WATER IS A SOURCE OF ENERGY

Ph. M. Kanarev

The Kuban State Agrarian University. Department of Theoretical Mechanics.
Doctor of Texnical Sciences, Professor.
E-mail: <kanphil@mail.kuban.su>

More than ten years have passed from the date when the American scientists Fleishmann and Pons have reported about obtaining of additional energy during water electrolysis and about the fact that cold nuclear fusion is the source of this energy [15]. Hundreds of experiments were made in various countries in order to check this fact [15], [17], [18], [19]. A part of the scientists confirmed it, and another part received a negative result [15], [17], [19].

The results of the experiments put the main question: by which physical and chemical phenomenon is additional energy generated during water electrolysis? The first hypothesis: nuclear fusion at low temperature (cold nuclear fusion) is being checked for more than 10 years, but still it has no definite confirmation [15], [23]. The second hypothesis assumes that there is a certain particle called «ersion», which is responsible for the emergence of additional energy [22]. But the main characteristics of this particles remain unknown, that's why it is necessary to check one more hypothesis: additional energy is extracted from energies of chemical bonds of water molecules.

It is considered that the nuclei of three atoms of water molecule form an isosceles triangle with two protons belonging to hydrogen atoms situated in the base (Fig. 1, a) [1], [9], [13], [14].

It is supposed that one pair out of 10 electrons (5 pairs) is situated near hydrogen nucleus. There are inner electrons. The rest electrons are considered to be external ones. One pair of external electrons unites one hydrogen proton with oxygen nucleus, another pair - the second proton. Two pairs remain undivided. It is supposed that they are directed to the vertices of the tetrahedron being opposite to the protons (Fig. 1, a). In accordance with such notions it is supposed that there are 4 poles of charges in water molecule. Two poles are negative. They are created by the access of electron density in the places of arrangement of undivided pairs (Fig. 1, b) of the electrons. Two positive poles are formed by the protons of hydrogen atoms.

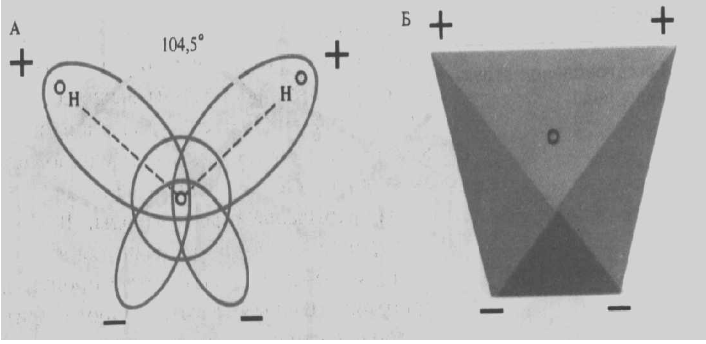

Fig. 1. Diagram of water molecule structure

This information is insufficient to get answer to the arising question: by which physical and chemical phenomenon is additional energy generated during water electrolysis?. It originates from the analysis of energies of chemical bonds in water molecule, that's why these energies should be represented in its structure. But neither modern chemistry, nor modern physics have such information.

It is natural that we'll find no replies for these question within the frames of the existing physical and chemical notions concerning water molecule structure and its electrolysis process, that's why we have the only possibility: to consider our own results of investigations in this field [3], [4], [5], [7], [8], [11], [16], [17], [20], [21].

First of all it is necessary to have a theory, which would allow to calculate energies of chemical bonds of the electrons with atomic nuclei when they are at any energy level. As the atoms of hydrogen and oxygen play the main role during water electrolysis, we'll determine binding energies of their electrons with atomic nuclei.

The law of formation of spectra of atoms and ions have the following mathematical expression [8], [11], [16], [20]:

$$F = E_i - \frac{E_1}{n^2}, \qquad (1)$$

where E_i is atom ionization energy; E_1 is binding energy of electron with nucleus when it is on the first energy level; n =2,3,4… is the main quantum number.

Binding energy E_c of the electron with the atomic nucleus is determined according to the formula [8], [11], [16], [20]:

$$E_c = \frac{E_1}{n^2}. \tag{2}$$

Taking into consideration that ionization energy E_i of hydrogen atom is equal to binding energy E_1 of the electron with the nucleus corresponding to the first energy level $E_i = E_1 = 13.598$ eV and using formulas (1) and (2) we shall obtain theoretical values F (theor) of energies of the photons absorbed or radiated by the electron during its transition in hydrogen atom, which practically coincide with the experimental F (exp) values of these energies. We have binding energy E_c of the electron with the atomic nucleus too (Table 1).

Table 1

Hydrogen atom spectrum

Values, n	2	3	4	5	6
F (exp.),eV	10.20	12.09	12.75	13.05	13.22
F (theor.),eV	10.198	12.087	12.748	13.05	13.22
Ec (theor)eV	3.40	1.51	0.85	0.54	0.38

Hydrogen is the simplest atom. It has one electron, and its nucleus consists of one proton. The information found out by us concerning the structure of the electron and the proton allows to get a notion about the formation process of this atom [20].

One can suppose that magnetic fields of both the proton and the electron are similar to magnetic fields of the bar magnets and have magnetic poles (Fig. 2). As proton mass is much more greater than electron mass, the hydrogen mass formation will begin with the convergence of the electron to the proton. We know that in free state the electron has magnetic moment and rather large magnetic field strength in its geometrical centre, that’s why both electrical force and magnetic forces will govern the process of the convergence of the electron with the proton at the first stage (Fig.2).

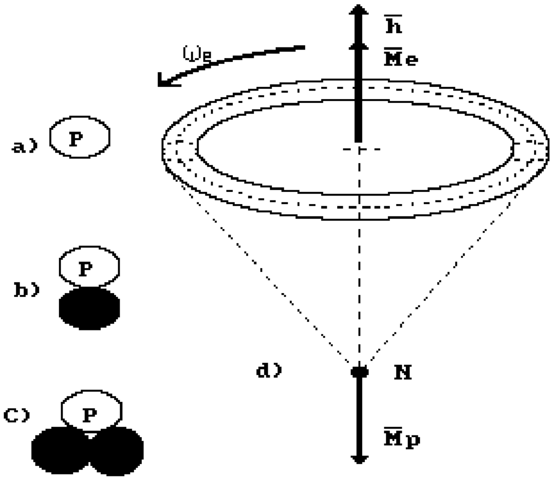

Fig. 2. Diagram of hydrogen atom model: a) proton; b) deuterium atom nucleus; c) tritium atom nucleus; d) hydrogen atom

As the magnetic fields of both the proton and the electron have the largest strength about their axes of rotation, the electron and the proton will rotate align during the convergence. If their opposite magnetic poles are directed to meet each other, both the electrical forces and the magnetic ones will draw the electron and the proton together, and the proton will absorb the electron and will become a neutron. When the electron is drawn together with the proton and their like magnetic poles are directed to meet each other, Coulomb’s forces acting not along the convergence axis, but normally to toroidal surface of the electron will draw it together with the proton, and magnetic forces will repulse them from one another. An equilibrium will be set between these forces, and the structure being formed in such a way is the hydrogen atom (Fig. 2) [16], [20].

