Some Considerations Regarding Obtaining Hydrogen by Electrolysis

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GOAL OF THE STUDY

Using hydrogen as a fuel solves big problems. The first is related to energy security. Hydrogen is the most widespread element in the Universe and can be found in a large number of compounds. Obtaining hydrogen reduces dependence on oil and increases energy security. The second problem that the use of hydrogen solves is environmental protection. Hydrogen is a clean fuel that produces no greenhouse gas emissions or air pollutants when used. The goal of this work is to analyze the efficiency of the electrolysis process, under different conditions.

METHODOLOGY OF THE INVESTIGATION

Electrolysis occurs when the continuous electric current passing through the solution or melt of an electrolyte causes the process of orientation and separation of the ions of the electrolyte with the help of the direct electric current. To initiate the process, the voltage at the electrode terminals must also cover the voltage drop in the electrolyte, contacts and electrodes, Fig. 1.

The components of the electrolysis circuit are: the hydrogen sensor, the power supply and the module that reads the data and is interfaced with the computer, Fig. 1. Were used two sensors to detect hydrogen concentration, MQ-8 (special design to measure hydrogen concentration) and MQ-2 (general sensor for inflammable gases). The power supply is working in constant current mode, to avoid threshold voltage of electrodes. After reading data from sensors, is not necessary another processing of signals because it is very stable. If desired, it is possible to use average formula or moving average.
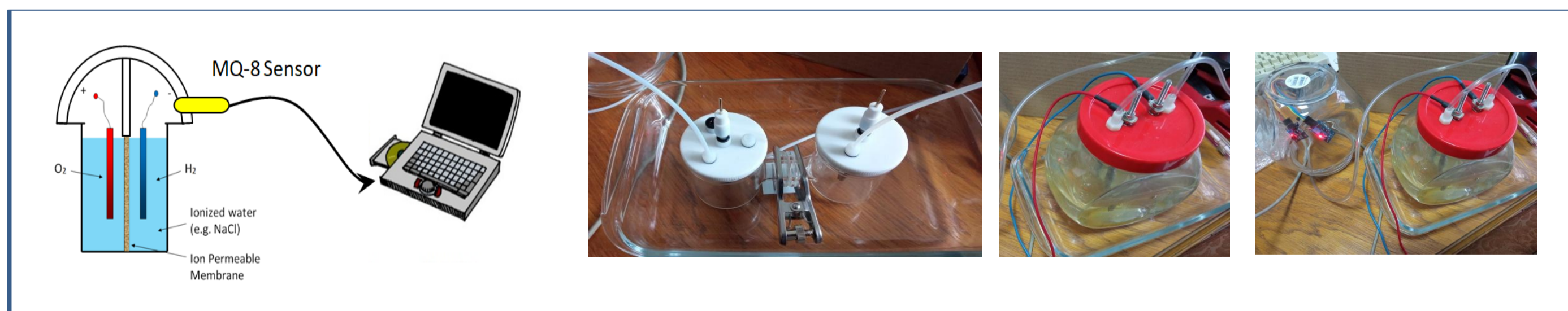

Fig. 1. Electrolysis process (left) and aspects of experimental setup (center and right).

MAIN RESULTS FROM THE STUDY

Solutions of Sodium Chloride - table salt (NaCl), Sulfuric Acid (H_2SO_4) and Sodium Bicarbonate, also known as baking soda ($NaHCO_3$) were used to carry out the experiments. Was made 0.5 M and 1 M solution and use 0.5 A, 1 A, 1.5 A for constant current power supply.

