LOW CURRENT PROCESS OF WATER ELECTROLYSIS

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Low voltage process of water electrolysis is known from Faraday's times. It is widely used in modern industry. A voltage of 1.6 to 2.3 volts is the operational voltage between the anode and the cathode of the electrolyser; and the current used is tens to hundreds of amps. In accordance with Faraday's law, energy consumption for production of one cubic meter of hydrogen is nearly 4 kWh with this type of electrolysis.

The analysis of the water molecule structure (**Fig.1**) worked out by us, shows the possibility of water electrolysis at minimal current and even without it. The protons of the hydrogen atoms in water molecules can be combined with each other and can form clusters. As a result, an orthohydrogen molecule is formed (**Fig.2**). A question arises: "Is it possible to separate this molecule from such a cluster?". The search for the answer to this question has lasted nearly three years. The results are given in Tables 1, 2 and 3.

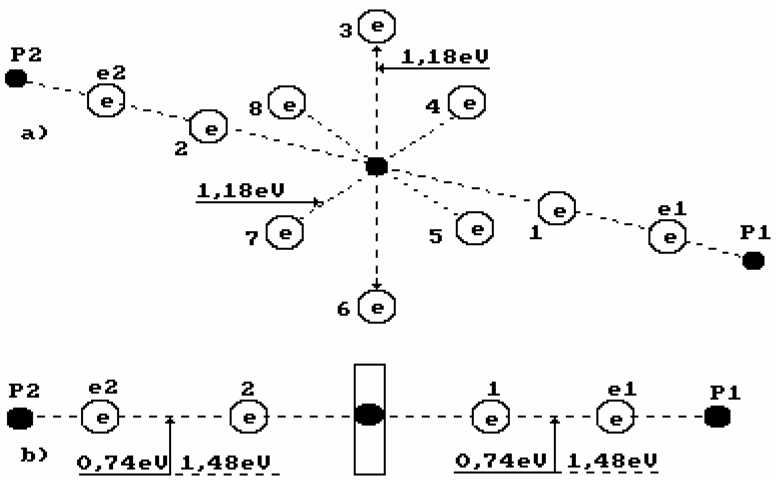

Fig.1. Water molecule diagram:

Here, **1,2,3,4,5,6,7** and **8** are the numbers of the electrons of the oxygen atom, while **P1** and **P2** are the hydrogen atom nuclei (the protons), and **e1** and **e2** are the electron numbers of the hydrogen atoms.

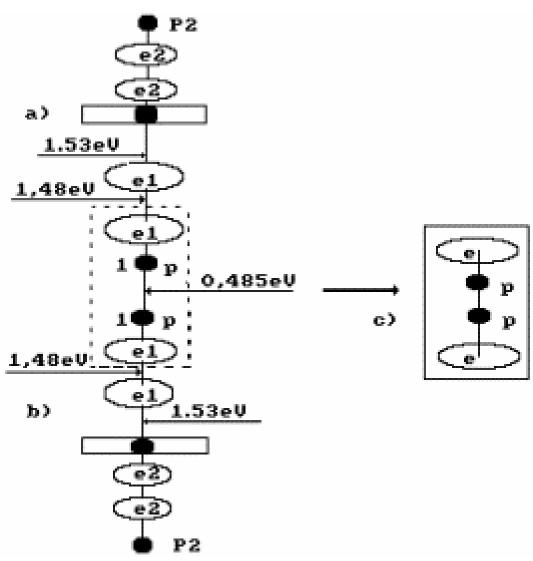

Fig.2. Formation diagram of orthohydrogen **a)** and **b)** water molecule diagrams; **c)** orthohydrogen

It is known that a gram-atom is equal to the atomic mass of a substance. A grammolecule is equal to the molecular mass of a substance. For example, the grammolecule of hydrogen in the water molecule is equal to two grams, while the gram-atom of the oxygen atom is 16 grams. The grammolecule of water is equal to 18 grams. The mass of hydrogen in a water molecule is 2 x 100 / 18 = 11.11%. The oxygen mass is 16 x 100 / 18 = 88.89%. This is the ratio of hydrogen and oxygen in one litre of water. It means that 111.11 grams of hydrogen and 888.89 grams of oxygen are in 1000 grams of water.

One litre of hydrogen weighs 0.09g. One litre of oxygen weighs 1.47g. This means that it is possible to produce 111.11 / 0.09 = 1234.44 litres of hydrogen and 888.89 / 1.47 = 604.69 litres of oxygen from one litre of water. It appears from this, that one gram of water contains 1.23 litres of hydrogen. Energy consumption for the production of 1000 litres of hydrogen is 4 kWh and for one litre 4 Wh. As it is possible to produce 1.234 litres of hydrogen from one gram of water, then, 1.234 x 4 = 4.94 Wh is spent in producing hydrogen from one gram of water using current methods of electrolysis.