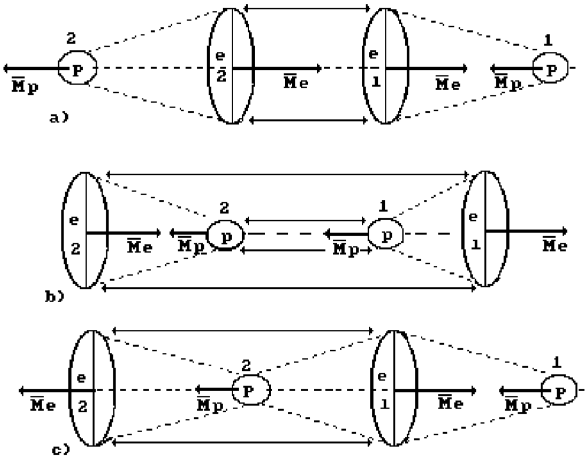

Fig. 3. Diagram of hydrogen molecule H_2 : a), b) - orthohydrogen c) - parahydrogen

Let us note an important moment. In accordance with the existing notions the hydrogen molecule can have two structures. In the structure of orthohydrogen the directions of vectors of magnetic moments of the protons are turned to one direction, and in the structure of parahydrogen to opposite directions [2]. The value of magnetic moment of the proton is by a factor of 10^2 less that the value of magnetic moment of the electron, that's why the hydrogen molecule classification adopted in modern chemistry should be determined not by magnetic moment of the proton, but by magnetic moment of the electron. If this peculiarity is taken into consideration, the hydrogen molecule will have the following difference in its structure [20].

In Fig. 3, a, b, the directions of vectors of magnetic moments $\overline{M}_e$ of both electrons coincide; it means that the directions of vectors of their angular momentum $\bar{h}$ coincide. Let us call this structure orthohydrogen. In Fig. 3, c the above-mentioned vectors are opposite, that's why let us call this structure parahydrogen [1], [9].

As the surface electrons of the atoms take part in chemical reactions namely, let us consider only the calculation of energies F, the absorbed and emitted photons as well as binding energies E_C of the electrons with the nuclei of the first two surface electrons of oxygen atom (Fig.4).

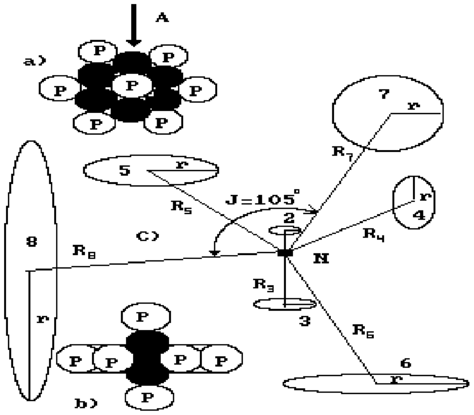

Fig. 4. Diagrams of models of oxygen nucleus and atom: a) diagram of the nucleus of oxygen atom (view to the pane of the nucleus); b) view to the nucleus from the face (arrow A); c) diagram of the model of the atom; 1-8 – the numbers of the electrons; N- the nucleus of the atom; r – radii of the electrons; R_1, R_2, R_3… R_8– radii of energy levels.

Ionization energy of the eight the electron of oxygen atom is equal to E_i =13.618 eV, and its binding energy with the atomic nucleus corresponding to the first energy level is equal to E_1=13.752 eV. Energy indices calculation of this electron according to the formulas (1) and (2) gives the following results (Table 2) [20].

Theoretical values of binding energies of the electron of the first atom of hydrogen and the eighth electron of oxygen atom in water molecule obtained on the grounds of spectrum formation law (1) and (2) are similar to the experimental values of this energy [20].

Table 2

Spectrum of the 8th electron of oxygen atom

Value	n	2	3	4	5	6
F (exp)	eV	10.18	12.09	12.76	13.07	13.24
F (theor.)	eV	10.16	12.09	12.76	13.07	13.24
Ec (theor.)	eV	3.44	1.53	0.86	0.55	0.38

Ionization energy of the seventh electron of oxygen atom is equal to E_i =35.116 eV, and its binding energy with the nucleus corresponding to the first energy level is equal to E_l=83.98 eV. We'd like to draw attention of the reader to great devisations between the experimental data of spectroscopy of the seventh potential of exitation of oxygen atom given in reference books [2] and [6]. We have great trust in new data specified in the reference book [2]. Taking it into consideration, for the seventh electron of oxygen atom we have the results specified in Table 3.

Oxygen is rather complicated atom (Fig.4). It has eight electrons. The main peculiarity of this atom is in the fact that oxygen atom has one electron, which differs from the whole structure. It is the eighth electron. It plays the leading role in the interactions of this atom with the atoms or ions of other chemical elements. To put it short, it is the main valence electron (Fig. 4) [20].

Table 3

Spectrum of the 7th electron of oxygen atom

Value	n	2	3	4	5	6	7	8	9	10	11
F (exp)	eV	14.12	25.83	29.81	31.73	32.88	-	-	-	-	-
F (theor.)	eV	14.12	25.79	29.87	31.76	32.78	33.40	33.80	34.08	34.28	34.42
Ec (theor.)	eV	21.00	9.33	5.25	3.36	2.33	1.71	1.31	1.04	0.84	0.69

Binding energies of the seventh electron of oxygen atom with its nucleaus are larger than the corresponding binding energies of the eighth electron. It proves stability of bonds in ion OH^- and possible greater binding energy of the second atom of hydrogen in water molecule [20].

Now we have every reason to suppose that the eighth electron of oxygen atom establishing the bond with the first atom of hydrogen in water molecule is on the third (E_C=1.53 eV) energy level (Table 2), and the seventh electron of oxygen atom forms the bond with the second atom of hydrogen in water molecule being on the fourth (Table 3) energy level with E_C=5.25 eV [20].

The information obtained by us allows to discover and analyse the structural peculiarities of water molecule. We have shown that the electrons in the atom have no orbital movement, they interact with the nucleus like a rotating whipping top [16]. As there are the electrons and the protons of the like electrical fields and magnetic ones with vividly expressed magnetic poles in the structure, it gives them the possibility to interact with each other and to limit their rapprochement. Due to this fact the bond between the valence electrons in the molecule and between the electrons and the protons in the atom can be depicted with the help of simple lines. Valence electrons of the atoms, which form a molecule, can get connected with each other or with the protons of the nuclei if the proton cell is free [20].