First remark is about linear dependency of voltage across electrodes vs. current through electrolyte cell (acid or salt water), Fig. 2. The electrolyte cell has a constant resistance in the conditions of the experiment (solution concentration and the range of considered currents). It is remarkable that the voltage across electrodes is very different in these cases, and reveal how important is to use constant current power supply, to avoid waste of electric energy. For a complete experimental data, results reveals, at the same current, the amount of hydrogen is the same finally, even the concentration is different, but this concentration affect only the moment when the maximum concentration of hydrogen is reached, Fig. 2.
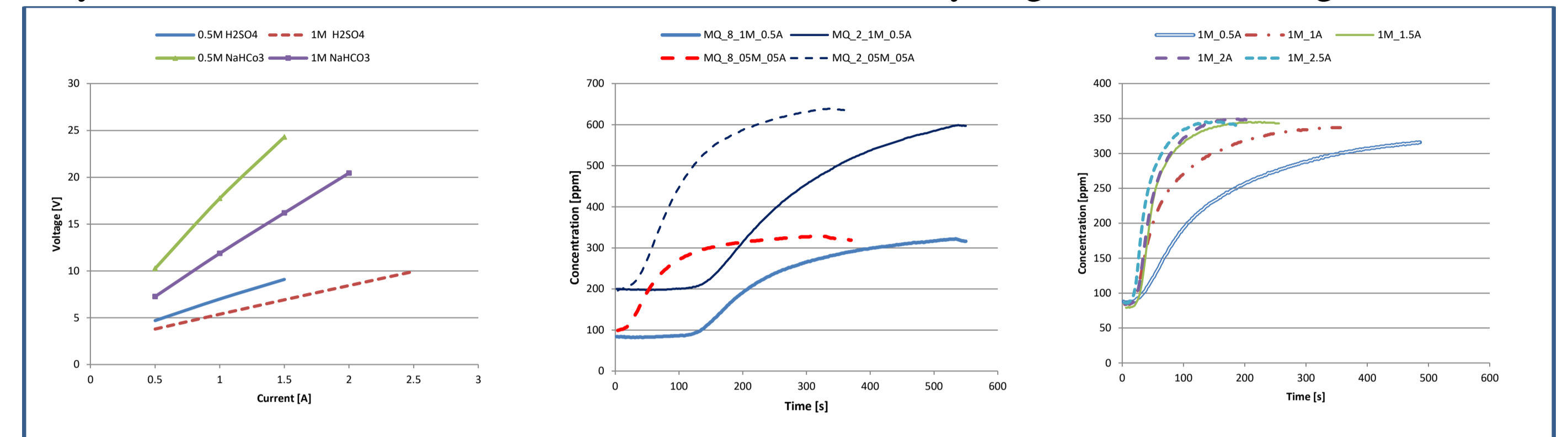

Fig. 2. V vs. I of electrolysis cell (left), influence of concentration of NaCl electrolyte at the same current (center) and influence of current to electrochemical process (H_2SO_4).

CONCLUSIONS

The experiment reveals results from comparing the different configuration of electrolysis cell functioning. The cell was tested with different electrodes, different molar concentration of electrolyte and different current through electrolytic cell. During the experiments, the use of graphite electrodes led to much weaker results than in the case of the use of stainless steel electrodes, and therefore the results obtained are only with stainless steel electrodes.

The best and most effective results were those obtained with electrolyte solutions based on salts. And among those studied (NaCl and $NaHCO_3$), the one with sodium bicarbonate is the most convenient to use. After using NaCl, the solution changes its color to brown after a while. For bicarbonate, the solution remains quite clear, like the initial solution. Using salt water to produce hydrogen is also a comfortable solution because more than 97 % is salt water on Earth. The chemical formula (salt, alkaline or acid) of the electrolyte influences the electrical resistance of the electrolysis cell, but this is constant, the voltage vs. current characteristic being linear.

For optimal results, after each experiment, the electrolysis installation was ventilated, removing any compounds left from the previous electrolysis process. Because was choose to use constant current power supply, this give a less warm up of electrolytes and influence of temperature to electrolysis process is reduced significant. A technical solution used in this experiment, to avoid using membrane of diaphragm (which increase the cost), was to surround each electrodes by collector cone for directing the gas to collecting tube of each resulting gas. Confidence in the experimental results is given by the sensors used (MQ-8 and MQ-2). They are specially designed for the measurement of combustible gases, more one of the two is specially designated for the measurement of hydrogen concentration. Because of promising technology, it is important to know how this simple and wide spread element, hydrogen, can help us to replace conventional energy resources. Applications are many, e.g. automotive industry. Also, some gas distribution companies use a mixture of hydrogen with fossil gas, used in proportion of 20%, without risks in use.