

Hydrogen Energetics

Review by Alla Pashova

A Russian writer Ludmila Ulitskaya, who is rather far from energy problems, says: "I'm quite sure that cheap electric energy sources have been already worked out and are hidden in oil king's safes. However such projects won't be taken out of the safes until the last oil drop is combusted. They don't want redistribution of money, world, power, and soon". Experts are sure to agree with the writer.

Now only ideas which can coexist together with the traditional oil power engineering and with a system of world oil distribution can escape the safes. Some expensive scientific toys promising future universal welfare are created to reassure ecologists, viz automobiles equipped with hydrogen engine. According to estimation of Japan representatives of motor car industry, installation of the hydrogen engine into such a car as a classical Sedan now comes to about \$700 000. Approximate cost of a hydrogen bus named Kitaro achieves the astronomic amount of \$1.25 million.

The hydrogen engine consists of several fuel elements, which are known as fuel cells. Hydrogen under pressure of 1.5-2.7 atmospheres comes to an anode. A cavernous catalyst splits the molecules into electrons and protons. The electrons set the electric engine in motion, and the protons come through a membrane acting to a cathode as an electrolyte. Here the catalyst combines them with the working electrons and with atmosphere oxygen into water molecules. It should be noted that the Europeans and the Americans are extremely charmed by this water streamlet which is exhausted instead of poisoning gases. Moreover, output of the fuel cell is 3-5 times more than output of the petrol engine.

The first hydrogen power station inaugurated in Las Vegas, Nevada, in 2002, (see Fig.1, 2) represents a system of the fuel cells with the proton penetrable membrane as an electrolyte (they are designed and produced by experts of Plug Power Inc.). The station produces hydrogen transforming and cleaning natural gas and generates electric power combining hydrogen stored in reservoirs with atmosphere oxygen. The USA Energy Department and Air Products Inc. together paid \$ 10.8 million for this project.

It is necessary to note that the priority branch of the hydrogen engineering is providing new means of transport with fuel, and electric power production is just the second aim. The mentioned station produces electric power in addition to its main function. Nevertheless, if fuel market begins to

decrease then the electric power payments will provide the "hydrogen magnates" with stable profit.



Fig. 1
Hydrogen power station

Nowadays the hydrogen automobiles allow oil kings keep the system of centralized fuel distribution and the infrastructure of service stations which will provide the means of transport with methanol, natural gas with hydrogen blend, and liquefied or gaseous hydrogen. Thus interested companies control the hydrogen engineering and scientific thought.

Moreover, oil can be applied as it is useful for board reforming (conversion), i.e. it can be used as a hydrogen source. The systems based on conversion have been known for a long time but there was need to work at them.

Russian experts improved the conversion system by replacement of the catalyst by plasma. Thus the conversion occurs in gas discharge of HVF appearing in the blend which needs to be converted. According to experts' opinion the Russian system is portable and has high output. In 2001 a group of experts of Russian Centre of Automobile Engine represented experimental prototype basing on Chevrolet Pickup S 10.

The ideal of modern hydrogen engineering is the following: "There should be minimal changes in the system of fuel distribution, non-polluted air, and thin streamlet of distil exhausted". However, evidently, the exhausted water is an ideal source for hydrogen fuel reproduction by means of high effective electrolyzing. If the closed system is worked out we would obtain an energy source powered by continuous chain of electrolyzing and recombination whose efficiency would be more than 100 %.

What are the known ways of hydrogen production? The greatest amount of the gas is produced on the base of catalytic conversion of hydrocarbon with water vapor. Temperature of the process depends on the catalyst composition. It is known that temperature of propane reaction can be decreased to 370° using bauxite as a catalyst. Approximately 95% of by-product carbon monoxide is further used in the reaction with water vapor.

A significant part of the total hydrogen production is given by a method of water gas. The essence of the method lies in reaction of water vapor with coke that is followed by the producing of carbon monoxide with hydrogen mix. The reaction is endothermal, it occurs at 1000°C. The heated coke is processed by the vapor; extracted purified mix of gases contains some hydrogen, some carbon dioxide, and great share of carbon monoxide. Further vapor processing of the carbon monoxide at 370°C increases the hydrogen extraction. The amount of carbon dioxide increases as well however it is easy to be removed by passing the gases mix through a scrubber sprayed by a water contraflow.



Fig. 2

There is a well-known iron-vapor method according to which vapor is passed above iron at 500-1000°C. Hydrogen obtained by this method is usually applied to hydrogenise fats and oils. Composition of the iron oxide depends on the process temperature. Iron-3 oxide (Fe_3O_4) prevails at the temperature below 560° C. If the vapor is passed above the iron at the temperature above 560° C then iron-2 oxide (FeO) share increases. A slight admixture of carbon monoxide is removed when the heated mix passes above a catalyst. At this time the carbon monoxide is transformed into methane.

In the processes of oxidation and thermal cracking of hydrocarbons at soot production hydrogen is produced as a by-product.

The next effective method is methanol-vapor one. It is an endothermal reaction which is proceeds in common iron reactors at 260° C temperature and at 20 atmospheres pressure.

There should be also mentioned a catalytic reaction of ammonia decomposition at which nitrogen and hydrogen is produced. The reaction can be profitable if it is necessary to produce great amount of hydrogen. The method is useful if the obtained hydrogen is directly applied.

