Cyprien Soulaine

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33 years old

> ## Research Scientist
> ### Computational Fluid Mechanics
> ### Multiscale Modeling and Numerical Simulation

WORK EXPERIENCES

2013 - (4.5 years)

Stanford University, Department of Energy Resources Engineering, SUPRI-B (Stanford, CA, USA) – Research Associate (with Hamdi Tchelepi)

- Lead of the pore-scale simulation activity,
- Development of Computational Fluid Mechanics tools for flow and transport in porous media,
- Pore-scale simulation of unconventional resources (TOTAL STEMS project),
- Modeling of dissolution phenomena at the pore-scale for CO_2 sequestration (US Department of Energy, Center for Nanoscale Controls on Geologic CO_2),
- Multiphase flow in porous media at the pore-scale.

2012 - 2013 (8 months)

Institut de Mécanique des Fluides de Toulouse (IMFT) / European Organization for Nuclear Research (CERN) (Toulouse, France) - post-doctoral position

- Development of an OpenFOAM® code to simulate superfluid helium flow (cooling of the Large Hadron Collider's magnets),
- Theory of superfluid helium in porous media.

2009 - 2012 (3 years)

Air Liquide / Institut de Mécanique des Fluides de Toulouse (IMFT) (Toulouse, France) – PhD candidate (CIFRE) - *«Modeling of flow in structured packings: from pore to column scale».* Advisor : Michel Quintard.

- Theoretical development and numerical implementation in OpenFOAM® of a comprehensive macroscopic model using multi-scale techniques to simulate turbulent multicomponent two-phase flow in distillation columns equipped with structured packings,
- Evaluation of macro-scale parameters from pore-scale simulations,
- Comparison of simulation results with experimental data.

2008 - 2009 (18 months)	**Air Liquide Research Center** (Paris, France) – Research Engineer
	• Implementation of new thermal models for adsorption columns in the in-house simulation code,
	• Simulation of gas separation processes involving adsorption phenomena (PSA technology),
	• Performance assessment of phase change materials on hydrogen production units,
	• Coupling between the adsorption code and a multi-objectives optimisation software,
	• Maintenance of the code and support to users.
2007 (4 months)	**SOLEIL Synchrotron** (Paris, France) – Internship
	• Evaluation of performances of a micro-channels heat exchanger,
	• Finite elements simulations of heat transfer in micro-channels.

EDUCATION

2009/2012 **Ph.D. of Institut National Polytechnique de Toulouse** specialized in *« Hydrology, Hydrochemistry, Soil and Environnement »* (Toulouse, France). Advisor : Michel Quintard

2005/2008 **ENSEIRB-MATMECA,** French Engineering School (M.Sc.) in applied mathematics and mechanics (Bordeaux, France) http://www.enseirb-matmeca.fr/

2007/2008 **Master degree's in Mechanical Engineering at University of Bordeaux** (Bordeaux, France)

2003/2005 Preparation in Mathematics and Physics for the entrance examination to French Engineering Schools: Lycée Michelet (Paris, France)

GENERAL SKILLS

Technical skills

- Fluid mechanics: CFD, Navier-Stokes, flow in porous media, multiphase flow, Volume of Fluid, turbulence, heat and mass transfer, finite volumes, thin films
- Porous media: upscaling, volume averaging, multi-scale, adsorption, absorption, inertial flow, multiphase, dissolution, carbonate, sandstone, microporosity, reactive transport modeling
- Reservoir engineering: Multiphase flow, IMPES, fracture, dual media, acid stimulation, Digital Rock Physics, pore-scale.

IT skills

- General : Linux, Windows, MS Office, LaTeX,
- Scientific software : OpenFOAM®, Salomé, ParaView, COMSOL Multiphysics®, Ansys Fluent, MathCAD, Maple, MATLAB, modeFRONTIER™,
- Programming language : FORTRAN 77/90, Python, C/C++.

Language French (native speaker), English (fluent)

AWARDS

- Léopold Escande prize, best thesis in Engineering, National Polytechnic Institute of Toulouse (2012)

- Jean Nougaro award, best thesis in Engineering, Toulouse Academy of Sciences, France (2013)

TEACHING

- "First steps with OpenFOAM®": 2-days training class to CNRS researchers (15 attendees)

- Teacher at ENSEEIHT (www.enseeiht.fr): Computational Fluid Dynamics with OpenFOAM® and Salomé Platform (20 students)

- "Simulation of flow in porous media with OpenFOAM®": 5x3h training class to Stanford ERE (15 students/researchers)

- Lectures in Stanford's Advanced Topic in Reservoir Simulation (Energy 224): "Flow simulation at the pore scale"

- Lectures in Stanford's Fundamentals of Multiphase Flow (Energy 221): "Flow simulation at the pore scale"

- Short course Computational Fluid Dynamics with OpenFOAM® at Interpore Conference, Rotterdam, May 13, 2017 (25 participants)

REFEREES

Pr. Michel Quintard

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PUBLICATIONS

Publications under review:

- **C. Soulaine**, S. Roman, A. Kovscek, H. Tchelepi *« Pore-scale modeling of multiphase reactive flow. Application to mineral dissolution with production of CO2»*

- J. Maes and **C. Soulaine** *« A new compressive scheme to simulate species transfer across fluid interfaces using the Volume-of-Fluid method»*

- **C. Soulaine**, P. Creux, H. Tchelepi *« New insights into multiphase flow in soaked fracture in gas shale formations: impact of clays on gas production from very mature kerogen»*

