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Promising Method for Hydrogen Producing and Its Potential Use on Board the Vehicle

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Abstract- This article describes an important step in the global project of gradual transition to hydrogen energy, namely, the creation of highly efficient on-board vehicle hydrogen generator that allows recycle hardly used thermal energy. Authors proposed a new approach to creating a hydrogen generator based on the process of decomposition of water in an artificial centrifugal field. A question of the opportunities of practical implementation of creating a centrifugal hydrogen generator and its use on board the vehicle are theoretically considered. The article presents the results of calculations of the current processes, weight and size of the proposed hydrogen generator. Some conclusions are drawn about the possibility and economic efficiency of its use in road transport. The results obtained allow conclude about the prospects of the proposed centrifugal hydrogen generator.

Keywords- hydrogen generation, electrolytic cell, centrifugal field, water decomposition.

1. Introduction

Usage of hydrogen as energy carrier is considered today by one of leading directions in alternative power of future. The reached successes allow expect application of the received results first of all on transport.

Promising of hydrogen's use as fuel for transport power train (for internal combustion engines or for fuel cells) is connected, mainly, with its ecological cleanliness and practically unlimited stocks.

Use of hydrogen allows over come one of the main lacks of internal combustion engines - sharp decrease in efficiency on partial loadings.

In the classical electrolysis lost a lot of energy, in particular in the process of production and transformation. To reduce these losses is proposed to generate electrical energy directly into the working fluid, on the basis of the effect of a unipolar generator.

Researches carried out the world show, that storage of hydrogen onboard a vehicle is the extremely irrational. The most expedient are the independent hydrogen generator, allowing develop hydrogen on demand directly onboard a vehicle.

Creating a onboard highly effective hydrogen generator will allow for a gradual transition from vehicle purely with fossil fuel to purely with hydrogen (Fig.1).

The best solution would combine lower consumption due to increased efficiency with onboard hydrogen generation since no additional infrastructure would be needed.

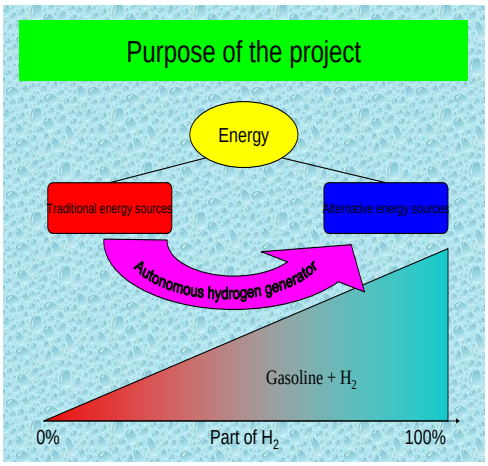

Fig. 1. Scenario for the transition to a hydrogen energy

In this case, hydrogen could be used as an additive to organic fuel (on the basis of crude oil or renewable primary products) added to the organic fuel in small percentages of mass. If the production rate is high enough hydrogen could also feed a fuel cell, e.g. used as an auxiliary power unit.

Figure 2 shows the approximated dependency of relative fuel consumption on the quantity of added hydrogen. The diagram is based on experimental data of cars with gasoline carburetor engines [1].

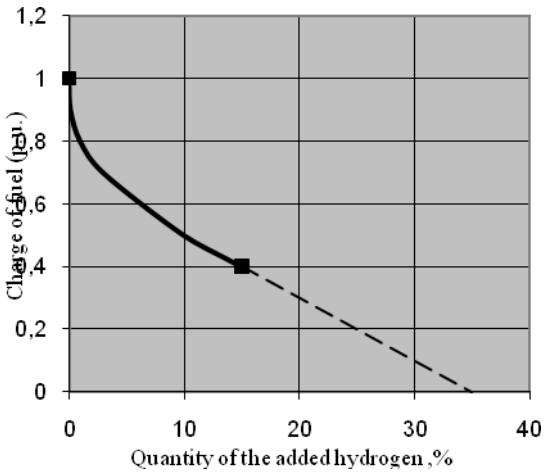

Fig. 2. Dependency of relative fuel consumption on the quantity of added hydrogen.