The investigations of the chemists show that in the general case water molecule has two vividly expressed zones on its surface with a positive charge and one zone with a negative charge [9], [13]. In the general case, water molecule behaves as a dipole in the electric field (Fig. 1).

The structure of hydrogen atom (Fig. 2) demonstrates that if this atom unites with the eighth electron of oxygen atom by its only electron, the proton will be on the surface of the molecule and will form a zone with positive charge, which is generated by the proton of hydrogen atom (Fig. 5). The proton of the second hydrogen atom forms the same zone. It is connected with the seventh electron of oxygen atom (Fig. 5). The negatively charged zone is formed by the 6th and the 5th electrons of oxygen arranged near the surface of the atom being opposite to the 8th and the 7th electrons. Dipole water molecule is formed in such a way (Fig. 5).

When the photons are absorbed, binding energy of the electron with the nucleus is reduced, and it goes on rotating and precessing on the nucleus and moves away from it getting nearer to the surface of the atom. When the electron emits the photons, energy of its bond with the atomic nucleus is increased, and it penetrates deeper into its "cell". "Cell" means a volume of a conic form with a vertex on the atomic nucleus, in which the electron rotates like a whipping top. The greater the binding energy of the electron with the nucleus, the nearer it is situated to the nucleus or deeper in its cell [20].

The new theory puts the following questing before us: how many electrons are in water molecule? Do the eighth and the seventh electrons of oxygen atom always remain in their cells when the electrons of hydrogen atoms come nearer to them? We have no definite answer to this question? And we suppose that all possible variants are realized. In some cases the eighth and the seventh electrons of oxygen atom are absent in water molecule, and their places are occupied by the electrons of hydrogen atoms. But the presence of these electrons in water molecule is not excluded, because when valence electrons of the atoms unite, they are connected not only with the protons of the neighboring atom, but also with its valence electrons. (Fig. 5).

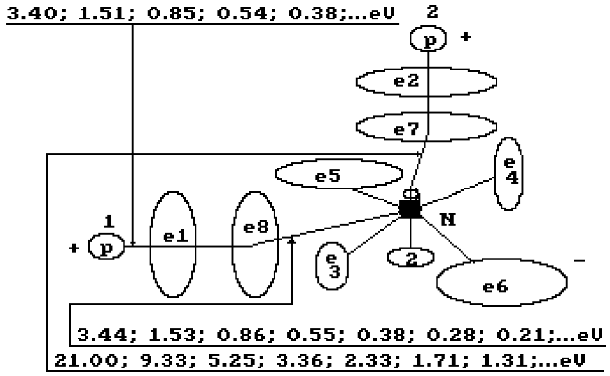

Fig. 5. Diagram of the model of water molecule:
1, 2, 3, 4, 5, 6, 7, 8 are the numbers of the electrons of oxygen atom; N is the nucleus of oxygen atom; P is the nuclei of hydrogen atoms (protons); e_1 and e_2 are the numbers of hydrogen electrons; e_8 and e_7 are the surface electrons of oxygen atom

It is clear from Fig. 5 that if water molecule H_2O is in potential electric field, their surface protons begin to interact with the cathode. The surface protons of hydrogen atoms connected with the eighth electrons of oxygen atoms (Fig. 6) will get electrons e_k due to the contact with the cathode. Then two molecules unite, and molecular hydrogen is formed in the zone of their connection. The bond between the protons of hydrogen atoms in water molecule and their electrons is the weakest bond in the chain being formed (1.51 eV). These bonds are disconnected, and hydrogen molecule appears in free state (Fig. 6, c).

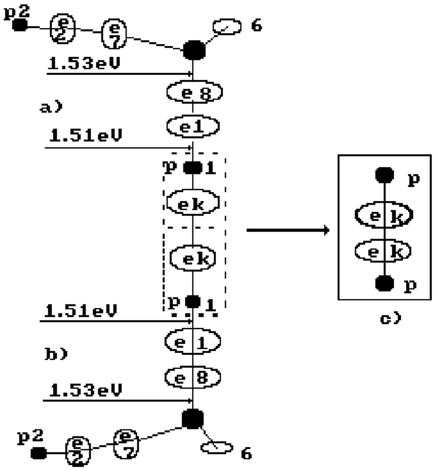

Fig. 6. Diagram of orthohydrogen molecule formation during
water electrolysis (s. Fig. 3, a)

In the given diagram (Fig. 6) of hydrogen molecule formation the electrons e_k emitted by the cathode unite with the protons of hydrogen atoms in water molecule. As each water molecule receives the electron emitted by the cathode, this process corresponds completely to Faraday’s law. When two water molecules are combined, they form a structure, in which hydrogen molecule exists in the formed state. Hydrogen molecule is separated from this structure without the process of its fusion. This is the main reason of lack of additional energy during the existing process of water electrolysis.

Let us consider how parahydrogen molecule is formed (Fig. 3,c). Electron e_k emitted by the cathode (Fig. 7) unites two water molecules. There is a structure of hydrogen molecule in the chain being formed. It is formed by the proton of hydrogen atom of one molecule of water, by electron e_k emitted by cathode and by proton with its electron (hydrogen atom) of the second water molecule. Thus, one electron emitted by cathode is consumed for the formation of one parahydrogen molecule (Fig. 7).

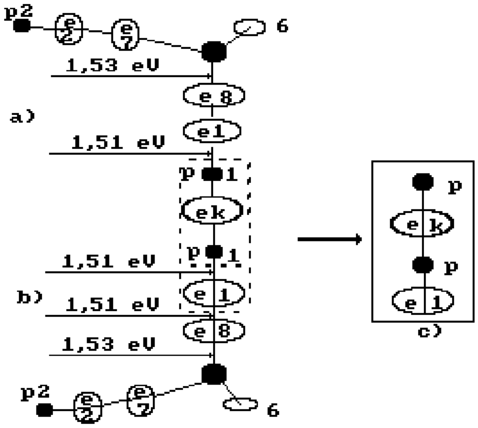

Fig. 7. Diagram of formation of the second model of parahydrogen
(s. Fig. 3, c); a) and b) diagram of water molecules; c) parahydrogen

The following reaction takes place at the cathode in this case:

$$2e^- + 2H_2O \rightarrow H_2 + 2OH^-. \tag{3}$$

Two electrons, which have arrived from the cathode, react with two molecules of water forming hydrogen molecule H_2 and two ions of hydroxyl OH^-. Molecular hydrogen forms the bubbles of gaseous hydrogen (when the solution near the cathode has been saturated with hydrogen), and the ions of hydroxyl remain in the solution.