Publications in peer review journals:

[1] M. Graveleau, **C. Soulaine,** H. A. Tchelepi *« Pore-scale simulation of interphase multicomponent mass transfer for subsurface flow»* Transport In Porous Media (2017), 120(2), 287-308

[2] **C. Soulaine**, S. Roman, A. Kovscek, H. Tchelepi *« Mineral dissolution and wormholing from a pore-scale perspective»* Journal of Fluid Mechanics (2017), 827, 457-483

[3] **C. Soulaine**, M. Quintard, B. Baudouy, R. van Weelderen *« Numerical investigation of thermal counterflow of He II past cylinders»* Physical Review Letters (2017), 118, 074506(5)

[4] **C. Soulaine** and H. A. Tchelepi *« Micro-continuum approach for pore-scale simulation of subsurface processes»* Transport In Porous Media (2016), 113, 431-456

[5] **C. Soulaine**, F. Gjetvaj, C. Garing, S. Roman, A. Russian, P. Gouze, H. A. Tchelepi *« The Impact of Sub-resolution Porosity of X-ray Microtomography Images on the Permeability»* Transport In Porous Media (2016), 113, 227-243

[6] S. Roman, **C. Soulaine**, M. Abu AlSaud, A. Kovscek, H. Tchelepi *« Particle Velocimetry Analysis of Immiscible Two-Phase Flow in Micromodels»* Advances in Water Resources (2016), 95, 199-211

[7] **C. Soulaine**, M. Quintard, H. Allain, B. Baudouy, R. van Weelderen *« A PISO-like algorithm to simulate superfluid helium flow with the two-fluid model»* Computer Physics Communications (2015), 187, 20-28

[8] P. Horgue, **C. Soulaine**, J. Franc, R. Guibert, G. Debenest, *« An open-source toolbox for multiphase flow in porous media»* Computer Physics Communications (2015), 187, 217-226

[9] L. Orgogozo, N. Renon, **C. Soulaine**, F. Hénon, SK. Tomer, D. Labat, OS. Pokrovsky, M. Sekhar, R. Ababou, M. Quintard, *« An open-source massively parallel solver for Richards equation: Mechanistic modelling of water fluxes at the watershed scale»* Computer Physics Communications (2014), 185, 3358-3371

[10] **C. Soulaine**, P. Horgue, J. Franc, M. Quintard, *« Gas–Liquid Flow Modeling in Columns Equipped with Structured Packing »* AIChE Journal (October 2014), 60(10), 3665-3674

[11] **C. Soulaine** and M. Quintard, *« On the use of a Darcy–Forchheimer like model for a macro-scale description of turbulence in porous media and its application to structured packings »* International Journal of Heat and Mass Transfer (2014), 74, 88 – 100

[12] **C. Soulaine**, Y. Davit, M. Quintard, *« A two-pressure model for slightly compressible single phase flow in bi-structured porous media »* Chemical Engineering Science (June 2013), 96(1), 55-70

[13] H. Allain, R.V. Weelderen, B. Baudouy, M. Quintard, M. Prat, **C. Soulaine**, *« Investigation of suitability of the method of volume averaging for the study of heat transfer in superconducting accelerator magnet cooled by superfluid helium »* Cryogenics (January 2013), 53, 128-134

[14] **C. Soulaine**, G. Debenest, M. Quintard, *« Upscaling multi-component two-phase flow in porous media with partitioning coefficient »* Chemical Engineering Science (December 2011), 66(23), 6189-6192

Conference proceedings published in journals with peer review:

[15] **C. Soulaine**, M. Quintard, H. Allain, B. Baudouy, R. Van Weelderen, *« Numerical Investigation of Heat Transfer In a Forced Flow of He II »* Proceedings of the 15th International Heat Transfer Conference, IHTC-15 August 10-15, 2014, Kyoto, Japan, 2014

Conference proceedings published in journals:

[16] **C. Soulaine** and H. A. Tchelepi, *« Micro-continuum Formulation for Modelling Dissolution in Natural Porous Media »* Proceedings of the 15th European Conference on the Mathematics of Oil Recovery, ECMOR XV, 29 August – 1 September 2016, Amsterdam, Netherlands

ORAL COMMUNICATION (selection)

- *"Minerals dissolution and wormholing from a pore-scale perspective",* Gordon Research Seminar on Flow & Transport in Permeable Media, July 7-8, 2018. Sunday River, Newry, ME, USA (invited speaker)

- *"Micro-continuum approach for pore-scale simulation of subsurface processes",* SIAM Conference on Mathematical and Computational Issues in the Geosciences, Sept 11-14, 2017. Erlangen, Germany (invited speaker)

- *"Micro-continuum approach for pore-scale simulation of subsurface processes",* 53rd Annual Technical Meeting of the Society of Engineering Science, Oct 2-5, 2016. University of Maryland, College Park, USA (invited speaker)

- *"Simulation of multiphase flow at the pore scale: doable, useful?"*, AGU Fall Meeting 2014, San Francisco, USA (invited speaker)

- *"Numerical Investigation of Heat Transfer In a Forced Flow of He II"* 5th International Heat Transfer Conference, IHTC-15 August 10-15, 2014, Kyoto, Japan

- *"Gas-Liquid flow modeling in columns equipped with structured packing seen as bi-structured porous media"*, AIChE Annual Meeting 2013. San Francisco, CA, USA