Master project: Activation of bioelectrochemical reactors

Location: Group of Energy Materials, EPFL-Valais, Rue de l'Industrie 17, 1950 Sion

Target: Master Thesis, Research & Development

Context: Bioelectrochemical systems (BES) are electrochemical cells where the electrodes are activated by biocatalysts. Microbial Fuel Cells (MFC) and Microbial Electrolysis Cells (MEC) are the main types of BES. The activation step, also known as inoculation, is a crucial phase of the process. It consists in inoculating the reactor with microorganisms that will eventually deposit at the electrode surface to form a biofilm. Cathodic and anodic biofilms differ from each other by the bacteria strains that compose them. Methanogenic *Archaea* are needed at the cathode, for example, to reduce CO_2 into methane. At the anode, *Geobacter* strains are well-known electrogenic bacteria and can extract electrons from (=oxidize) organic pollutants present in wastewater.

The nature and characteristics of the biofilms are determining factors in the final performances of the MEC and it is therefore of utmost importance to define a staunch and robust inoculation protocol.

Thesis objectives: The objective of this work is to elaborate and refine the inoculation protocol to achieve highly efficient activation of the electrodes. Efficiency criteria will be the electrode coverage, the biofilm growth rate, composition, and electrochemical activity, as well as the reproducibility of the process. The candidate will work in collaboration with biologists with whom he/she will cultivate bacteria in anoxic environments. These cultures will be used to formulate the inocula that will be tested in bio-electrochemical cells. The anodic biofilm is the priority as it is currently the limiting factor in electro-methanogenesis. The project currently focuses on *Geobacter* strains but could integrate other components as further knowledge may unveil other opportunities. The candidate will unfold several techniques to study the inoculum and the formed biofilm, using (electro-)analytical chemistry as well as physical characterization methods.

Your tasks:

- Plan and schedule experiments.
- Cultivate bacteria in anaerobic environment.
- Formulate and characterize inocula for the activation of the anode material.
- Refine electrochemical parameters to optimize the growth of the biofilm.
- Define and quantify performance indicators that translate the activity, durability, and reproducibility of the biofilm.
- Establish a well-documented inoculation protocol.

Your background:

- The candidate is familiar with environmental science and biology
- Knowledge of electrochemical principles and methods are a plus
- Knowledge of analytical chemistry techniques

For further information, please contact Jan Van herle and Cédric Frantz

Contact: Jan Van herle
Jan.vanherle@epfl.ch
Group of Energy Materials, SCI-STI-JVH
Rue de l'industrie 17
1950 Sion

Cédric Frantz
Cedric.frantz@epfl.ch