Instruments and equipment used during the experiment

Special experimental low-current electrolyser (**Fig.3**).
Voltmeter of the highest accuracy class (accuracy class of 0.2 GOST 9711-78).
Ammeter of the highest accuracy class (accuracy class of 0.2 GOST 9711-78)
Electronic scales with scale division value of 0.1 and 0.01 g.
Stop watch with scale division value of 0.1 sec.

Experimental results

Table 1

Indices	Sum
1 - duration of the experiment t, h	6.000
2 – readings of voltmeter V, volts	3.750
3 – ammeter readings I, amperes	0.020
4 – power P, watts hour (P=VxIx?/60)	0.450
5 – continue of experiment without input energy in 6 series, min	0.000
6 – mass difference, grams	0.52
7 – mass of evaporated water, grams	0.01x6=0.06
8 – mass of water converted in hydrogen m, grams	0.46
9 – specific power P'=P/m, Watt/gram of water	0.98
10 – existing specific power P'', Watt/gram of water	4.94
11 – the reducing power on the production of hydrogen, times K=P''/P'	5.04
12– quantity of released hydrogen, ?? =0.46x1.23x0.09=0.051, grams	0.051
13 – energy content of hydrogen being obtained (?=0.051?142/3,6)=2.008 Wth	2.008
14- energy efficacy of low ampere process of water electrolysis (E?100/P), %	446.2

Note: In Table 1, the results of the experiment are given when frequency of nearly 500 Hz has been generated in the power supply

Table 2

Indices	Sum
1 - duration of the experiment with input energy in 6 series t, min	6x30=180.0
2 – readings of voltmeter V, volts	3.750
3 – ammeter readings I, amperes	0.022
4 – power P, watts hour (P=VxIx?/60)	0.247
5 – continue of experiment without input energy in 6 series, min	6x30=180.0
6 – mass difference, grams	0.45
7 – mass of evaporated water, grams	0.01x6=0.06
8 – mass of water converted in hydrogen m, grams	0.39
9 – specific power P'=P/m, Watt/gram of water	0.63
10 – existing specific power P'', Watt/gram of water	4.94
11 – the reducing power on the production of hydrogen, times K=P''/P'	8.40
12– quantity of released hydrogen, ?? =0.39x1.23x0.09=0.043, grams	0.043
13 – energy content of hydrogen being obtained (?=0.043?142/3,6)=1.70 Wth	1.70
14- energy efficacy of low ampere process of water electrolysis (E?100/P), %	689.0

Note: In Table 2, the results of the experiment are given when no additional frequency has been generated by the power supply

Table 3

Indices	Sum
1 - duration of the experiment with input energy in 6 series t, min	6x5=30
2 – readings of voltmeter V, volts	13.60
3 – ammeter readings I, amperes	0.020
4 – power P, watts hour (P=VxIx?/60)	0.136
5 – continue of experiment without input energy in 6 series, min	6x55=330
6 – mass difference, grams	0.44
7 – mass of evaporated water, grams	0.01x6=0.06
8 – mass of water converted in hydrogen m, grams	0.38
9 – specific power P'=P/m, Watt/gram of water	0.358
10 – existing specific power P'', Watt/gram of water	4.94
11 – the reducing power on the production of hydrogen, times K=P''/P'	13.80
12– quantity of released hydrogen, ?? =0.38x1.23x0.09=0.042, grams	0.042
13 – energy content of hydrogen being obtained (?=0.042?142/3,6)=1.66 Wth	1.66
14- energy efficacy of low ampere process of water electrolysis (E?100/P), %	1220.0

Note: In Table 3, the results of the experiment are given when frequency of nearly 500 Hz has been generated in the power supply

First of all, we should note that the anode and the cathode are made of the same material, namely, steel. This excludes the possibility of the formation of a galvanic cell. If we analyse Tables 1, 2 and 3, we see the electrolysis process takes place at the very low current of 0.02 amps, and that is why it has been called "low current" electrolysis. Further, this process consisted of two cycles in some experiments. In one cycle, the electrolyser is connected to the power line, while in the other cycle, it is disconnected.

The gas generation process is seen by the release of the bubbles being formed by the process. These bubbles go on being released after the electrolyser is disconnected from the supply line (Tables 2 and 3). When the electrolyser is de-energised, gas release intensity is reduced, but it does not stop for many hours afterwards. It is proved by the fact that electrolysis takes place at the expense of potential difference on the electrodes. It should be noted that small potential difference takes place on the electrodes of the empty electrolyser and immediately after it has been charged with electrolyte prior to its connection to the supply line.

If water electrolysis took place only at the expense of the electrons emitted by the cathode, i.e. according to Faraday's law, current value would be greater and the stock of these electrons would give out after the electrolyser was de-energised and the gas-release process would stop.

