Rafael M. Oliveira

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EDUCATION

Sep 2007 – Mar 2012 **PhD, Mechanical Engineering**
University of California, Santa Barbara
Dissertation title: Three-dimensional Navier-Stokes simulations of miscible displacements in Hele-Shaw cells.
Advisor: Prof. Eckart Meiburg

Mar 2005 – Feb 2007 **MsC, Physics**
Universidade Federal de Pernambuco, Brazil
Thesis title: Ferrofluids confined in Hele-Shaw cells: influence of magnetic field and viscous stresses.
Advisor: José A. Miranda (co-advisor: Prof. Sérgio Coutinho)

2001 – 2005 **BsC, Physics**
Universidade Federal de Pernambuco, Brasil
Major studies: soft condensed matter, fluid dynamics, porous media flows.

PROFESSIONAL EXPERIENCE

Ago 2018 – current **Assistant Professor - Mechanical Engineering, PUC-Rio**

Jan 2017 – July 2018 **Postdoc** – Mechanical Engineering, PUC-Rio

- Teach one engineering course per semester:
  - 2017.1 and 2017.2: 'ENG 1011: Transport Phenomena I'.
- Perform linear stability analysis and nonlinear simulations to investigate double-diffusion instabilities and displacements of complex fluids in porous media.
- Research led to one publications at Physical Review Letters and another at Journal of Fluid Mechanics Rapids.

Dec 2012 – Feb 2016 **Senior Physicist** – Halliburton Brazil Technology Center

- Our team has investigated gas invasion into oils wells, a challenging topic to the oil industry. We have developed a mathematical model, a numerical software, and built a large scale Well Simulator to perform cementing experiments.
- We also contributed to the development of the research portfolio of the Technology Center by proposing research projects in enhanced oil recovery, flow assurance, drilling and fracturing fluids and cementing.

May 2012 – Nov 2012 **Postdoc** – Applied Math, IMPA-Brazil

- Finite-difference discretization of the three-dimensional, variable viscosity Navier Stokes equations.

Sep 2007 – Mar 2012 **Research Assistant** – *Department of Mechanical Engr.* (UCSB)

- Served in role under Prof. Eckart Meiburg for 2 ½ years.
- Developed three-dimensional parallel code in C language via Direct Numerical Simulation to model displacements of miscible, confined two-phase flows in porous media or Hele-Shaw cells.
- Research led to three publications at Journal of Fluid Mechanics.

Sep 2007 – Mar 2012 **Teaching Assistant** – *Department of Mechanical Engr.* (UCSB)

- Served in role for two years.
- Graded assignments and proctored exams.
- Led mathematics review sections, and provided matlab tutorial to 100 students.
- Held weekly office hours.

Jan 2006 – Jul 2007 **Assistant Professor** – Department of Mathematics (UFRPE, Brazil)

- Instructed differential and integral calculus to freshmen, sophomore and junior years of Math, Physics, Chemistry and Computer Science majors.
- Taught about 50 students per class, three classes per semester.

FELLOWSHIPS & AWARDS

Jan 2017 – Jul 2018 **Postdoc Fellowship**
CAPES + PUC-Rio

May 2012 – Nov 2012 **Postdoc Fellowship**
IMPA

Sep 2007 – Mar 2012 **Doctoral Research Fellowship**
CAPES (Brazilian research agency) + FULBRIGHT

Mar 2007 – Aug 2007 **Predoctoral Research Fellowship**
FACEPE (Brazilian research agency)

Mar 2005 – Feb 2007 **Masters Research Fellowship**
CNPq (Brazilian research agency)

2004 **Undergraduate Scientific Research Honor** (first place)
UFPE – Universidade Federal de Pernambuco

2003 – 2005 **Undergraduate Research Fellowship**
CNPq (Brazilian research agency)

2002 – 2003 **Undergraduate Teaching Assistant Fellowship**
UFPE – Universidade Federal de Pernambuco

RESEARCH EXPERIENCE

Porous media and Hele-Shaw flows, enhanced oil recovery, computational fluid dynamics, numerical methods, nonlinear dynamics, hydrodynamic instabilities, pattern formation, magnetic fluids, Newtonian and non-Newtonian fluids, rheology, adhesion phenomena, cementing of oil wells.