Let us calculate energy consumption for water electrolysis processes corresponding to (Fig. 6, 7). In order to get the molecules of orthohydrogen or parahydrogen (Fig. 6, 7 c), it is necessary to destroy two bonds with total energy of 2x1.51=3.02 eV.. If we convert this energy into kilojoules (kJ), we shall have:

$$3.02\cdot 1.602\cdot 10^{-19}\cdot 10^{-3} = 4.84\cdot 10^{-22}\,kJ. \tag{4}$$

One cubic metre of hydrogen contains 1000/22.4=44.64 moles. In order to produce one cubic metre of hydrogen it is need consume the energy

$$4.84\cdot 10^{-22}\cdot 44,64\cdot 6.023\cdot 10^{23} = 13007.9kJ \tag{5}$$

or

$$13007.9kJ/3.6\cdot 10^{3} = 3.61kWth \tag{6}$$

Modern electrolysers consume 3.8...4.0 kWth of electric power for obtaining one cubic meter of hydrogen. If energy expenses for heating of the solution of electrolytes are taken into consideration, the results of the theoretical calculation (3.61 kW per hour) will be near to the actual energy expense (3.8…4.0 kW per hour) for obtaining of one cubic metre of hydrogen.

Certainly, when such formation process of hydrogen molecule takes place, there is no free proton existence stage and atomic hydrogen formation stage (Fig. 6, 7). There is no atomic hydrogen fusion process and hydrogen molecule fusion process, and there is no energy corresponding to these process. COP of such process of water electrolysis is less one.

If water molecule is in the electric and thermal field with high temperature and if active turbulent flow is added to it, the process of the separation of hydrogen atoms from water molecules acquires chaotic character, and other variants of the formation of hydrogen molecules are possible (Fig. 8).

If the electrolysis process is organized in such a way (Fig. 8) that first of all hydrogen atom (Fig. 8 c, d) is separated from water molecule, 3.02 eV of energy will be spent for it (Fig. 8,a,b).

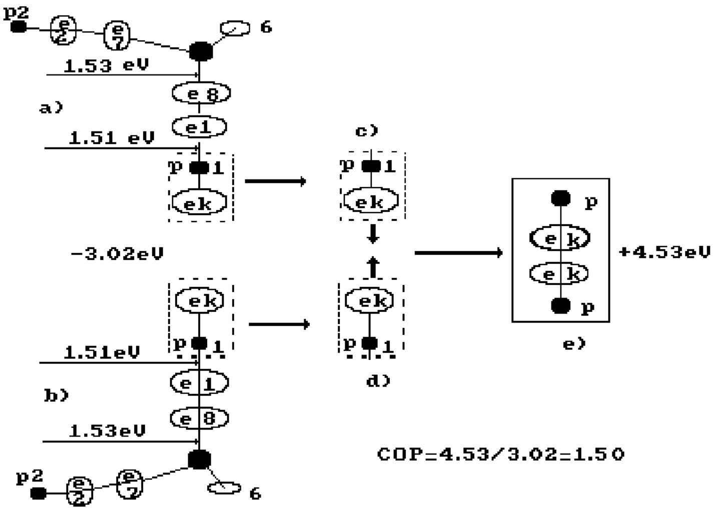

Fig. 8. Diagram of fusion molecule oh hydrogen during water electrolysis (s. Fig. 3, a): a), b) - water molecule; c), d) - hydrogen atoms; e) - orthohydrogen

Chemists have determined that 436 kJ are released during the fusion of one mole of hydrogen molecules. Let us calculate the energy corresponding to two chemical bonds in hydrogen molecule

$$\frac{436\cdot 1000}{6.02\cdot 10^{23}\cdot 1.6\cdot 10^{-19}} = 4.53eV \qquad (7)$$

4.53 eV of energy are released during the following fusion of hydrogen molecule.

The following reaction takes place at the cathode in this case:

$$2H_2O + 2e^- \Rightarrow H + H + 2OH^- \Rightarrow H_2 + 2OH^- + 4.53eV \qquad (8)$$

Index of thermal energy efficiency of this process will be as follows:

$$K = 4.53/(2x1.51) = 1.50 \qquad (9)$$

Fusion energy of one water molecule is equal to:

$$\frac{285.8\cdot 1000}{6.02\cdot 10^{23}\cdot 1.6\cdot 10^{-19}} = 2.97eV \qquad (10)$$

Total theoretical index of energy efficiency will be:

$$K_o = (4.53 + 2.97)/3.02 = 2.32. \qquad (11)$$

Experimental results

We'd like to warn in advance that the effect is demonstrated in a narrow range of the combination of various parameters of the reactor (Fig. 9) and plasma – electrolytic process. The plasma - electrolytic reactor generates energy being available in heat of heated water, water steam of various temperature, atomic and molecular hydrogen, oxygen, ozone, light radiation and noise.

It is not easy to register each of the above-mentioned types of energy separately. It is easy to measure thermal energy being available in heated water and stream. The experience has shown that it is enough for the proof of positive efficiency of the plasma – electrolytic reactor (Fig.9).

But one should bear in mind that not all designs of the reactors and not all operation modes demonstrate positive (K_0 >1) efficiency. It is easy to burn plasma, but it is difficult to produce additional energy from it.

The preliminary tests performed by the authors have shown that the values of heat capacity C_1 and heat of evaporation C_2 for the solution do not differ greatly from the respective values for water; therefore, these parameters have been taken the same as for water: C_1=4.19 kJ per kg degrees and C_2=2269 kJ per kg.

The experiments method is simple: electrolytic solution passes through an electrolytic cell (reactor). Released energy has been determined according to difference of temperature at the input and at the output of the reactor and expended energy has been determined with the help of a domestic electricity meter as well as voltmeter and ammeter of the highest accuracy class. Energy losses have not been taken into consideration.

The application No. 98112312 for the reactor No. 3 was registered on July 8, 1998 (Fig. 9).

