LO – H2 Project n°1

Title: Membrane less electrolyser stack characterization

Project: Master project / Semester project

Introduction:

Renewable energies have been developed significantly in the last decade in an effort to reduce the need for hydrocarbon fuels. Consequently, the cost of energy from renewable sources is becoming competitive compared to fossil fuels. However, the renewable energy sources are intermittent and a storage mechanism is required to compensate for their intermittency. Energy storage in the form of hydrogen has been regarded as one of the primary storage strategies due to the high energy density of hydrogen. Water electrolysis is the major technology for clean hydrogen production. However, hydrogen produced through water electrolysis is too expensive due to the high capital and operating costs of electrolyzers. Technological innovations are required to improve the performance of water electrolyzers and reduce the cost of hydrogen production.

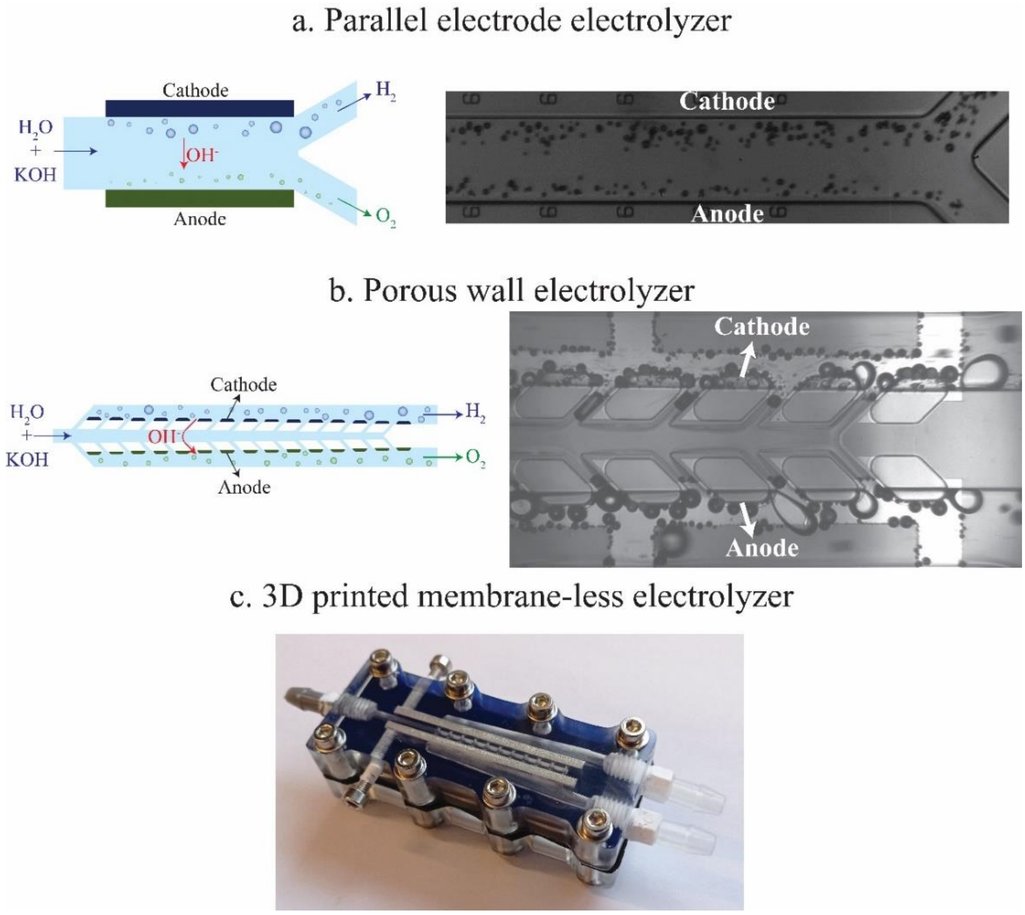

Figure 1. Membrane-less electrolyzers developed at LO: a) Parallel electrodes electrolyzer relies on the fluidic flow to separate the oxygen and hydrogen bubbles, b) Porous wall electrolyzer utilizes fluidic flow and geometrical topographies to achieve highly pure hydrogen production, c) a picture of the 3D printed membrane-less electrolyzer.