GRANTED PATENTS

1. E. C. Rodrigues, Rafael M. Oliveira, and F. H. Marchesini; “Methods for evaluating the performance of cement fluid-loss-control additives for field applications”; PCT filing date: 08.05.2015. **Granted in United Kingdom** on 01.09.2019 (GB2555546B); **Granted in Canada** on 01.08.2019 (CA2990599C); Publication in WIPO of WO2017023319A1 on 02.09.2017; Publication in Australia of AU2015404555A1 on 01.25.2018; Publication in United States of US20180201824A1 on 07.19.2018; Publication in Mexico of MX2018001064A on 05.17.2018; Publication in France of FR3039853A1 on 02.10.2017; Publication in Norway of NO20172044A1 on 12.22.2017.
2. F. H. Marchesini, Rafael M. Oliveira, M. Khammar, A. K. Santra, and M. D. M. Paiva; “Methods for producing fluid invasion resistant cement slurries”; PCT filing date: 10.31.2012. **Granted in United States** on 08.14.2018 (US10047587B2); **Granted in Canada** on 01.03.2017 (CA2885479C); **Granted in Australia** on 10.27.2016 (AU2013338387B2); Publication in Brazil of BR112015005448A2 on 07.04.2017; Publication in Mexico of MX2015003453A on 09.23.2015; Publication in Europe of EP2914803A4 on 07.13.2016; Publication in WIPO of WO2014070503A9 on 06.19.2014; Publication in Argentina of AR093259A1 on 05.27.2015; Publication in India of IN2015DN02350A on 08.28.2015.

PATENT APPLICATIONS

3. E. C. Rodrigues, F. H. Marchesini, and Rafael M. Oliveira; “Optimizing hydraulic fracturing in a subterranean formation”; PCT filing date: 11.24.2014, PCT/US2014/067147. Publication in United States of US20170241251A1 on 08.24.2017; Publication in WIPO of WO2016085454A8 on 07.07.2016; Publication in Argentina of AR101947A1 on 01.25.2017.

4. Rafael M. Oliveira, F. H. Marchesini, “Injection rate tuning for oilfield operations”. PCT filing date: 12.23.2015, PCT/IB2015/059953. Publication in United States of US20180016882A1 on 01.18.2018; Publication in WIPO of WO2017109553A1 on 06.29.2017.

PEER-REVIEWED JOURNAL PUBLICATIONS

1. *Irreversible time-dependent rheological behavior of cement slurries: Constitutive model and experiments.* Flavio H. Marchesini, Rafael M. Oliveira, H. Althoff and P. R. de Souza Mendes. J. Rheol. **63**, 247 (2019). *(pdf)*
2. *Settling-driven instability in two-component stably stratified Hele-Shaw flows*. Rafael M. Oliveira and E. Meiburg, J. Fluid Mech. Rapids **843**, R1, 1-12 (2018). (pdf)
3. Saffman-*Taylor instability and the inner splitting mechanism.* Rafael M. Oliveira and E. Meiburg, Phys. Rev. Lett. **118**, 124502 (2017). (pdf)
4. *Three-dimensional Navier-Stokes simulations of buoyant, vertical miscible Hele-Shaw*

displacements. F.. H. C. Heussler, Rafael M. Oliveira, M. O. John and E. Meiburg. J. Fluid Mech. **752**, 157-183 (2014). (pdf)