The fact that gas production continues for a long period of time after the electrolyser is disconnected from its electrical supply, proves that the molecules of oxygen and hydrogen can be formed without the need for any electrons emitted by the cathode, i.e. at the expense of the electrons of the water molecule itself. Let us analyse this process in detail:

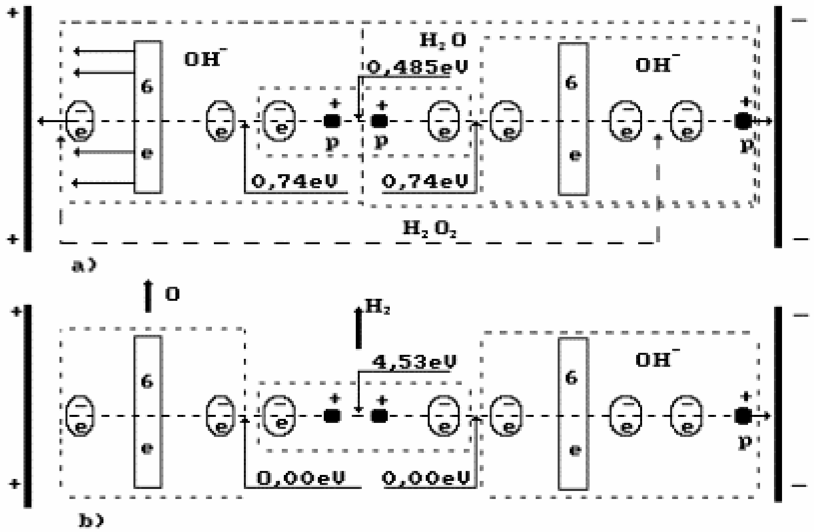

Fig.4. Diagram of low current electrolysis process

In **Fig.4**, the anode is shown on the left and the cathode is shown on the right. The proton of the hydrogen atom in water molecule is oriented to the cathode; another proton of this molecule is connected with the proton of the ion OH\` (leftward). As a result, a cluster chain is formed; on the right, the water molecule $H_2O$ is situated, while on the left, the OH\` ion is situated (**Fig.4, a**); the orthohydrogen molecule H_2 is in the centre (**Fig.4**, **a, b**). Both protons of the hydrogen molecule are connected by energy 0.485eV corresponding to the water molecule cluster formation energy at a temperature of 20°C. Binding energies of the left electron of the hydrogen molecule with the electron of the oxygen atom and the right electron with the electron of the ion OH\` are equal to 0.74eV (**Fig.1**).

Thus, the complex cluster chains with strict orientation between the anode and the cathode are formed in the electrolyte solution under the influence of the electrostatic field.

Let us pay attention to the fact that the axis electron of the oxygen atom and its six ring electrons of the ion OH\` are attracted to the anode simultaneously (**Fig.4, a**). Electrostatic forces attracting six ring electrons to the anode deform the electrostatic field in such a way that the axis electron comes to the nucleus of the oxygen atom, and six ring electrons withdraw from the atomic nucleus. As the electron withdrawal process from the atomic nucleus is an endothermic one, six ring electrons absorb 1.18 eV x 6 = 7.08 eV (**s. Fig.5**). It will automatically transform both axis electrons of the oxygen atom to the energy levels corresponding the excited state of the oxygen atom. Energy absorbed by the ring electrons of two atoms of oxygen is:
7.08 x 2 = 14.16eV.

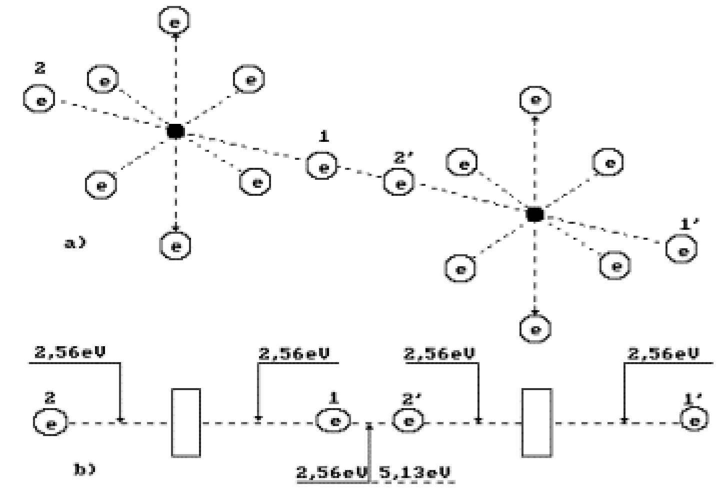

Fig.5. Diagram of binding energy distribution between the electrons in the oxygen molecule

When two oxygen atoms have been separated from two cluster chains, their two axis electrons form a covalent bond releasing 5.13eV of energy (**s. Fig.5**). The two other electrons of the oxygen atoms arranged at the ends of the axis of the O_2 molecule will go to the energy levels with binding energies of 2.56eV having emitted (2.56 - 0.74) x 2 = 6.92eV.