One of promising methods of hydrogen generating onboard a vehicle is the decomposition of water, spent under action of centrifugal forces, due to the impact which the unique properties of water, non-linear change its physical and chemical properties.

In this paper based on the results of experiments conducted by scientists and researchers in various countries around the world [2-6], as well as its own research and calculations of the authors of the report [1, 7] the features of decomposition of water in an artificial centrifugal field and, in particular, a question on an opportunity of creating a centrifugal hydrogen generator and its use on board the vehicle are theoretically considered.

2. Approach

The main purpose of this study - a comprehensive analysis of the feasibility and practical use in a vehicle centrifugal hydrogen generator. A large number of experimental studies in various laboratories around the world virtually confirmed the possibility and prospects of the low current dissociation of water molecules in the low-temperature plasma. In this paper, we will not touch the theory of this process, especially since the researchers themselves often disagree.

Although, in our opinion attracts the attention of the theory described in [4], that actually predicted the results of the plasma - electrolytic experiments.

Reliability of this theory of a microcosm was proved not only new interpretation of huge quantity of the experimental information on a life of elementary particles, but also results of own experimental researches on studying electromagnetic structures of photons, electrons, atoms, molecules and clusters.

The author believes that low current electrolyser has the properties of the capacitor and a source of electricity at the same time. Recharge at the beginning, he gradually discharged under the influence of electrolytic processes occurring in it.

Quantity of electricity generated is insufficient to support the process of electrolysis, and it gradually runs down. If it is recharged periodically by voltage pulses, compensating power consumption, the charge of the cell as a capacitor will remain constant, but the process of electrolysis - stable.

Results of experiments with rotation of the electrolytic cell shown, that the saving in cell voltage, and thus energy consumption, are significantly larger than the small amount of energy required for rotation of the cells [5].

3.Theoretical evaluation of implementation in vehicle

Based on the analysis of theoretical and experimental data in this field of science, as well as the principles of the theory of infinite hierarchical nesting of matter, at the Munich University of Technology (TUM) was designed the original hydrogen generator that operates on the basis of effects implemented in a centrifuge.

The essence of the hydrogen generator (HG) is that the dissociation of water molecules produced by a mechanical gravitational effect on the

working fluid without external supply of electrical energy under conditions of constant heating.

In this connection, we can also consider the HG, as a new type of heat pump.

Main feature of the process in a strong gravitational field is a constant quantity of motion of the solution when the generator is in steady state. Mechanical work outside source consumed for the increment of the kinetic energy of water flowing into the bowl of the rotor in the form of hydrate molecules are fully compensated for the kinetic energy of gases pop-up to the rotational axis.

Thus, in the gravitational electrolysis the mechanical work of the external source of energy is spent mainly on overcoming the friction capacity of the air and supports of HG, fluid friction and circulation of the refrigerant in the heat exchange system.

It should be noted that the temperature of the solution plays an important role in this process.

With its increased speed of the rotor is minimized. The optimal operating tempera- ture range from near freezing solution to 85° C.
The scheme of energy conversion in the HG is shown in Fig. 3.

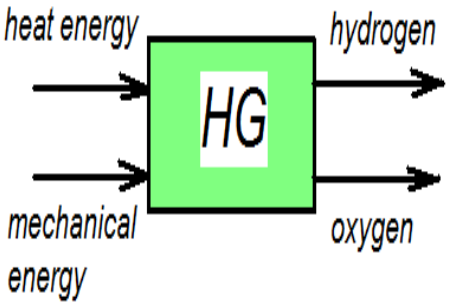

Fig. 3. Energy conversion in centrifugal hydrogen generator

To estimate the energy efficiency of hydrogen production using centrifugal HG performed the energy balance of the working process of the centrifugal hydrogen generator in comparison with the conventional electrolyzer, as shown in Figure 4.