5. *Three-dimensional vorticity configurations in miscible Hele-Shaw displacements.* Rafael M. Oliveira and Eckart Meiburg. Procedia IUTAM **7**, 203-212(2013). (pdf)
6. *Variable density and viscosity, miscible displacements in horizontal Hele-Shaw cells. Part 2. Nonlinear simulations.* Michael O. John, Rafael M. Oliveira, Felix. H. C. Heussler and E. Meiburg. J. Fluid Mech. **721**, 295-323 (2013). (pdf)
7. *Miscible displacements in Hele-Shaw cells: three-dimensional Navier-Stokes simulations.* Rafael M. Oliveira and Eckart Meiburg. J. Fluid Mech. **687**, 431-460 (2011). (pdf)
8. *Stationary shapes of confined rotating magnetic liquid droplets.* Sérgio A. Lira, Rafael M. Oliveira and José A. Miranda. Phys. Rev. E. **82**, 036318 (2010). (pdf)
9. *Field-induced patterns in confined magnetorheological fluids.* Sérgio A. Lira, Rafael M. Oliveira and José A. Miranda. Phys. Rev. E. **81**, 046303 (2010). (pdf)
10. *Ferrofluid patterns in a radial magnetic field: Linear stability, nonlinear dynamics, and exact solutions.* Rafael M. Oliveira, Eduardo S. G. Leandro and José A. Miranda. Phys. Rev. E. 77, 016304 (2008). (pdf)
11. *Geometric approach to stationary shapes in rotating Hele-Shaw flows.* Eduardo S. G. Leandro, Rafael M. Oliveira and José A. Miranda. Physica D **237**, 652-664 (2008). (pdf)
12. *Stretching of a confined ferrofluid: Influence of viscous stresses and magnetic field.* Rafael M. Oliveira and José A. Miranda. Phys. Rev. E. **73**, 036309 (2006). (pdf)
13. *Magnetic fluid in a time-dependent gap Hele-Shaw cell.* Rafael M. Oliveira and José A. Miranda. J. Magn. Magn. Mater. **289**, 360-363 (2005). (pdf)
14. *Adhesion phenomena in ferrofluids.* José A. Miranda, Rafael M. Oliveira and David P. Jackson. Phys. Rev. E. **70**, 036311 (2004). (pdf)
15. *Time-dependent gap Hele-Shaw cell with a ferrofluid: Evidence for an interfacial singularity inhibition by a magnetic field.* José A. Miranda and Rafael M. Oliveira. Phys. Rev. E. **69**, 066312 (2004). (pdf)

APPROVED PROJECT BY BRAZILIAN GOVERNMENT AGENCY

1. Chamada MCTIC/CNPq No 28/2018 - Universal/Faixa A - Até R$ 30.000,00. Title: Simulações não lineares de instabilidades hidrodinâmicas de interfaces móveis. Professor: Rafael M. Oliveira. Award: R$ 10,000.00 and 24 months of undergraduate scholarship.

INVITED LECTURES

1. “Hydrodynamic instabilities in Hele-Shaw cells in miscible and immiscible displacements”, DMAT, UFPE, Recife, PE, Brazil (July 2018).
2. “Three-dimensional instabilities of Hele-Shaw displacements with miscible fluids”, PUC-Rio, Rio de Janeiro, RJ, Brazil (April 2017).
3. “Three-dimensional Navier-Stokes simulations of miscible displacements in Hele-Shaw cells”, IMPA, Rio de Janeiro, RJ , Brazil (June 2012).
4. “Three-dimensional Navier-Stokes simulations of miscible displacements in Hele-Shaw cells”, UCSB, Santa Barbara, CA, USA (April 2012).
5. “Ferrofluids confined in Hele-Shaw cells: influence of magnetic field and viscous stresses”, UFPB, João Pessoa, PB, Brazil (May 2007).

PERIODIC REVIEWER

2018 – Physical Review Fluids
2017 – Journal of Fluid Mechanics
2017 – European Journal of Mechanics / B Fluids
2013 – Physics of Fluids
2013 – Boletín de la Asociación Matemática Venezolana

COMPUTATIONAL LANGUAGES

Matlab, Mathematica, C, Bash (Unix shell), Message Passing Interface (Parallel Computing), LaTex.

GRADUATE ADVISER

2018 – Coadvised Master thesis of André Pimentel next to Professor Ivan Menezes. Dissertation title: “Aplicação da derivada topológica na otimização estrutural”;

CURRENT STUDENTS

2018 – Coadvising PhD candicate Behbood Abedi next to Professor Paulo R. Souza Mendes. Title of qualifying exam: “Viscous fingering in non-Newtonian fluids: elasto-viscoplastic & thixotropic”

2018 – Coadvising PhD candidate Pedro Tomas on Axisymmetric displacement flows of non-Newtonian fluids: nonlinear numerical simulations.

COMMITTEE MEMBER for PhD THESIS

2019 – Paulo Henrique de Lima Silva, “Reologia de pastas de hidratos de tetrahidrofurano”. Advisor: Mônica F. Naccache and P. R. de Souza Mendes. Departamento de Engenharia Mecânica, PUC-Rio.

