Prospective energy savings in electro-based technologies – PEM fuel cell

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Electrokinetic (EK) and electrodialytic (ED) technologies are clean-up processes applied to contaminated liquid and solid matrices. These processes are based on the application of an electric current density of the order of milliamps per square centimeter to the cross-sectional area of a matrix between the electrodes, producing electric potential drops of the order of volts per centimeter. Due to the electric field present, the contaminants are removed from the matrix and driven towards one of the electrodes, from where they may be collected. It is widely accepted that EK/ED treatments are efficient for the removal of both organic and inorganic contaminants.

"*Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas*" (Sustainable Development Goals, 2015). In order to make EK/ED technologies more competitive, either on its removal efficiency or on its economic feasibility, a reliable energy scheme is needed.

During the ED\EK processes, the following electrode reactions occur at the electrodes:

Cathode: $\frac{1}{2}\ O_2 + 2H^+ + 2e^- \longrightarrow H_2O$

Anode: $H_2 \longrightarrow 2H^+ + 2e^-$

Certain competitive electrode reactions may occur, depending on the contaminants present in the treated matrix, as e.g. chloride oxidation at the anode. However, water oxidation and reduction are dominant in most cases, involving the production and release of hydrogen gas at the anode. Herein, we evaluate the possibility to reuse the emitted H_2 gas as energy source via combustion to produce water, as:

The chemical reaction: $2H_2 + O_2 \longrightarrow 2H_2O$

There is, therefore, a potential to turn EK/ED treatment energy more self-sufficient. With a proton exchange membrane (PEM) fuel cell, that uses hydrogen and oxygen gases to the conversion of chemical energy into power needs. In order to develop a working system, several parameters were analyzed such as voltage, current, O_2 and H_2 levels, energy balance and yield. Also, in EK/ED processes, the cell design and the type of matrices (liquid or solid) may influence the PEM system. To define the best system design, improve the performance and efficiency of PEM fuel cells, applied to electro-based technologies, experimental tests were carried out at the laboratory.