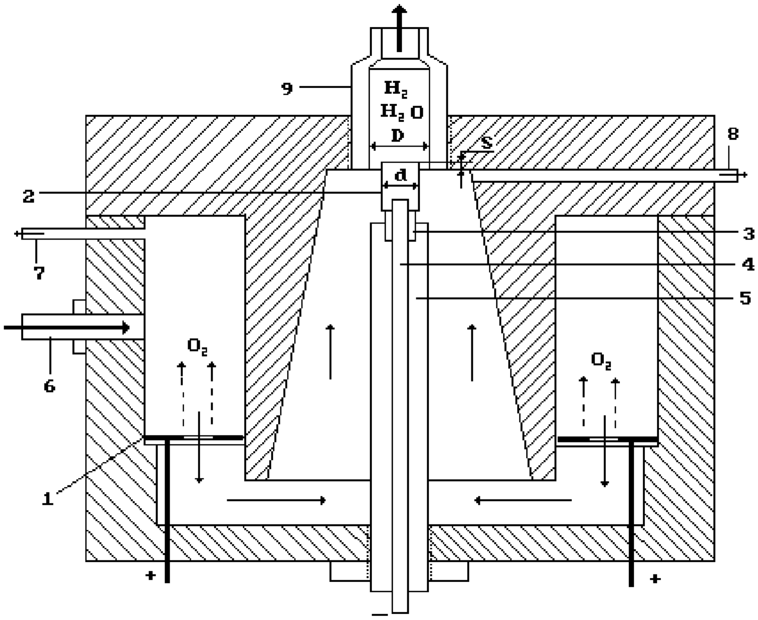

Fig. 9. Diagram of the model of plasma – electric reactor N3

1- anode (ortho); 2 – cathode (molybdenum); 3 – protection of dielectric core 5 from overheating; 4 – tungsten core; 6 – pipe for solution feeding; 7 – pipe for oxygen output; 8 – pipe for hydrogen output; 9 – pipe for output of vapour gaseous mixture

Table 4

Indices	1	2	3	Average
1 – mass of empty measuring glass m_o , grams	…	…	…	345
2 – mass of the solution prior its entering the reactor m_1, grams	1200	1195	1200	1198
3 – mass of the solution after outflow from the reactor m_2, grams	1180	1180	1180	1180
4 – mass difference, inlet and outlet, $\Delta m= m_1- m_2$, grams	20	15	20	18.3
5 - reactor inlet temperature t_1 , degrees	21	21	21	21
6 - reactor outlet temperature t_2 , degrees	85	85	85	85
7 - temperature difference $\Delta t= t_2- t_1$, degrees	64	64	64	64
8 - duration of the experiment, τ, s	279	307	282	289
9 – number of rotations of the electric meter disc during the experiment n, rot.	39.5	44.5	41.5	41.8
10 – electric energy consumption according to the electric meter readings, E_1=n·3600/600, kJ. Note: 600 rotations of the electric meter correspond to 1 kW h of electric power.	237	267	249	251
11 – readings of voltmeter V, volts	196	200	199	198.3
12 – ammeter readings I, amperes	3.66	3.30	3.58	3.51
13 – electric energy consumption according to the readings of the voltmeter and the ammeter, $E_2=I\cdot V\cdot\tau$, kJ	220.1	202.6	200.9	201.2
14 – power energy for heating the solution, $E_3= C_1\cdot m_1\cdot \Delta t$, kJ	322.0	320.4	322.0	321.5
15 – energy consumed for forming of vapours, $E_4= C_2\cdot \Delta m$, kJ	45.4	34.0	45.4	41.6
16 – total energy for heating and vapours $E_0= E_3+ E_4$, kJ	367.4	354.5	367.4	363.1
17 – COP of the reactor according to the electric meter readings				

$K_1= E_0/ E_1$	**1.55**	**1.33**	**1.47**	**1.45**
18 – COP of the reactor according to the voltmeter and ammeter readings $K_2= E_0/ E_2$	**1.87**	**1.75**	**1.85**	**1.82**

During the experiment it can be easily seen that gases are flowing out of the connection pipes of the cathode and anode spaces. These gases are products of the decomposition of the solution, mainly of the water molecules, and are contributing to the decrease of the weight of water. The authors have not yet elaborated a method for measuring the quantity of these gases in this case, and therefore their energy content was added to the energy content of the water vapours. Given that the energy content of the gases is much higher than that of the vapours, the COP of the reactor is higher as stated in Table 4.

A modified plasma-electrolytic reactor (Fig.9) adjusted to non-plasma operation mode has been used for this experiments (Table 5,6,7).

Table 5

Indices	1	2	3	Mean
1 – mass of the solution, which has passed through the reactor m, gr.	1100	1070	1060	1077
2 – temperature of solution at the input of the reactor t_1, degrees	17	17	17	17
3 – temperature of the solution at the output of the reactor t_2, degrees	22	22	22	22
4 – temperature difference of the solution $\Delta t= t_2 - t_1$, degrees	5	5	5	5
5 – durability of the experiment $\Delta\tau$, s	300	300	300	300
6 – number of rotations of the disc of the counter during the experiment n, rotations	2.4	2.4	2.4	2.4
7 – electric power consumption according to the reading of the counter, $E_1 =\cdot 3600/600$ Kj. Note: 600 rotations of the counter correspond to 1 kWh of electric power	14.4	14.4	14.54	14.4
8 – reading of voltmeter V, V	140	140	140	140
9 – reading of ammeter I, A	0.34	0.34	0.34	0.34
10 – electric power consumption according to indices of voltmeter and ammeters, $E_2=I\cdot V\cdot\Delta\tau$, kJ	14.28	14.28	14.28	14.28
11 – power spent for heating of the solution, $E_3=C\cdot m\cdot\Delta t$, kJ	23.45	22.42	22.21	22.69
12 – reactor efficacy efficiency index according to the reading of the counter $K_1 = E_3/ E_1$	**1.60**	**1.56**	**1.54**	**1.57**
13 – reactor efficiency index according to the reading of voltmeter and ammeter $K_2= E_3/ E_2$	**1.64**	**1.57**	**1.56**	**1.59**

When the proton of hydrogen atom, is separated from water molecule, the same quantity of energy of 1.51 eV is spent for this purpose (Fig. 10). During the next fusion of two hydrogen atoms (0.86x2)=1.72 eV are separated. Then, during hydrogen molecule fusion 4.53 eV of energy are released. When the fusion of two atoms and one molecule of hydrogen takes place, 1.72+4.53=6.25 eV of energy are released. The following reaction takes place at the cathode:

$$\begin{aligned} &2H_2O \Rightarrow H^+ + H^+ + 2e^- \Rightarrow H + H + 2OH^- + 2\cdot 0.86eV \Rightarrow \\ &\Rightarrow H_2 + 2OH^- + 1.72eV + 4.53eV \Rightarrow H_2 + 2OH^- + 6.25eV \end{aligned} \tag{12}$$

where H^+ - is proton.
In this case the index of thermal energy efficiency will be as follows:

