PhD Position on Fluid Mechanical Modeling of Membraneless and Micro-fluidic Redox Flow Batteries (1st call)

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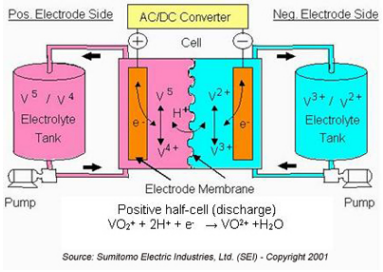
Carlos III University of Madrid (UC3M) is a relatively small, innovative, public university, providing teaching of the highest quality and focused primarily on research. The mission of Carlos III University of Madrid is to contribute to the improvement of society through teaching of the highest quality and cutting-edge research in line with stringent international guidelines. UC3M is included in the QS Top 50 Under 50, a ranking of the world's top 50 universities established within the last 50 years.

The Fluid Mechanics Research Group of the Department of Thermal and Fluids Engineering at UC3M carries out research on a wide variety of topics in fluid mechanics and combustion, encompassing theoretical, numerical and experimental studies.

Background and motivation: Renewable-energy sources, such as solar and wind, are being deployed in larger numbers than ever before, but these sources are intermittent and often unpredictable. Analysis suggests that an electric grid could become destabilized if non-dispatchable renewable energy exceeds 20% of the energy-generation capacity without energy storage. As this level of deployment is being expected in the next future worldwide, there is a pressing need for grid-connected energy storage technologies to complement and enable renewable standards [1, 2].

Among other electrochemical energy storage systems, redox flow batteries (RFBs) exhibit very high potential due to their ability to store large (i.e., grid-scale) amounts of electrical energy relatively cheaply and efficiently, as well as their high localization flexibility. A flow battery is a type of rechargeable battery where rechargeability is provided by two chemical components dissolved in liquids contained within the system and most commonly separated by a membrane. Redox flow batteries also offer greater flexibility to independently tailor power rating and energy rating for a given application than other electrochemical means for storing electrical energy. Redox flow batteries are suitable for energy storage applications with power ratings from 10's of kW to 10's of MW and storage durations of 2 to 10 hours. [3]



Project: This project aims to enhance the current understanding of the fluid dynamical aspects affecting the design and operation of innovative energy storage systems, such as1) membraneless flow batteries operating with immiscible redox electrolytes and 2) micro-fluidic redox flow batteries based on laminar flows with passive pumping strategies. The specific target of this project is to increase our understanding of the dynamics of the free surface coupled with the complex mass and charge transport processes that take place in membraneless flow batteries, and to devise new designs for improved flow, mass and charge transport in micro-fluidic flow batteries, proposing in both cases ways to improve the overall system's efficiency. This goal will be achieved through a methodology that combines theoretical analysis with mathematical modeling and numerical integration. The PhD candidate will also collaborate with the experimental team based at IMDEA Energy Institute, whose work will serve 1) to provide useful data on the redox-flow pair properties, such as densities, thermal conductivities, solute diffusivities, surface tensions, etc., both as a function of temperature and of solute concentration, and 2) to validate the mathematical models developed by at UC3M. This will enable the development of prediction tools that could be used to optimize the design and operation of the devices under study.

Industrial Partners: PVH ENERGY STORAGE [4].

Conditions: Doctoral studies extend over a 4-year period during which the PhD-student will receive a salary as an employee of the department. Doctoral students are expected to engage in full-time study and research, and to participate actively in the department's activities. The candidate should have finished his/her Masters studies by September 2017. **A solid background on Fluid Mechanics is highly desirable.**

Funding: Universidad Carlos III de Madrid & IMDEA Energy Institute, under European Research Council ERC Consolidator grant "MFreeB (Membrane-Free Redox Flow Batteries)"

Currently there is an open call (**details below**) for PhD Candidates open at the Thermal and Fluids Department, although there will be also future opportunities in case the position remains vacant after this first call.

PIPF UC3M 01-1718
http://portal.uc3m.es/portal/page/portal/inicio/universidad/empleo_universidad/personal_docente_e_investigador/pif
Department: THERMAL AND FLUIDS ENGINEERING
Reference number: 782
Number of positions: 2
Doctoral programs: MECHANICAL ENGINEERING AND INDUSTRIAL ORGANIZATION / FLUID MECHANICS INTERUNIVERSITARY PhD PROGRAM
Deadline: April 6th, 2017 (!)

Placement: Department of Thermal and Fluids Engineering at Carlos III University of Madrid

Type of employment: Full time, 4 years

Number of positions open for this Project: 1

Town/Province/Country: Leganés/Madrid/Spain

References:

[1] Weber, A. Z., Mench, M. M., Meyers, J. P., Ross, P. N., Gostick, J. T., & Liu, Q. (2011). Redox flow batteries: a review. Journal of Applied Electrochemistry, 41(10), 1137. http://link.springer.com/article/10.1007/s10800-011-0348-2

[2] Alotto, P., Guarnieri, M., & Moro, F. (2014). Redox flow batteries for the storage of renewable energy: A review. Renewable and Sustainable Energy Reviews, 29, 325-335.

[3] http://energystorage.org/energy-storage/storage-technology-comparisons/flow-batteries

[4a] http://pvhardware.com/products-overview/
[4b] https://www.youtube.com/watch?v=7yCHA_XtkAs