2017 – William Fernando Lopez Candela, “Escoamento de Bolhas de Gás em Materiais Viscoplásticos e Tixotrópicos”. Advisor: P. R. de Souza Mendes. Departamento de Engenharia Mecânica, PUC-Rio.

COMMITTEE MEMBER for MSc DISSERTATION

2019 – Eduardo Villela Machado dos Reis, “Instabilidade linear modal e não-modal de Poiseuille-Bénard-Marangoni induzida por dissipação viscosa”. Advisor: Leonardo Santos de Brito Alves. Departamento de Engenharia Mecânica, UFF.

COMMITTEE MEMBER for PhD QUALIFYING EXAM

2017 – Behbood Abedi, “Viscous fingering in non-Newtonian fluids: elasto-viscoplastic & thixotropic”. Advisor: P. R. de Souza Mendes. Coadvisor: Rafael M. Oliveira. Departamento de Engenharia Mecânica, PUC-Rio (2017).

2012 – Laís Corrêa, “Simulação de grandes escalas de escoamentos incompressíveis turbulentos

envolvendo superfícies livres móveis". Advisor: Valdemir Garcia Ferreira. Instituto de Ciências Matemáticas e de Computação – USP, São Carlos (2012).

COMMITTEE MEMBER for UNDERGRADUATE FINAL PROJECT

1. Pedro Resende Breitschaft, "Estudo numérico de uma bolha de Taylor em escoamento vertical". Advisor: Angela Ourivio Nieckele. Departamento de Engenharia Mecânica, PUC-Rio (2018).
2. Priscilla de Souza Pimenta, "Investigação do comportamento gravitacional de tampões em poços de petróleo a partir de suas propriedades mecânicas". Advisor: Mônica Feijó Naccache. Coadvisor: Aline Anaral Quintela Abdu. Departamento de Engenharia Mecânica, PUC-Rio (2018).
3. Gustavo Gorentein Martins. "Análise e caracterização de mirocápsulas frente a modificações de salinidade e acidez". Advisor: Márcio da Silveira Carvalho. Coadvisor: Débora Freitas do Nascimento. Departamento de Engenharia Mecânica, PUC-Rio (2018).
4. Tatiana Naccache Rochinha. "Análise de força normal em fluidos viscoplásticos". Advisor: Paulo Roberto de Souza Mendes. Coadvisor: Priscilla Ribeiro Varges. Departamento de Engenharia Mecânica, PUC-Rio (2018).
5. Geovane Abraão Benfica Junior. "Reologia de suspensões de grafeno na indústria do petróleo". Advisor: Mônica Feijó Naccache. Coadvisor: Lorena Rodrigues da Costa Moraes. Departamento de Engenharia Mecânica, PUC-Rio (2018).

CONFERENCE PROCEEDINGS

1. Rafael M. Oliveira and E. Meiburg, "10th International Conference on Multiphase Flow", 10th International Conference on Multiphase Flow. Rio de Janeiro, RJ, Brazil (May 2019).
2. Rafael M. Oliveira and F. H. Marchesini, "Evolution of pressure profiles after cement placement in annular spaces", VIII Brazilian Conference on Rheology. São Leopoldo, RS, Brazil (June 2018).
3. Rafael M. Oliveira and E. Meiburg, "Inner splitting and the Saffman-Taylor instability", 70th Annual Meeting of the APS Division of Fluid Dynamics. Denver, CO, USA (november 2017).
4. F. H. Marchesini, Rafael M. Oliveira, S. S. Ribeiro, H. Althoff, C. R. Miranda, J. M. Rocha, E. C. C. M. Silva, "Construction of oil wells: cement rheology and pressure profiles after pumping", XVII International Congress on Rheology, Kyoto, Japan (August 2016).
5. F. H. Marchesini, H. Althoff and Rafael M. Oliveira, "Irreversible time-dependent rheological behavior of cement slurries", VII Brazilian Conference on Rheology, UTFPR, Curitiba, Brazil (July 2015).
6. Rafael M. Oliveira and F. H. Marchesini, "Predicting pressure profiles of cement columns in oil wells using a thixotropic model", 67th Annual Meeting of the APS Division of Fluid Dynamics. San Francisco, CA, USA (november 2014).
7. F. H. Marchesini and Rafael M. Oliveira, "Utilizing an elasto-viscoplastic model to predict the downhole pressure profile after primary cementing", 85th Annual Meeting of the Society of Rheology. Montreal, Canada (October 2013).
8. Rafael M. Oliveira, "3D miscible displacements in Hele-Shaw cells: How to incorporate non-Newtonian contitutive relations?", VI Brazilian Conference on Rheology. PUC-Rio, Rio de Janeiro, Brazil (July 2013).