$$K= 6.25/3.02=2.07, \tag{13}$$

and the total energy index will be

$$K_o = (1.72+4.53+2.97)/3.02=3.05. \tag{14}$$

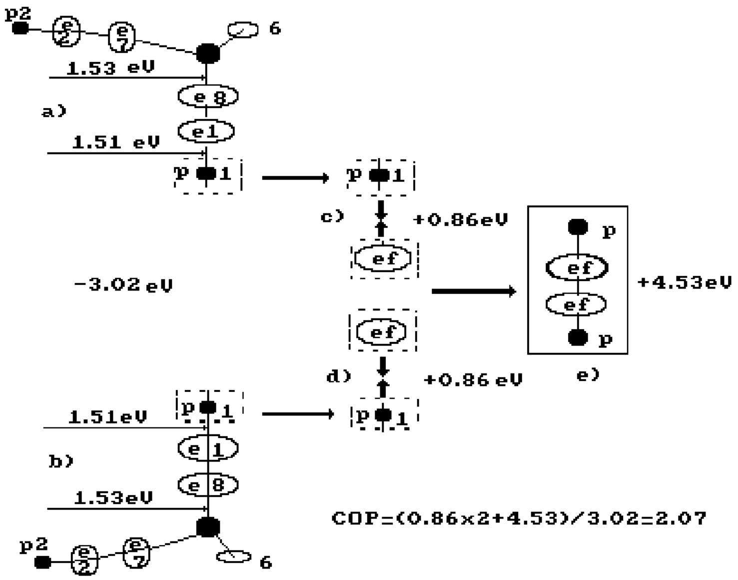

Fig. 10. Diagram of fusion atom and molecule oh hydrogen during water electrolysis (s. Fig. 3, a): a), b) - water molecule; c), d) - hydrogen atom; e) - orthohydrogen

In reality the protons and the atoms of hydrogen are separated from water molecules simultaneously, and the index of thermal energy efficiency is changed in the range of 1.50...2.07 (Table 4, 5). The same indices of energy efficiency are obtained when the existing energy expenses for hydrogen production are taken into consideration.

Let us give the second variant of calculation, in which the experimental value of energy consumed for the water electrolysis process, not the theoretical one.

One cubic metre of hydrogen contains 1000/22.4=44.64 moles of molecular hydrogen or 89.28 moles of atomic hydrogen. We have already shown that 0.86 eV of energy are released during hydrogen atom fusion. The following quantity of energy will be released during the fusion of 89.28 moles

$$H^+ + e^- \to H + 0.86\cdot 89.28\cdot 1.602\cdot 10^{-19}\cdot 6.023\cdot 10^{23} = 7322.3 kJ/m^3 \qquad (15)$$

Hydrogen molecule fusion energy is added to it

$$H + H \to H_2 + 436\cdot 44.64 = 19463.0 kJ/m,^3 \qquad (16)$$

If we sum up (7322.3 + 19463.0), we'll get: 26785.3 kJ. Let us compare this energy with electric power consumption of modern electrolyzers. In order to produce one cubic metre of hydrogen they consume nearly 3.8 kWh of electric power, or (3.8x3600) = 13680 kJ. COP of such process of water electrolysis, which takes into consideration thermal energy only, is (Table 6, 7):

COP = (26785.3/13680)= 1.96 (17)

If we add energy content of produced hydrogen (90 x 142)=12780 kJ, COP is

COP = (39565.3/13680)=2.89. (18)

As it is clear, two methods of the calculation give almost similar results (13) (14) and (17) (18).

Table 6

Indices	1	2	3	Mean
1 – mass of the solution, which has passed through the reactor m, gr.	1250	1250	1240	1247
2 – temperature of solution at the input of the reactor t_1, degrees	18	18	18	18
3 – temperature of the solution at the output of the reactor t_2, degrees	31.0	31.0	31.0	31.0
4 – temperature difference of the solution $\Delta t = t_2 - t_1$, degrees	13	13	13	13
5 – durability of the experiment $\Delta\tau$, s	300	300	300	300
6 – number of rotations of the disc of the counter during the experiment	6.67	6.65	6.67	6.66

n, rotations				
7 – electric power consumption according to the reading of the counter, $E_1= n\cdot 3600/600$ kJ Note: 600 rotations of the counter correspond to 1 kWh of electric power	40.02	39.00	40.02	39.68
8 – reading of voltmeter V, V	50	50	50	50
9 – reading of ammeter I, A	2.10	2.10	2.09	2.097
10 – electric power consumption according to indices of voltmeter and ammeters, $E_2=I\cdot V\cdot\Delta\tau$, kJ	31.50	31.50	31.35	31.45
11 – power spent for heating of the solution, $E_3=C\cdot m\cdot\Delta t$, kJ	68.09	68.09	67.54	67.91
12 – reactor efficacy efficiency index according to the reading of the counter $K_1 = E_3/ E_1$	**1.70**	**1.75**	**1.69**	**1.71**
13 – reactor efficiency index according to the reading of voltmeter and ammeter $K_2= E_3/ E_2$	**2.16**	**2.16**	**2.15**	**2.16**

Table 7

Indices	1	2	3	Mean
1 – mass of the solution, which has passed through the reactor m, degrees	1200	1230	1160	1197
2 – temperature of solution at the input of the reactor t_1, degrees	20	20	20	20
3 – temperature of the solution at the output of the reactor t_2, degrees	31.0	30.5	31.0	30.8
4 – temperature difference of the solution $\Delta t= t_2 - t_1$, degrees	11.0	10.5	11.0	10.8
5 – durability of the experiment $\Delta\tau$, s	300	300	300	300
6 – number of rotations of the disc of the counter during the experiment n, rotations	4.44	4.44	4.44	4.44
7 – electric power consumption according to the reading of the counter $E_1= n\cdot 3600/600$ kJ Note: 600 rotations of the counter correspond to 1 kWh of electric power	26.64	26.64	26.64	26.64
8 – reading of voltmeter V, V	40	40	40	40
9 – reading of ammeter I, A	1.80	1.80	1.80	1.80
10 – electric power consumption according to indices of voltmeter and ammeters, $E_2=I\cdot V\cdot\Delta\tau$, kJ	21.60	21.60	21.60	21.60
11 – power spent for heating of the solution, $E_3=C\cdot m\cdot\Delta t$, kJ	55.31	54.11	53.46	54.29
12 – reactor efficacy efficiency index according to the reading of the counter $K_1= E_3/ E_2$	**2.08**	**2.03**	**2.01**	**2.04**
13 – reactor efficiency index according to the reading of voltmeter and ammeter $K_2= E_3/ E_2$	**2.56**	**2.50**	**2.47**	**2.51**

The calculation results being presented demonstrate the possibility of production of additional energy during water electrolysis, but it is necessary to create conditions for the realization of this possibility.

Plasma-electrolytic Reactor as Gas Generator

In this experiment the reactor No. 3 (Fig. 9) was adjusted to vapour-gaseous operation mode and equipped with a heat exchanger for vapour condensation (Fig. 11). Gas output rate after vapour condensation was measured with the help of anemometer. Cooling liquid (water) consumption, its temperature change as well as the time and the reading of the instruments, which measured electric power consumption were registered.

The application No. 99112024 for obtaining of a patent for the reactor (Fig. 11) was registered on 16 June, 1999.