A water electrolyzer requires catalysts to split water molecules into hydrogen and oxygen and an ion-conducting medium (electrolyte) to conduct ions between the catalysts. The products of water electrolysis are in gas form. Therefore, we need a mechanism to separate hydrogen and oxygen bubbles. Commercial electrolyzers use a membrane or a separator to keep hydrogen and oxygen bubbles separated. This gas separation mechanism can limit the operating conditions of the water electrolyzer and increase the hydrogen production costs. Optics Laboratory (LO) is developing a novel flow-based electrolyzer called "**membrane-less electrolyzer**" that resolves many technological issues of commercial electrolyzers.

A membrane-less electrolyzer utilizes flow to separate the bubbles and eliminates the need for the membrane. Figure 1 shows two membrane-less electrolyzers. Figure 1.a shows the parallel electrodes membrane-less electrolyzer where the electrolyte flow applies inertial forces on bubbles to keep the two streams of oxygen and hydrogen bubbles separated. Figure 1.b depicts the porous wall membrane-less electrolyzer that separates the oxygen and hydrogen bubbles using electrolyte flow and geometrical topographies. Figure 1.c shows a picture of 3D printed membrane-less electrolyzer.

Project description:

The electrolyser system, Figure 2, is composed of a pump flowing an electrolyte through a membrane less electrolysis stack. The water is then split to hydrogen and oxygen gases, these gases will flow with the liquid and be separated in two different gas separation units. Once the gases are removed, the electrolyte is returned to the pump. The collected hydrogen is dried and analyzed by a gas chromatograph.

The operating parameter of the electrolyser such as flow, temperature, pressure or electrolyte composition are affecting the efficiency of the system and also the purity of the delivered gases. In this project you are going to measure the performance of a stack of several membrane-less cells that will be integrated into the electrolysis system built in the laboratory. In addition to that, the electrical behaviour of a stack of membrane less electrolyser cell has to be quantified and controlled to operate over long period of time with a high stability.

This project provides an exceptional opportunity to learn or improve your knowledge and expertise in electrochemistry, prototyping, water electrolysis, and fluid mechanics.

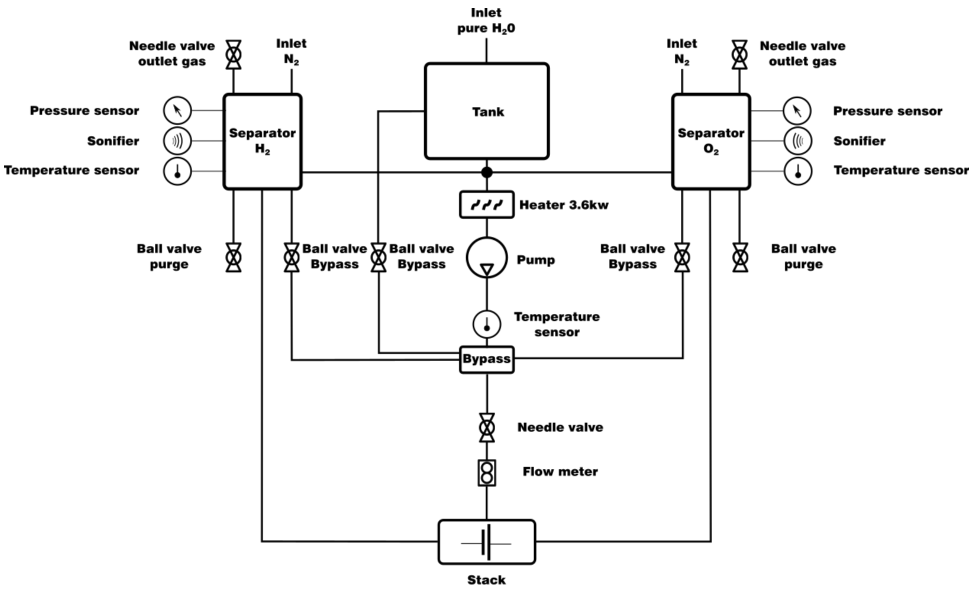

Figure 2: Membrane less electrolysis system developed within the laboratory of optics