ADVANCED ELECTROLYTIC HYDROGEN PRODUCTION

Dragica Lj. Stojić*, Milica P. Kaninski, Aleksandar Maksić and Šćepan S. Miljanić(1)

Vinča Institute of Nuclear Sciences, Laboratory of Physical Chemistry
11001-Belgrade, P.O. Box 522, Serbia and Montenegro

(1) University of Belgrade, Faculty of Physical Chemistry
11001-Belgrade, P.O. Box 137, Serbia and Montenegro

INTRODUCTION

Hydrogen energy is becoming increasingly important as recent technology progress makes hydrogen a realistic energy option with little or no pollution. In the sense of hydrogen, as the energent of new millenium, development of new methods and improvement of conventional technology for its production is important.

In spite of the fact that, among overall world technologies for hydrogen production today, only 4% belong to the electrolysis (energy consumption: 4.5 to 5 kWh/ m^3_n H_2), this is one of the promissing methods in the future. Improvement of the electrolytic process includes decreasing of energy required for hydrogen production, with the idea to make electrolysis an acceptable method for that production, it means to adjust all aspects of "hydrogen philosophy" with sustainable development concept.

The aim of this work was the attempt to reduce energy consumption in the electrolytic hydrogen production by changing cell geometry and using ionic activators.

RESULTS AND DISCUSSION

The energy requirement for the electrolytic process run was calculated using the relation:

$$Q = I \times U \times t$$

where I(A) and U(V) are overall current and voltage through the cell, and t(s) is the time of evolution of a certain volume of hydrogen.

The experiments, with the idea to improve the electrolytic process, were routed in two directions: optimization of cell geometry, as well as the activation of electrodes to catalyze the process by using ionic activators. Two kinds of cells were used: (i) a simple glass-made cell of defined geometry and (ii) a Plexiglas-made cell with much smaller gap between electrodes [1].

* Fax: + 381 11 444 72 07 E-mail: estojicd@vin.bg.ac.yu

The results, obtained in standard electrolyte (30 wt% KOH), clearly indicate the role of temperature and specially cell geometry. The energy consumption per one mol of hydrogen was significantly reduced using cell (ii).

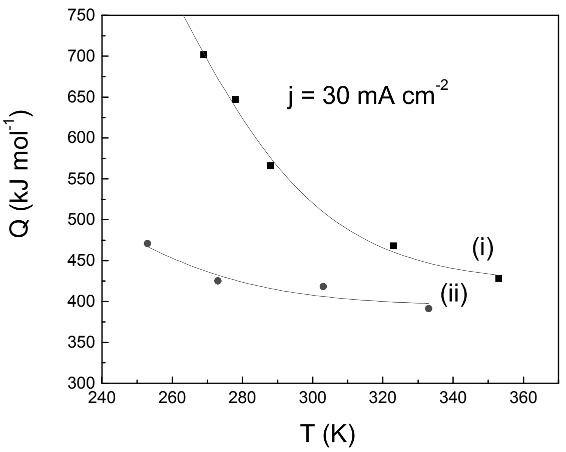

Figure 1. Energy consumption per one mole of hydrogen evolved as a function of temperature for two electrolytic cells.

The all used ionic activators reduced also energy consumption in the electrolytic hydrogen production in comparison with the standard electrolyte, Table 1. However, the best of all is combination (lowest row).

Table 1. Energy consumption per one mol of hydrogen produced at the current density of j=43.8 mA cm^{-2} and temperature of 323 K

Electrolyte	Q (kJ mol^{-1})
30% KOH in distilled water (standard electrolyte)	510.3
1×10^{-3} M $[Co(tn)_3]Cl_3$ in the standard electrolyte	497.1
1×10^{-3} M $[Co(en)_3]Cl_3$ in the standard electrolyte	487.7
1×10^{-3} M $[Co(tn)_3]Cl_3$+ 1×10^{-2} M Na_2MoO_4 in the standard electrolyte	454.6
1×10^{-3} M $[Co(en)_3]Cl_3$+ 1×10^{-2} M Na_2MoO_4 in the standard electrolyte	450.9

Possible mechanism through which ionic activators increases electrolytic efficiency could be electro-catalytic effect of two d-metals (Co and Mo), deposited on the electrode surface [2], providing at the same time very large surface area of active centers, shown on the SEM microphotography (T = 253 K; j = 30 mA/cm^2), Figure 2.

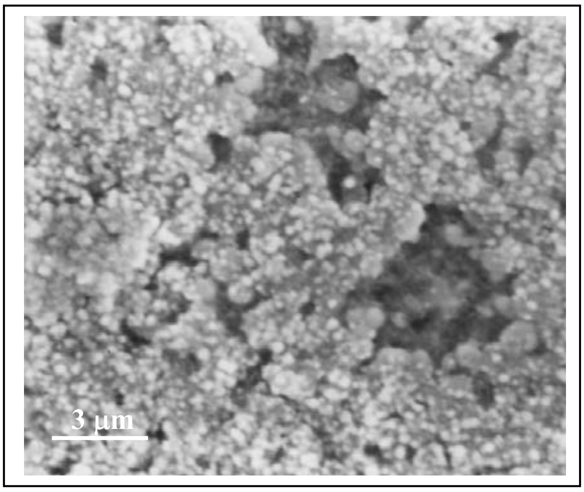

Figure 2. SEM microphotography of the Ni cathode, which was used for electrolysis with ionic activator (Co-Mo combination).

The ionic activators stability, investigated with the idea to estimate the real energy consumption in a long-term run, and possible use of this method on a large scale, was overlooked for about two months. The graph in Figure 3. shows the influence of ionic activators on the overall voltage through the cell, that is on energy consumption.

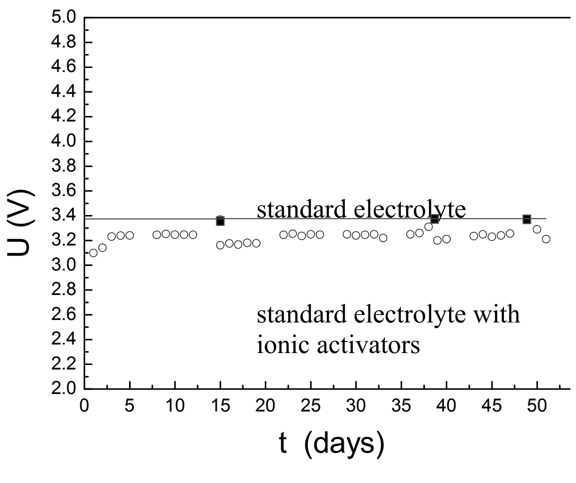

Figure 2. Long term run electrolysis: Illustration of the ionic activator effects.

As it can be seen, the electrolytic system is stable in time. Square dots indicate that system need reactivation on every ten to fifteen days with starting concentration of ionic activators. Since added quantities are very small and cheap, it does not have any significant influence on the economy of the process.

CONCLUSIONS

Advantages in the electrolytic production of hydrogen were achieved by using ionic activators, changing cell geometry and temperature. It was pointed out that the energy saving can be beyond 10% in some cases, compared to those of non-activated ("standard") electrolytes.

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2. Č. M. Lačnjevac, M. M. Jakšić, J. Res. Inst. Catalysis, Hokaido Univ. 31(1) (1983) 7.

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