Post-doctoral position

Experimental study and modelling of electrochemical dehydrogenation of Liquid Organic Hydrogen Carriers (LOHCs)

LEMTA Laboratoire Energie et Mécanique Théorique et Appliquée – Université de Lorraine – CNRS Nancy – FRANCE (https://lemta.univ-lorraine.fr)

Starting date: 1st October 2024 no later than 1st January 2025
Duration: 24 months
Location: LEMTA – 54000 Nancy

Contact: Applications (CV, letter of motivation) should be sent by email to:
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Context

The storage and transport of hydrogen gas is not trivial and requires complicated infrastructures. In the case of conventional technologies for storing hydrogen by liquefaction and compression, several challenges have to be overcome, such as low storage density, boil-off losses, relatively high costs, and safety and transportation concerns. In this context, the use of a Liquid Organic Hydrogen Carrier (LOHC) is a promising way of simplifying hydrogen storage and transport [1]. Handling a liquid instead of hydrogen gas presents a level of complexity similar to that of hydrocarbons already in use worldwide, with the advantage of hydrogen as sustainable energy vector. Hydrogen storage and transport using LOHCs are based on two-step cycles, such as (i) loading/storage of hydrogen by catalytic hydrogenation of H_2-lean compounds and (ii) unloading/releasing hydrogen by electrochemical dehydrogenation of the resulting H_2-rich liquids.
The aim of the project is to study the electrocatalytic dehydrogenation of biobased polyols (ethylene glycol and glycerol) as LOHCs. This is part of a larger project (PEPR – BHyoLOHC in partnership with 3 other labs) involving the synthesis of catalysts and catalyst supports for the hydrogenation step, and the selection of electrocatalytic materials.

Project

The objective of the post-doctoral project is to develop both an experimental set-up and a theoretical tool to obtain more information on the dehydrogenation reaction and to propose optimizations. To study the dehydrogenation of a LOHC, an instrumented (segmented) cell [2] will be designed and built considering the order of magnitude of the active surface for a prospective industrial cell. This cell allows local characterization of the electrochemical system (local current density, EIS, …) to better understand the evolution of performance from cell inlet to outlet, and to detect charge and/or mass transport limitations. The design of the segmented cell will be defined by considering the properties of the fluids chosen and the range of the operating conditions (flow rate, concentrations, temperature, viscosity). A parameter study will then be conducted with the experimental set-up, varying the cell voltage, fluids concentration, flow rate, temperature ... In addition, in-house electrodes assemblies will be manufactured using commercial and/or non-commercial materials. Depending on the results, the ink composition will be optimized.
Besides the experimental work, a mass, charge and heat transfer model will be developed at the cell level to gain a better understanding of the phenomena observed experimentally. As the electrochemical dehydrogenation process combines reactions with liquid electrolytes and gas production, the development of the model will be based on the knowledge acquired by LEMTA

researchers during several studies on PEM water electrolysis. Then, the combined modeling-experimental approach will be used to extend the study to process optimization.

[1] D. Teichmann, W. Arlt, P. Wasserscheid, R. Freymann, Energy Environ. Sci. 4 (2011) 2767–2773
[2] S. Abbou, J. Dillet, G. Maranzana, S. Didierjean, O. Lottin, J. of Power Sources, http://dx.doi.org/10.1016/j.jpowsour.2016.11.079

Skills recommended: The candidate should have knowledge of electrochemistry, if possible applied to the fuel cell or water electrolysis field, and be comfortable with experimental studies. Knowledge of heat and material transfer, and modelling would be a plus.

Net salary per month: 2100 €