9. Rafael M. Oliveira, “Thee-dimensional vorticity configurations in miscible Hele-Shaw displacements”, Mini-Workshop on Fluid Dynamics and Partial Differential Equations. UFPE, Recife, Brazil (November 2012).
10. Rafael M. Oliveira, “Three-dimensional Navier-Stokes simulations of Hele-Shaw flows using finite-difference schemes”, Nonlinear PDE's @ IMPA. Rio de Janeiro, Brazil (August 2012).
11. Participation in the CFD Oil 2012, 5th Latin American CFD Workshop Applied to the Oild and Gas Industry, Rio de Janeiro, Brazil (July 2012).
12. Rafael M. Oliveira and E. Meiburg, “Three-dimensional instabilities of miscible fingers in a Hele-Shaw cell”, 64rd Annual Meeting of the APS Division of Fluid Dynamics. Baltimore, MD, USA (november 2011).
13. Rafael M. Oliveira and E. Meiburg, “Three-dimensional Navier-Stokes simulations of miscible viscous fingering in Hele-Shaw cells”, Liepman-Ludwig Seminar. Göttingen, Germany (September 2011).
14. Rafael M. Oliveira, “Influence of streamwise vorticity on the pattern formation of miscible Hele-Shaw interfaces”, 5th southern California symposium on flow physics, USC, CA, USA (April 2011).
15. Rafael M. Oliveira and E. Meiburg, “Unstable miscible displacements in Hele-Shaw cells: Three-dimensional Navier-Stokes simulations”, 63rd Annual Meeting of the APS Division of Fluid Dynamics. Long Beach, CA, USA (november 2010).
16. Rafael M. Oliveira and E. Meiburg, “Miscible displacements in porous media or Hele-Shaw cells: 3D Navier-Stokes simulations”, CSDMS meeting on Modeling for Environmental Change, San Antonio, TX, USA (October 2010).
17. Rafael M. Oliveira and E. Meiburg, “Miscible displacements in Hele-Shaw cells: non-linear 3D simulations”, 4th southern California symposium on flow physics, UCI, CA, USA (April 2010).
18. Participation in the 62rd Annual Meeting of the APS Division of Fluid Dynamics, Minneapolis, MN, USA (Novembro 2009).
19. Participation in the 3rd Southern California Symposium on Flow Physics, UCSD (April 2009).
20. Participation in the 61st Annual Meeting of the APS Division of Fluid Dynamics, San Antonio, TX, USA (November 2008).
21. Rafael M. Oliveira, “Ferrofluid patterns in a radial magnetic field: Linear stability, nonlinear dynamics and exact solutions”, 2nd Southern California Symposium on Flow Physics, UCLA, CA, USA (April 2008).
22. Rafael M. Oliveira and J. A. Miranda, “Exact solutions for interface patterns of confined ferrofluids”, 24th Physics Meeting of North/Northeast Brazil, João Pessoa, PB, Brazil (October 2006).
23. Rafael M. Oliveira, “Streching of a confined ferrofluid: influence of normal stresses and magnetic field”, Summer School on Soft Matter Physics, São Paulo, SP, Brazil (Feb 2006).
24. Rafael M. Oliveira and J. A. Miranda, “Streching of a confined ferrofluid: influence of normal stresses and magnetic field”, 23rd Physics Meeting of North/Northeast Brazil, Maceió, AL, Brazil (November 2005).
25. Rafael M. Oliveira and J. A. Miranda, “Control of interfacial instabilities and singularities in confined ferrofluids: role of magnetic field and viscous stresses”, 28th Condensed Matter Physics Meeting of the Brazilian Physical Society, Santos, SP, Brazil (May 2005).
26. Rafael M. Oliveira and J. A. Miranda, “Magnetically enhanced adhesion”, 21st Physics Meeting of North/Northeast Brazil, Maceió, AL, Brazil (November 2003).