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Electrically Induced Nuclear Processes in Electrolyzer

Balasanyan R. N.*, Kostanyan R. B.

Institute for Physical Research, NAS of Armenia, Ashtarak, Armenia

Abstract

The paper provides a model describing the causes of an excess heat by passing of electric current through the water with use of aluminum electrodes. Based on the direct measurements of γ-radiation and repeatedly verified experimental data the possible model of nuclear transformation of Al(n,γ)Si and the possibilities to control this process with use of electric field is proposed. The possible mechanism of neutrons origination in electrolytic cell is also discussed.

Keywords

Joule Energy, Nuclear Transformation, Electrolyzer, γ-radiation, Thermal Neutron

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1. Introduction

In many published papers authors reported about nuclear transmutation reactions with anomalous isotopic compositions in different electrolysis systems. As an evidence of nuclear reactions the heat excess and craters on electrodes are quoted [1-7]. The transmutations of nuclei, described in these papers, authors mainly seek to explain through the phenomenon of nuclear cold fusion, for example, D-D and other nuclear reactions.

In [8] presented the repeatedly verified experimental data, which show a considerable excess of general thermal heat as compared with the Joule energy released by the passage of electric current through the electrolyte, which is the ordinary water. It is also shown in [8] that when using aluminum electrodes silicon is formed at the cathode which can't be explained by the chemical transformations.

In this paper we provide a model describing the causes of an excess heat by passing of electric current through the water with use of aluminum electrodes. Based on the direct measurements of γ-radiation and repeatedly verified experimental data the possible model of nuclear transformation of Al(n,γ)Si and the possibilities to control this process with use of electric field is proposed. The possible mechanism of neutrons origination in electrolytic cell is discussed.

2. Materials and Methods

Investigations were carried out on an electrolytic cell using aluminum electrodes.

As an electrolyte, the ordinary drinking water was used. In these experiments, the water volume was 1.15 liters. The electrodes cross section was approximately equal to 78cm^2, and the spacing between them was equal to 13 cm. As an electrolyzer container vessels made of porcelain, glass and food plastics were used. In all cases, by the passage of electric current through the water excessive heat was generated. Direct measurement of the temperature near the electrodes showed that the temperature near cathode is higher of anode temperature. Therefore, the experimental setup is assembled so that the cathode was placed at the bottom of the tank and the anode was on the top at opposite side. Such a setup scheme allows obtaining of relatively uniform temperature of the electrolyte in the electrolyzer due to

* Corresponding author
E-mail address: rafikbal@mail.ru (Balasanyan R. N.)

thermal convection.

The electric voltage, the electric current and the duration of current supply on electrodes have been measured. Based on these measurements, the energy release in accordance with the law of Joule (Q_{el}) and the total heat energy (Q_T) were calculated. It is evident that in the nominally pure water the H^+ and OH^- ions, as electric current carriers, reach and react with the electrodes under the influence of applied constant electric field and, besides the release of the H_2 and O_2 gases, the other compounds may be produced by way of exothermic and endothermic reactions. This occurs because the H^+ and OH^- ions are more chemically active compared with hydrogen and water molecules.

For greater reliability of our conclusions it is assumed that all formed chemical compounds have maximum possible amount of formation energy.

The variety of potential chemical compounds in the electrolytic cell with involvement of hydrogen, oxygen, and aluminum electrodes is shown in Table 1 [9, 10].

Table 1. The potential chemical compounds in the electrolytic cell.

Compound	Standard formation heat -ΔE, kJ/mole	Molar weight	Standard formation heat -ΔE, kJ/g
H_2O	286.08	18.01488	15.88
HO	-38.98	17.00694	-2.29
H_2O_2	187.90	34.01388	5.52
H_2O_3	46.10	50.01288	0.92
HO_2	-20.55	33.00594	-0.62
H_2O_4	27.40	66.01188	0.42
AlH_3	11.40	30.00536	0.38
$Al(OH)_3$	1294,0	78.00236	16.59
AlO(OH)	985,0	59.98748	16.42
Al_2O_3	1676.81	101.96008	16.45
O_2	495.6	31.998	15.49
H_2	435,0	2.01588	215.79

Table 1 shows that the maximal standard formation heat, normalized to one gram of material, which can be released in the region of anode, is for the compound of aluminum hydroxide $Al(OH)_3$ and one is equal to 16,59 kJ/g, while close to the cathode, the greater energy is released during formation of hydrogen molecules, since the standard formation heat for it is equal to 215,79 kJ/g.

In order to calculate the weights of hydrogen and hydroxyl group, values of electrochemical equivalent k = 0.01045 mg/C for hydrogen and k = 0.177 mg/C for OH^- group are used [11]. Considering the measured data of electric current value and duration of current passage through the electrolyzer, masses of precipitated amounts of hydrogen molecules and hydroxyl groups are calculated. Based on these calculations and using the data in Table 1 formation energies of amount of hydrogen molecules and aluminum hydroxide were calculated. Despite the fact that possible chemical compounds with maximum formation energy are consciously chosen, measured total thermal energy was noticeably exceeding the sum of consumed electrical and chemical compounds formation energies. During electrolysis oxygen release at cathode region as well as at anode region is also observed. If in the above calculations with aluminum hydroxide formation also take into account partially the formation of oxygen molecules then the mentioned difference between released by the electrolysis thermal energy and the sum of formation energy of chemical compounds and consumed electric energy becomes even greater.

