10.2516/ogst/2009081.

Fourar M. and **Radilla G.** (2009). Non-Fickian description of tracer transport through heterogeneous porous media. *Transport in Porous Media* (80)3, pp. 561-579, DOI: 10.1007/s11242-009-9380-7.

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

Rodríguez de Castro, A., Ahmadi-Sénichault, A., Omari, A., Savin, S., Madariaga, L.-F., Characterizing porous media with the Yield Stress Fluids porosimetry Method, Transport in Porous Media 114 (2016) 213-233.

<http://dx.doi.org/10.1007/s11242-016-0734-7>

Rodríguez de Castro, A., Oostrom, M., Shokri, N., Effects of shear-thinning fluids on residual oil formation in microfluidic pore networks, Journal of Colloid and Interface Science 472 (2016) 34-43.

<http://dx.doi.org/10.1016/j.jcis.2016.03.027>

FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:

ali.siadat@ensam.eu AND yvon.velot@ensam.eu