Should also be noted that, with increasing rotation speed of HG, it's possible receive additional electrical energy, which will further increase the efficiency of the hydrogen generator.

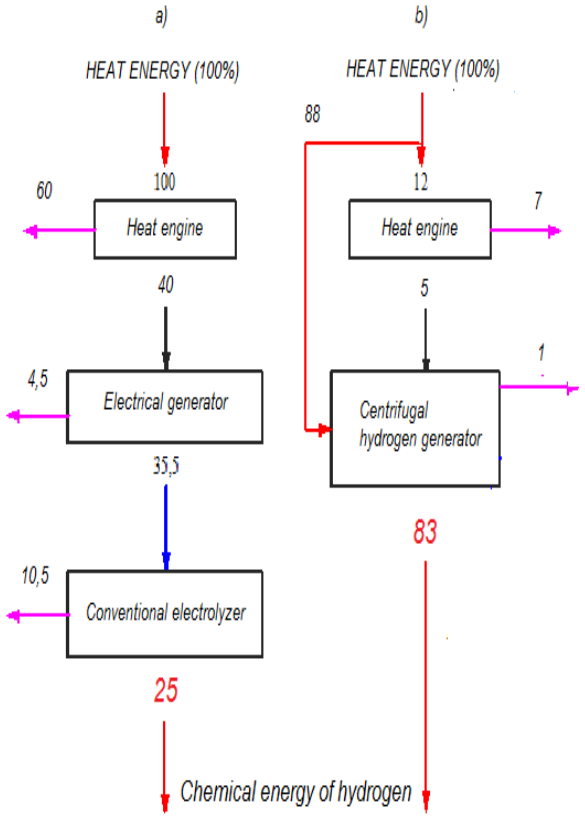

Fig. 4. Energy balance of hydrogen producing a) conventional electrolysis, b) centrifugal hydrogen generator

Should also be noted that, with increasing rotation speed of HG, it's possible receive additional electrical energy, which will further increase the efficiency of the hydrogen generator.

On the possibility of dissociation of water through the creation of electrical discharges in gases, non-equilibrium plasma is known for a long time. At the same time, most authors of studies indicate insufficient knowledge of the field of science and registration with the experiments of a number of anomalous phenomena [2-4].

It is known that the vibrational excitation of the energy threshold usually coincides with the activation barrier of the reaction and is considerably below the threshold of the reaction by electronic excitation of the reactants.

Calculations of scientists Kurchatov's Institute (Russia) show that the effective dissociation of water vapor (and the production of hydrogen by plasma with an efficiency equal to 50-70%) can be implemented as a dissipative electron

attachment to water molecules, and also through the vibrationally excited state of the reactants.

The first way takes a lot of energy: for the dissipative electron attachment is necessary that their temperature T_e >1,5 eV.

As for the second way of water molecules dissociation, it is quite easy to implement in practice using high frequency capacitive circuit discharge.

Experiments shown, that simultaneously with the decreasing temperature of electrons and hydrogen atoms in this mode, an increase of at least an order of effective frequency of collisions between electrons and heavy particles.

This also is favorable for the dissociation of water molecules due to vibrationally excited states of the reactants.

In order to estimate the feasibility, based on known dependences used to calculate the operating parameters of centrifugal hydrogen generator (inner rotor radius 0.3 m, column electrolyte solution height 0,22 m, electrolyte $HBrO_3$, temperature 18°C, the concentration of electrolyte C = 6 M, the degree of dissociation K = 0,85), presented in Table 1.

In an electrolyte solution between the volume charges of anions and cations, as in the external circuit between the electrodes creates a closed electrical field with stark internal tension, ie kind of charged electrolytic capacitor.