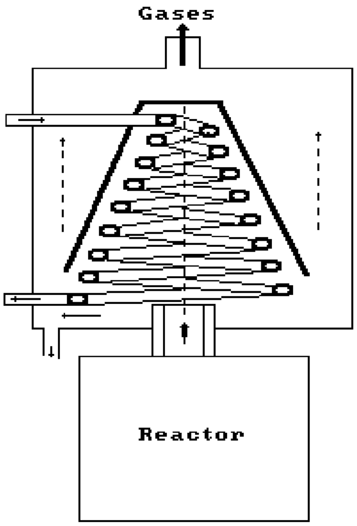

Fig. 11. Diagram of gas generator

Experimental results

Table 8

Indices	1	2	3	Average
1-durability of the experiment τ, s	300	300	300	300
2-cooling water consumption m, grams	8600	9250	8750	8867
3 – water temperature at the input into the cooler t_1, degrees	24	24	24	24
4 – water temperature at the output from the cooler t_2, degrees	29.0	28.5	29.5	28.8
5 - temperature difference of water Δ t= t_2- t_1, degrees	5.0	4.5	5.5	5.0
6-output of gases (hydrogen) according to anemometer readings w, l	19.2	20.7	25.5	21.8
7 - number of rotations of the electric meter disc during the experiment n, rot.	23.5	24.0	29.0	25.5
8 – energy consumption according to the electric meter readings, E_1=n·3600/600, kJ	141.0	144.0	174.0	153.0
9 – voltmeter readings V, volts	220.0	220.0	220.0	220.0
10 – ammeter readings I, amperes	1.66	1.75	1.89	1.77
11 – electric energy consumption according to the readings of the voltmeter and the ammeter, E_2=I·V·τ, kJ	110.0	115.5	124.7	116.7
12 – power energy for heating of cooling water, E_3= C_1· m· Δ t, kJ	179.7	174.0	201.2	185.0
15 – COP of the reactor according to the electric meter readings K_1= E_3/ E_1	**1.27**	**1.21**	**1.16**	**1.21**
16 – COP of the reactor according to the voltmeter and ammeter readings K_2= E_3/ E_2	**1.63**	**1.51**	**1.61**	**1.58**
17 – electric energy consumption for production of one cubic meter of gaseous mixture, kWh/ m^3	**2.0**	**1.9**	**1.9**	**1.9**

Note: hydrogen obtained after vapour condensation can contain admixtures of other gases: oxygen and ozone, and, probably, helium, but we have failed to carry out such analysis.

The accuracy of the following facts was left unimproved: energy of oxygen released in the anode cavity of the reactor, external losses of energy (the heat exchanger had no thermal insulation) as well as light radiation energy. The rest types of unregistered energy (noise, high frequency electric oscillations) can be neglected [20].

The question connected with the composition of the gases obtained after vapour condensation has remained undecided, that's why we continue to consider the gases being obtained to be a gaseous mixture [20].

Numerous attempts to define the volume of gaseous mixture generated by the reactor No. 3 more exactly with the help of the anemometer have shown that minimal energy expenses for the production of one cubic meter of gas mixture are less than 1 kWh. The question concerning quantity of hydrogen in this gas mixture remains undecided [20].

FUEL CELL EFFICIENCY

Fuel cells are considered to be one of the most prospective consumers of hydrogen. But efficiency of the process of the connection of hydrogen with oxygen in a fuel element as well as the formation of electric power are studied insufficiently.

The data of one of the fuel cells are given in the report [78]. At hydrogen consumption of 2 kg per hour it generates 30 kWh of electric power. As one cubic metre of gaseous hydrogen weighs 90 g, 2 kg of liquid hydrogen contain 22.2 m^3 of gaseous hydrogen. If we take into consideration that in order to produce 1 m^3 of hydrogen the best industrial electrolyzers consume 4 kWh and assume the energy value as 100%, we'll get energy efficiency of the fuel cell

$$\frac{30 \cdot 100}{22.2 \cdot 4} = 33.8\% \ . \tag{19}$$

The source of information [24] reports that efficiency of fuel cells of the third generation with solid electrolyte is near 50% and the use of technology of fuel cells allows to increase efficiency of electric power up to 75%; taking into consideration heat generated by them, efficiency is increased by 90% or 95%.

Efficiency of fuel cells depends on efficiency of the use of electric possibilities of hydrogen itself. If quantity of the electrons, which belong to the atoms of hydrogen and take part in the formation of electric power of a fuel cell, is taken into consideration, efficiency of physical and chemical process of this cell is less than 1%. Let us make a calculation for the fuel cell, which is described in the report [24]. This fuel cell generates 30 kW of electric power when 2 kg (22.2 m^3) of liquid hydrogen is consumed per hour. As the mole of gaseous hydrogen is equal to 22.4 litres, it is necessary to consume 22222.22/22.4=992.06 moles of molecular hydrogen for the production of 30 kW of electric power.

We'd like to remind that a value equal to the product of Avogadro number $N=6.022 \cdot 10^{23}$ by the electron charge $e = 1.602 \cdot 10^{-19}$ is called Faraday constant F_a . This value is measured in coulombs (C) per mole of substance.

$$F_a = N \cdot e^- = 6.022 \cdot 10^{23} \cdot 1.602 \cdot 10^{-19} = 96485 \text{ C/mol.} \tag{20}$$

If all protons of 992.06 moles of molecular hydrogen give their electrons to electric net of the fuel cell, $992.06 \cdot 2 \cdot 96485=191437818.2$ coulombs of electricity are formed, as a result. These are potential possibilities of 22.2 m^3 of molecular hydrogen. In what way are these possibilities used by modern fuel cells?

The fuel cell being considered operates at voltage of 100 V; that's why when 30 kW are generated, current of 30000/100=300 amperes per hour circulates in its electric circuit. 3600 coulombs of electricity are consumed at 1 ampere/hour and 1080000.0 coulombs are consumed at 300 ampere per hour. If we assume that potential quantity of coulombs of electricity, which 22.2 m^3 of hydrogen contain (191437818.2 coulombs) is 100%, actual quantity of coulombs of electricity generated by the fuel cell is [20]

$$\frac{1080000.0 \cdot 100}{191437818.2} = 0.57\% \tag{21}$$

These are the main reserves of efficiency improvement of the fuel cells!

Feeding of molecular hydrogen to the fuel element is the main cause of a very low (0.57%) electrical efficiency of the fuel cell. There is every reason to hope that minimal tenfold improvement of this efficiency will take place in the nearest future [20].