Hereby, the difference between the general thermal energy ($\mathbf{Q}_T$) and the sum of calculated quantity of heat at the expense of chemical transformations ($\mathbf{Q}_{chem}$) and the quantity of heat released at the expense of electric current passing through the electrolyte ($\mathbf{Q}_{el}$) still remains considerable:

$$\Delta\mathbf{Q} = \mathbf{Q}_T - (\mathbf{Q}_{chem} + \mathbf{Q}_{el}) > 0. \quad (1)$$

In addition to the excessive heat generation measurements radiation investigations were also carried out in the electrolyzer. By passing an electric current through the electrolyzer the level of γ-radiation near the cathode was controlled by means of scintillation counter of γ-quanta.

3. Results and Discussions

The results of the dependence of an excess heat $\Delta\mathbf{Q}$ on the density of electric current in the electrolyzer with aluminum electrodes is shown in Fig. 1.

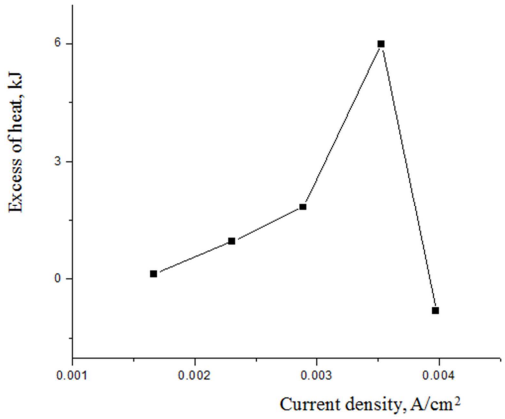

Fig. 1. The excess heat dependence on the current density.

The graph shows that the increase of electrolyzer current results in the corresponding increase of excess heat. However, this increase falls sharply at a certain value of the current density. The importance to identify the cause of such a complicated dependence represented in Fig. 1 is obvious. For this purpose, a study was conducted of the current characteristic of electrolyte cell. The results of these studies are represented in Fig. 2. It follows from Fig. 2 that the electrolyte-water shows no anomalous properties within these

limits of exposure to the electric field. Hence, the reason for such a complicated thermal behavior of electrolyzer represented in Fig. 1 may be the aluminum electrodes. This conclusion is confirmed by the study of the near-electrode area temperature of electrolyte cell by passing the electric current through it. The temperature measurements near cathode and anode show that the cathode is heated more than the anode.

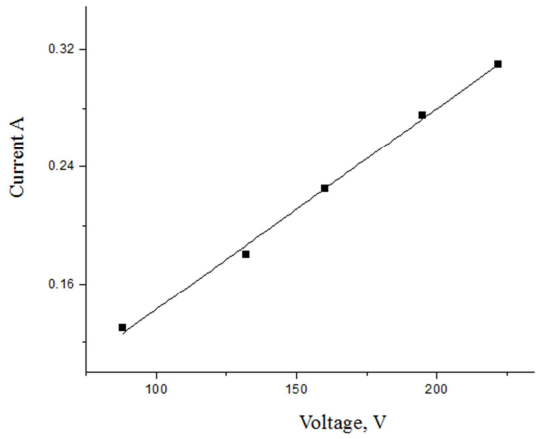

Fig. 2. The voltage-current characteristic of electrolyte cell.

Thus, we conclude that the reason for such a complex thermal behavior of electrolyte cell is in its cathode. As compared with the anode, which retains during the experiment its usual aluminum color, the dark gray color appeared on the cathode surface. The big difference of surface electrical resistance has been also obtained on the working surfaces of electrodes. During of experiments the surface resistance of cathode is increased up to $10^7 - 10^8$ times on average, which evidently points out on the origination of new compounds. As it was shown in [8] using the measurements of the scanning electron microscope (SEM) VEGA TS 5130MM with the micro analytical system INCA Energy 300, the essential change of the cathode surface content has been revealed after the influence of electrolysis. The most important is the great change of silicon content on the surface of cathode (from 0,28 up to 8,45 weight%). Undoubtedly, this fact explains the dark-gray shade and the sharp increase of electrical resistance of the surface. It is obvious that under our experimental conditions the occurrence of silicon cannot be explained by chemical reactions. Therefore, the origination of silicon is due to the nuclear processes taking place inside the cathode, where the aluminum atoms transform into the atoms of silicon. To confirm the presence of nuclear processes in the electrolytic cell under investigation, the radiation measurements have been also performed within the region of the experimental setup with the use of an installation sensitive to the γ-radiation. The pulse counting from the scintillation γ-detector depend on the magnitude of electric current through the electrolytic cell has been done. The results of these measurements are represented in Fig. 3, and under conditions of this experiment, these data show the presence of weak γ-radiation without any controversy and, consequently, the presence of nuclear processes which take place in the region of electrolytic cell cathode.