Hydrogen molecule fusion energy is (4.53 - 0.485 - 1.48 x 2) = 1.085eV taking into consideration a binding energy change between its protons and electrons (**Fig.4**) and conversion of orthohydrogen into parahydrogen. Fusion energy of two molecules of parahydrogen is 1.085 x 2 = 2.170eV. As a result, the total energy of fusion of one oxygen molecule and two hydrogen molecule is (5.13 + 6.92 + 2.170) = 14.22 eV.

The difference between the absorbed energy and the emitted energy will be (14.22 - 14.16) = 0.06eV. This is exothermic energy. If we take into account that nearly 0.5 litre of hydrogen has been released during the experiment, thermal energy should be generated.

$$\frac{0.5 \cdot 0.06 \cdot 6.02 \cdot 10^{23} \cdot 1.6 \cdot 10^{-19}}{22.4 \cdot 1000} = 0.129\text{кДж}. \qquad (1)$$

Solution mass in the electrolyser was nearly 0.3 kg. If we take this into consideration, then the solution should be heated by:

$$t = \frac{0.129}{4.19 \cdot 0.3} = 0.1^0 C \qquad (2)$$

The experiment has shown that when the electrolyser is energised, solution temperature is increased by 1.5^0 to 2^0C. When the electrolyser is powered down and the electrolysis process goes on, the solution temperature reduces. When the electrolyser is powered down, the potential on the electrodes is reduced gradually. This means that the initial stock of the electrons on the cathode is reduced as well. It takes place due to restoration of the ions of an alkaline metal. When the ions are restored, they take electrons from the cathode and reduce the potential between the electrodes. This is seen by the change in the colour of the surface of the cathode. The cathode takes on the colour of the alkaline metal being used.

Thus, the low-amperage electrolyser can operate in two modes: connected to the electrical supply line and disconnected from it. When the electrolyser is connected to the supply line, part of the gases are released using the electrons of the cathode, and a part released without the use of these electrons. When the electrolyser is disconnected from the supply line, the cathode electrons are used in the restoration of alkaline metals.

In **Fig.4, a,** the boundaries of the hydrogen peroxide molecule H_2O_2 are shown in the cluster chain (**Fig.6**). It is clear (**Fig.4**) that the hydrogen peroxide molecule is released only when a hydrogen atom being in contact with the cathode is released from the cluster chain. It takes place when the voltage is increased. Hydrogen peroxide is released and interacts with the anode material; if it is iron, foam with red flakes is formed at once. Foam is an apparent feature caused by the disturbance of the spontaneous gas release process.

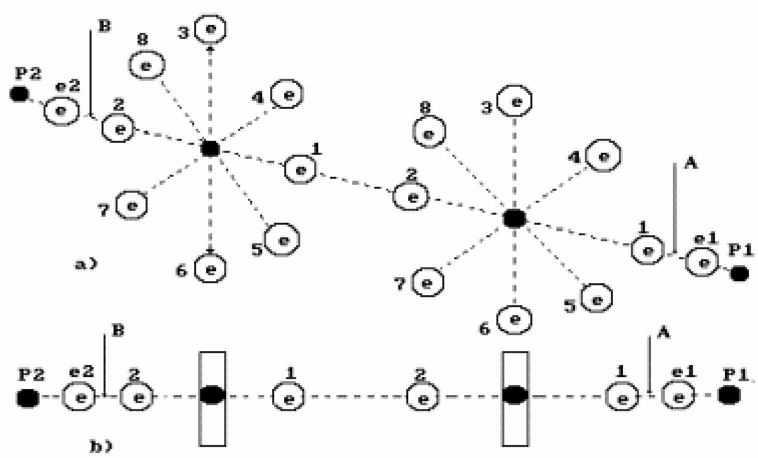

Fig.6. Diagram of the model of hydrogen peroxide H_2O_2

Involuntarily, the results being obtained form an aspiration to find an analogy of the described low-amperage process of water electrolysis in Nature.

It is known that carbon dioxide CO_2 is absorbed during photosynthesis. It is considered that carbon C of the molecule CO_2 is used for plant cell construction, and oxygen O_2 is released. Now we have every reason to doubt this and to suppose instead that the molecule CO_2 is used totally for plant cell construction. Water molecules release oxygen; the hydrogen atoms of water molecules are used as connecting links of the molecules, from which the plant cells are constructed. This process is similar to the process shown in **Fig.4**.

CONCLUSION

Simplicity and 100% reproducibility of the experiments being described, imply that mankind has got a chance to avoid both an energy famine and environmental crisis.

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