The given calculations show that energy properties of hydrogen in fuel cells are used only by 0.6%. **Tenfold increase of this index is equal to the transit to hydrogen power in all field of human activities.**

WATER IS A SOURCES OF ELECTRIC ENERGY

Theoretical and experimental investigations show that water is a source of not only thermal energy and the energy, which is available in hydrogen and oxygen, but also an electric energy source. A diagram of water molecules with ten electrons is shown in Fig. 5. We have called this structure a charged water molecule [17], [18]. It has turned out that it is possible to separate an electron belonging to the hydrogen atom, which is connected with the eighth electron of the oxygen atom, from water molecule. In this case the hydrogen atom proton is connected with the eighth electron of the oxygen atom. Having lost one electron, a water molecule becomes semi-charged (Fig. 11).

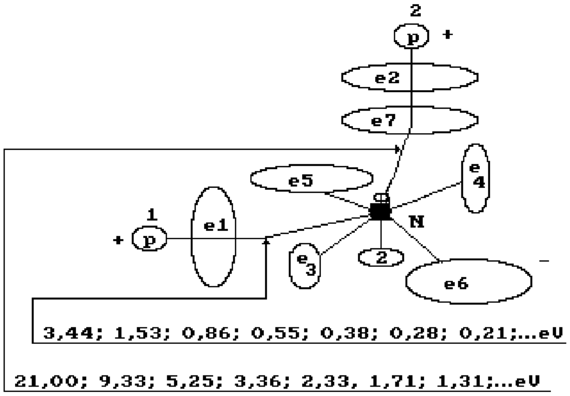

Fig. 11. Diagram of the fourth model of water molecule

The number of coulombs of electricity, which is generated in one litre of water with a loss of one electron by each water molecule, will be equal to the product of Avogadro number by the number of moles of water molecules in one litre.

$$96485 \cdot 55{,}56 = 5360706{,}5 \text{ Coulombs} \qquad (22)$$

Taking into consideration the fact that one ampere-hour is 3600 Coulombs of electricity, we find electrical capacitance of one litre of water.

$$\frac{5360706{,}5}{3600} = 1489{,}1 A \cdot h \qquad (23)$$

Theoretical and experimental investigations show that at the definite modes of plasma electrolysis of water in an electrolytic solution an electrical potential is formed, which exceeds the potential brought to the solution. As a result, electric energy exceeding the electric energy introduced into the solution is generated.

CONCLUSION

The theory forecasts and the experiment confirms that if there is no hydrogen molecule fusion process, COP is less than one.

If during water electrolysis the hydrogen molecule fusion process takes place, thermal COP will be increased up to 1.5 and total COP will be increased up to 2.3.

When during water electrolysis the processes of fusion both of the atoms and the hydrogen molecules take place, thermal COP will be 2.0 and total COP will be 3.0.

As it is very difficult to carry out each of these water electrolysis processes separately, they take place at the same time, and thermal COP will be within the ranges of 1.5…2.0, and total COP will be within the range of 2.0…3.0.

Thus, energy of chemical bonds of water molecules is the source of additional energy when different types of processing take place.

REFERENCES

1. L. Poling. General chemistry. M.: Mir, 1974.
2. A.R. Striganova, G.A. Odintsova. Tables of spectral lines. M.: Nauka. 1977.
3. Ph.M. Kanarev. New Analysis of Fundamental Problems of Quantum Mechanics. Krasnodar. 1990. 173 pages.
4. Ph. M. Kanarev. The Role of Space and Time in Scientific Perception of the World. Galilean Electrodynamics. Vol. 3, No. 6, pp. 106-109 (Nov./Dec., 1992)
5. Ph.M. Kanarev. On the Way to the Physics of the 21st Century. Krasnodar. 1995. 269 pages (In English).
6. A.N. Zaidel et al. Tables of Spectral Lines. M.: Nauka, 1997.
7. Ph.M. Kanarev. Analysis of Fundamental Problems of Modern Physics. Krasnodar. 1993. 255 pages.
8. Ph.M. Kanarev. Law of Formation of the Spectra of the Atoms and Ions. Proceedings of the international conference “Problems of space, time, gravitation”. St.-Petersburg. Publishing house “Polytechnic”, 1997, pp. 30-37.
9. V.V. Polevoi. Physiology of Plants. M.: Vyshaya Shkola, 1989.
10. Short Chemical Encyclopaedia. Volume 1. M.: Sovetskaya Entsiclopedia. 1961.
11. Ph. M. Kanarev. The Analytical Theory of Spectroscopy. Krasnodar, 1993. 88 pages. (In Englisch).

12. Bilan et avenir du “systeme” hydrogene. Pt. 1. Production transport et stockade/Logette S., Leclere, J.-P., Goff P. Le, Villermau. J.//Entropie. 1995. No. 188-189. Pages 95-99.
13. V.V. Sinyukov. Water known and unknown. M., Znanie, 1987. 174 pages.
14. V.P. Polishchuk. How to Discern a Molecule. M.: “Chemistry”, 1979. 380 pages.
15. Harold L. Fox. Cold Nuclear Fusion: Essence, Problems, Influence of the World. View from USA. Production group “SVITAX” M.: 1993, 180 pages.
16. Ph.M. Kanarev. Crisis of Theoretical Physics. The third edition. Krasnodar, 1998. 200 pages.
17. Ph.M. Kanarev. The Source of Excess Energy from Water, Infinite Energy. V. 5, Issue 25. Pages 21-58.
18. ICCF – 7 ACCEPTED ABSTRACTS. Infinite Energy. V. 4, Issue 20, p. 59-69.
19. Ya.B. Skuratnik, N.I. Khokhlov, A.K. Pokrovsky. Estimation of Possibility of Excess Energy during Water Electrolysis with Usual and Heavy Water. Cold transmutation of Nuclei. Proceedings of the 6th Russian Conference on cold transmutation of chemical elements. M., 1999. Pages 91-98.
20. Ph.M. Kanarev. Water as a New Energy Source. The second Edition. Krasnodar, 2000, 146 pages.(In Russian and in English).
21. Ph.M. Kanarev. Introduction in Hydrogen Power. Krasnodar, 1999. 22 pages. (In Englisch).
22. Yu.N. Bazhutov, G.M. Vershakov, R.N. Kuzmin, A.M. Frolov. Interpretation of Cold Nuclear Fusion with the help of Catalysis of Erzions. Collection “Physics of Plasma and Some Questions of General Physics”, CNIIMash, 1990, 67-70.
23. Ohmori and Mizuno. Strong excess Energy Evolution, New Element Production, and Electromagnetic Wave and/or Neutron Emission in Light Water Electrolysis with a Tungsten Cathode. Infinite Energy. 1988. V. 4, Issue 20, pages 14-17.
24. Soo Seddon. Fuel Cell Conference Report. Institute of International Research Conference on Fuel Cell Vehicles. Held on February 22, 1999. Infinite Energy Issue 25, 1999, pages 35-38.