Discharge of capacitor discharge will occur with the fall of potential on the electrodes as long as the energy of the centrifugal field becomes equal to the energy released by an external load. In this case, the process will stabilize and become permanent.

The process of hydrogen producing is easily controlled by changing the frequency of rotation of the tank or the amount of ohmic resistance of the external load.

The main condition for the feasibility of the process of gravitational electrolysis is the reduction of entropy thermochemical potential of the electrolyte solution by exposure to an external artificial inertial field, while the recovery of the inevitable while reducing the heat content of the system (enthalpy) of the influx of heat from an external source.

Table 1. Results of the parameters calculating of the working process of HG (for one liter of electrolyte solution).

1. Frequency of rotation of HG, rad /s	174,9
2. Rotor rotating speed, min^{-1}	1671,3
3. Average periphery velocity of the solution column, m/s	32,6
4. Tangential velocity of the column of solution, m/s	52,5
5. Kinetic energy of a heavy ion, 10^{-20}J	0,0334
6. Total energy heavy ions, 10^{-12} J	0,038
7. Emf of a heavy ion, V	0,002087
8. Anode potential, V	$2{,}375 \cdot 10^{5}$
9. Kinetic energy of the liquid disk, kJ	0,39
10. Usable energy of the gravitational field, kJ	0,34
11. Installed power, kW	0,43
12. Pressure of the solution, MP	2,32
13. The surface density of ions, ion/cm^2	$7{,}72 \cdot 10^{13}$
14. Conditional discharge duration, s	$7{,}355 \cdot 10^{-8}$
15. Quantity of discharging charges on the anode, $ion \cdot cm^2 \cdot s^{-1}$	$1{,}049 \cdot 10^{21}$
16. Maximum anode current density, A/cm	167,9
17. Maximum anode current, A	11 832
18. The potential difference between anode and cathode, V	0,029
19. Power on the external load, kW	0,0247
20. Energy deposition of heavy ions, kJ	0,025
21. Mass productivity of hydrogen, kg/s	$1{,}236 \cdot 10^{-4}$
22. Volume productivity of hydrogen, l/s	1,37

It should be noted that the coefficient of cooling capacity of the hydrogen generator, as estimated at 90 units, exceeds the characteristics of many heat pumps.

The centrifugal hydrogen generator is organically entered in the layout of the vehicle power train, especially with turbine engine.

Below in Table 2 are some data on an example of possible use of HG in the construction of middle class cars with engine capacity of 100 kW.

Table 2. Technical data of the car hydrogen generator.

Parameter	ICE type
	Otto, 100 kW
1. Heat balance, %:	100
Beneficial use of thermal energy	70 (30)
Losses with the exhaust gases	- (45)
Losses in the cooling system	- (20)
Other losses	5
Thermal energy to work HG	25
2. Active area of the heat exchanger, m^2	0,6
3. Maximum current density, A/cm^2	325
4. Total electrode area, m^2	0,22
5. Volume of electrolyte, m^3	0,015
6. Specific metal of the HG and auxiliary equipment, kg / kW	0,7
7. Specific volume of the HG and auxiliary equipment, m^3/kW	0,0016

Note: In claims the data of automobile engines without HG.

4. Conclusion

The main conclusion that can be done based on the analysis results of the calculations is that the proposed method of decomposition of water in an artificial gravitational field is feasible, and with ordinary constructive solutions.

Calculated specific capacity of the generator is sufficient for effective implementation with heat engines of vehicles, including cars, buses, tractors, agricultural and road-building machines, ships and so on, as well as the use with other industrial and natural sources of heat.

Parameters of the gravitational field taken in the calculations are not maximal, and in the following models of hydrogen generator can be significantly increased.

Technical problems to be resolved in the process of creating a generator, is to provide high-performance purification of hydrogen of by-products and traces of the electrolyte solution, as well as prevent or minimize spillage of the electrolyte in case of accident and automation of process control.

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