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IL DIPARTIMENTO DI SCIENZE MOLECOLARI E NANOSISTEMI

ORGANIZZA L'INCONTRO SCIENTIFICO :

Future Refueling Station, Martigny Demonstrator. Improve Vanadium Redox Flow Battery and Alkaline Electrolysis

Dr. Alberto Battistel

Ecole polytechnique fédérale de Lausanne (EPFL), Svizzera

November the 2nd , 2017
at 15:00
Conference Room – Scientific Campus

L' organizzatore
Prof. Salvatore Daniele

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Abstract for the presentation at Univerisita Ca' Foscari Venezia of 2nd November 2017.
Dr. Alberto Battistel

Future Refueling Station, Martigny Demonstrator

The first part of the presentation contains a description of the installations at the demonstrator of Martigny. The main goal of the demonstrator is to build, maintain, and evaluate a refueling stations for renewable-energies vehicle as electric and hydrogen cars. A redox flow battery (400 kWh and 200 kW) is used to buffer the electrical grid. The energy stored in the battery is either used directly through a fast charger (80 kW) to feed electrical vehicles or alternatively to produce hydrogen. At the demonstrator, hydrogen is produced by alkaline electrolysis (50 kW), compressed into various stages (from 200 up to 900 bar) and used to refuel fuel-cells vehicles. The main research goals are the whole development of the control system to automatize the installation and construct and test the compression system and the hydrogen station. Particular aspect of the demonstrator is in improving the whole efficiency of the process working on efficient and smart power management.

Improve Vanadium Redox Flow Battery and Alkaline Electrolysis

In the second part of the presentation I will focus on a particular implementation of redox flow batteries and alkaline electrolysis. In a redox flow battery the charge is not stored in the electrodes, but in two flowing electrolytes, one more positive in oxidation state and one more negative. One of the most common implementation is the vanadium redox flow battery where the positive electrolyte contains V^{IV} and V^{V} species and the negative one V^{II} and V^{III}. A membrane in the electrochemical cell avoids the mixing of the electrolytes and guarantees ionic conductivity. These batteries suffer of lower power density, lower energy density, and lower round trip efficiency compared to lithium ion batteries. However, they are neither flammable nor explosive, they are based on an aqueous electrolytes, and

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offer a longer lifetime (up to 20 years). I will show that it is possible to improve the efficiency of a redox flow battery employing a thermodynamic cycle in which the battery is charged and discharged at different temperatures. In this way some heat is converted directly into electrical work and stored in the battery, *de facto* increasing the total energy storage and efficiency of the battery.

Alkaline electrolysis, although it is an old technology (from more than century ago) technology, is one of two main candidates for the production of hydrogen from water. Basically it comprises an electrochemical cell in with two nickel-based electrodes immersed in a strong base (30 % KOH). By passage of electricity hydrogen is produced at the cathode and oxygen at the anode. The main goal in this project is to merge academic know-how in terms of new catalysts for hydrogen and oxygen evolution with a feasible economic scale up. In fact, lab-scale performances of many new materials are only the first step toward real implementation and application and many economic factors influence the development of a technology. Usually only the costs of the raw materials are taken into account, but these represent only a fraction of the total investment for an electrolyzer. This project moves from pure electrochemistry (testing of electrocatalysts) toward the realization of a small pilot alkaline electrolyzer capable of competing with state of the art commercial units.