The qualitative correlation between the amounts of γ-radiation (Fig. 3) and an excess heat (Fig. 1) is very valuable, i.e., the presence of some maximum, which depends on the magnitude of electric current through the electrolytic cell.

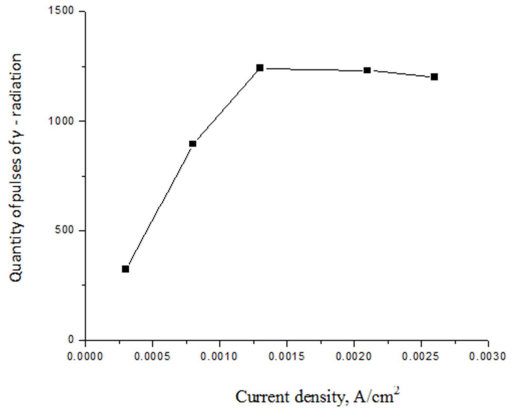

Fig. 3. The dependence of number of γ - radiation pulses during 100 sec (without the background) on the magnitude of current.

Based on these experimental facts one may suppose the possible nuclear transformation according to the Al(n,γ)Si scheme. The stable isotopes of aluminum and silicon are the elements with the nuclei $_{13}Al^{27}$ and $_{14}Si^{28}$, respectively. For radioactive capture of neutron by aluminum nucleus the heavier isotope of aluminum $_{13}Al^{28*}$ is originated, which is unstable with respect to the beta decay. Moreover, for the beta decay of this isotope the next element by an atomic number – the silicon (Si) is produced. The period of the life-span of isotope $_{13}Al^{28*}$ is 2, 24 minutes [10, 12]. This argument is clearly represented as follows:

$$_{13}Al^{27} + n \rightarrow {}_{13}Al^{28*} \rightarrow {}_{14}Si^{28} + \beta^- + 2{,}87\text{MeV}, \quad (2)$$

Where the possible source of thermal energy is shown. However, these judgments may occur only if there is a source of neutrons, which realize the above nuclear transformation.

It is known that when the electrodes immersed in the electrolyte, the polarization occurs between the electrolyte and electrode and, as a result, the double electrical layer originates, where the mobility of boundary charges is reduced due to the polarization field. In the case of electron-conductive metal electrode, the electrolyte is charged positively but the electrode is negative. The electric field arises near each electrode and the field strength is directed from the electrolyte towards electrode. The presence of two electrodes in electrolyte results in the fact that when we apply

the external electric field, one of the originated near-electrode field will be directed oppositely to the applied field. Therefore, to pass electric current through the electrolyzer, it is initially necessary to overcome the reverse field of double electrical layer, i.e., the electrochemical overvoltage is originating [13]. Due to the applied electric field, the hydrogen ion, that is the proton, jumps into the cathode-metal medium, where electrons undergo the relatively slow chaotic thermal motions near to the surface edge of cathode. By analogy with the K-capture, it is evident that the interaction of protons with slow electrons will take place with the capture of electron and proton becomes a thermal neutron according to the known scheme:

$$p^+ + e^- \rightarrow n + \upsilon. \quad (3)$$

It is known that the neutron originated according to this scheme has a mass defect with the energetic value 1.46 MeV, therefore, to compensate the mass insufficiency Δm=1.46 MeV/c^2 the neutron bonds energetically with the closest nucleus, transforming it to the unstable isotope of this atom.

The proposed mechanism describes qualitatively the causes of the excess heat in electrolyzers with the aluminum electrodes by passing the electric current through the water-electrolyte. In accordance with Fig. 1, the rise of electric current results in an increase of number of reaction acts (3) and (2), which is accompanied by the increase of heat release. However, the sharp decrease of heater lease (Fig. 1) and the number of γ-quanta for higher magnitudes of currents (Fig. 3) may indicate the violation of conditions of reaction implementation (3). Possibly, this fact is related to the increase of protons kinetic energy, owing to which the interaction with the electron results in the well-known chemical origination of the hydrogen atom.

$$H^+ + e^- \rightarrow H \quad (4)$$

Consequently, since the energetic of chemical synthesis of matter significantly lower to the nuclear energy, the abrupt decrease of the level of the excess heat is observed. The experimental data represented in Fig. 1 and Fig. 3 demonstrates the real feasibility for controlling the nuclear processes in electrolyzer with the use of electric field applied to electrodes.

4. Conclusion

Experimentally a condition is realized that allows receiving excessive heat in the electrolyzer with aluminum electrodes by passing an electric current through ordinary water. The reason of excessive heat origination and mechanism of its formation is revealed. Based on the direct measurements of γ-radiation the possible model of nuclear transformation of Al(n,γ)Si and the possibilities to control this process with use of electric field is proposed. The mechanism of silicon formation on the surface of the aluminum cathode is shown.

The possible mechanism of neutrons origination in electrolytic cell is presented.

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