Electrolysis is the oldest method to produce hydrogen. Direct current comes to electrodes, the cathode collects hydrogen, and the anode accumulates oxygen. The technology makes hydrogen to be too expensive energy carrier. There is often used a technology of hot processing of water vapor at 700-900° C accompanied with light petrol and heavy liquid fuel which bleeds oxygen. This method is quite expensive as well.

As it is known, **wasteful power consumption of classical electrolysis** is caused by the fact that it is used to overcome forces of hydrate bound of ions with water molecules and to compensate endothermal effect of water decomposition. Therefore, ions reduction at corresponding electrodes requires more current intensity than in the case of absence of this physical phenomena. Hence production of 1 cubic meter of hydrogen requires 18-21.6 MJ, and total power consumption exceeds 50 MJ (taking into account the electric power production). Therefore hydrogen becomes too expensive.

In 1888 D.A. Lachinov patented a method of non-contact electrolysis. Improvement of this method promises huge amount of cheap hydrogen and appearance of high effective energy source operating as a closed cycle. The main problem of Lachinov's method is a gas layer covering the electrode in some time and impeding the reaction. It was proposed by I. A. Goryachev to prevent the gas layer using pulsating electric field. A.V. Frolov has proposed to increase electrolysis efficiency by means of rotation. Centrifugal force causes more swift detach of gas blebs from electrodes surfaces. Power consumption to overcome frictional force in the construction and to generate potential electric field is insignificant as compared with output. Hence efficiency of the system may exceed 100%.

There is also described the experimental device for production of hydrogen and oxygen from water where modulated voltage (not dc voltage) is applied to the electrodes. Modulation frequency is in connection with proper oscillation frequency of water molecules as well as with spatial structure. Possible efficiency of water electrolysis in spark discharge which removes oxygen admixture should be investigated. Water electrolysis at the radiation

by electromagnetic waves of light range needs to be investigated as well.

Ikar Research Centre informs that plasma electrolysis can be the most probable source of cheap hydrogen. In 1987 a group of Russian scientists patented the first plasma-electrolytic reactor. Since the reactor had been worked out at a defense establishment then the patent was restricted and not covered by press. The patent contains a structural scheme of the reactor and some results of cleaning and disinfection of water by plasma. The patent does not represent any information of additional energy generated by plasma or hydrogen production.

In April of 1989 American scientists Pons and Fleishman published their experimental results on additional energy production at common water electrolysis. They claimed cold fusion to be source of this energy. However there is no reliable proof for this phenomenon.

In 1996 Yu. Beklyamishev, one of the co-authors of the first plasma-electrolytic reactor, published his experimental results. They demonstrated that there was additional energy in the plasma-electrolytic process. However he did not explain the energy source.

In 1998 there were published new experimental issues of appearance of additional energy in the plasma-electrolytic process. A group of Russian scientists tested one of the plasma-electrolytic reactors and officially fixed the additional energy. A report of the testing session was published in issue #22 of "Infinite Energy" magazine. In May of 1998 the third edition of a book named "Crisis of Theoretical Physics" was published by Prof. F. M. Kanarev. It contains data of additional energy production at plasma electrolysis of water defining the energy source. Soon Ohmori and Mizuno (Japan) published their results in works of Vancouver conference on cold fusion and in issue #20 of "Infinite Energy". Ohmori and Mizuno observed neutron radiation occurring at a plasma process as well as iron, chrome, nickel, and carbon appearance on a wolfram cathode. That seemed to be a strong evidence of cold nuclear fusion at plasma electrolysis of water. Ohmori and Mizuno have explained neutron radiation as a result of electrons captured by protons. Nevertheless their conclusions raise doubts as cold fusion would have produced much more additional energy than it was fixed.

In 1996 there appeared the first publications where hydrogen atoms fusion instead of nuclear fusion was supposed as the additional energy source at usual electrolysis as well as at plasma source. In Russia

first experimental results demonstrating energy consumption decrease for hydrogen production at plasma electrolysis of water were published in 1999 by Prof. F.M. Kanarev. (See F.M. Kanarev's article in this issue of NET).



Fig. 3

Honda FCX-V3 uses hydrogen as a fuel. Hydrogen is fed under high pressure in the engine.

Nevertheless we have to note that high efficiency electrolysis is possible! O. Hvolson in his "Physics" (Berlin, 1923) explains a method of designing of a machine which can produce heat due to positive difference between energy of hydrogen combustion and energy consumed to hydrogen production by means of water electrolysis. In this case we do not consume energy to split the atoms. It occurs due to intermolecular forces at water dissociation by sulphuric acid ions. Energy is consumed only to neutralize charges of existent hydrogen ions and acid residue ions. Hydrogen combustion produces the energy which would have been consumed to split the atoms in the air. **Hence 67.54 Kcal of energy can be produced at 5 Kcal consumed. (F. Lepehin)**

High effective electrolysis application is clear future of energetics. Nowadays Stuart Energy Inc applies water electrolysis as a hydrogen source in a frame of hydrogen-fuel project. Experts of Stuart Energy Inc have designed a refueling unit which produces hydrogen and stores it in a 104-pound reservoir. Thus several auto are provided with fuel and it takes a couple of minutes to refuel.

It is quite simple to predict social and economical consequences of innovation of high effective energy source operating as a closed cycle energy system. Economic activity and private life of people will be independent of cities, of their industry and power engineering. People will move out of the cities and they will use compact and powerful energy sources there. Hence, decentralization of world economics will happen.

Regions of any country become more free from the central authority, the power of which nowadays is based on centralized fuel energetics.