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Hydrogen electrolyzer for internal combustion

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ABSTRACT: The problem of deteriorating environmental situation in megacities, including due to the toxicity of exhaust gases of transport engines, requires a comprehensive solution. The use of hydrogen for the internal combustion engine is primarily determined by environmental purity, in limited and renewable raw materials, as well as unique motor qualities, which opens up the possibility of its wide-ranging use in modern engines without significant design changes. A lot of development has been done in this area with several experiments on gasoline as well as diesel internal combustion engines so far using HHO gas or brown gas as a fuel efficiency enhancer. This paper examines the methods of using hydrogen internal combustion engines as a qualified fuel.

KEYWORDS: Internal combustion, Internal engines, Analysis,Hydrogen Engine,Gasoline Engine, Brown gas.

I. INTRODUCTION

In general, it is not difficult to make the internal combustion engine run on hydrogen. However, making the internal combustion (IC) engine work well is a more difficult task. This study identifies the key components and techniques needed to distinguish between a hydrogen engine that works and an engine that works well. The earliest attempt to develop a hydrogen engine was reported by the Rev. W. Cecil in 1820. Cecil presented his work to the Cambridge Philosophical Society in a paper entitled "On the use of hydrogen gas to produce the driving force in equipment." The engine itself worked on the principle of vacuum, in which atmospheric pressure repels the piston from the vacuum to generate energy. The vacuum is created by burning a hydrogen-air mixture, allowing it to expand and then cool. Although the engine worked satisfactorily, the vacuum engines never became practical.[1]

Hydrogen can be used as fuel in a conventional internal combustion engine. The mixture of hydrogen and air is explosive. Hydrogen is more dangerous than gasoline because it burns in a mixture with air in a wider range of concentrations. The hydrogen propulsion system based on the traditional IC is much more difficult and more expensive to maintain. There is no way to refuel quickly on the way from the canister or from. The use of hydrogen for the internal combustion engine is primarily determined by environmental purity, in limited and renewable raw materials, as well as unique motor qualities, which opens up the possibility of its wide-ranging use in modern engines without significant design changes. Factors holding back the introduction of hydrogen technologies: the lack of hydrogen infrastructure; Imperfect hydrogen storage technologies No safety, storage, transportation, etc. standards; Common modern methods of safe storage of hydrogen require more fuel tanks than for gasoline. Increased output of nitrogen oxides due to higher temperature in the combustion chamber and increases the likelihood of valves and pistons burning for long periods of time at high power; hydrogen at the temperatures and pressures that are generated in the engine, is able to react with the engine's structural materials and lubricant, leading to rapid wear and tear.[2]

Features of hydrogen as a fuel for IC:

- After combustion, only water vapor is left.
- The reaction is much faster than in the case of gasoline or diesel.
- Detonation resistance can improve compression.
- Due to its flyability, hydrogen is able to penetrate into the smallest cavities, gaps between parts (only special alloys of increased strength are able to tolerate the destructive effects of hydrogen on the structure of the metal).
- Hydrogen combustion heat is 2.5 times greater than that of a petrol mixture.

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- Wide range of reactions. The minimum hydrogen proportion sufficient to react with oxygen is only 4%. This feature allows you to adjust the modes of operation of the engine, dosing the consistency of the mixture.

The main advantages and disadvantages of a hydrogen engine compared to conventional fuel.	
Advantages of the hydrogen engine:	**Disadvantages of the hydrogen engine:**
- Compact and easy to use; - Ideal flammability of the fuel mixture based on air and hydrogen, which makes it easy to start the engine at any ambient temperature; - High heat generation. The calorific value (140 MJ / kg) exceeds more than 3 times the rate of natural gas - methane; - Absolute environmental safety - exhaust gases turn into water; - 4 times higher combustion rate compared to a gasoline mixture; - The ability of the mixture to work without detonation at a high compression ratio; - The presence of an electronic device allows you to monitor and control the operation of the device; - The display visually displays data on engine operation; - Ability to connect to a remote computer; - The presence of a sensor exceeding the maximum pressure level, which can stop the electrolysis process in case of danger; - The ability to synchronize the operation of several generators combined in a cascade gives an increase in the productivity of the device several times; - A wide range of reactions. The minimum proportion of hydrogen sufficient to react with oxygen is only 4%. This feature allows you to configure the engine, dosing the consistency of the mixture;	- The high cost of producing hydrogen, as well as components for its storage and transportation. For example, to maintain a liquefied state you need to maintain a stable temperature of -253o C; - The inability to fit enough gas on the vehicle. The size of the fuel tank for hydrogen will be comparable to the parameters of the car itself; - A large gas explosive ness should rule out the possibility of the slightest leakage; - A cryogenic installation is needed in liquid form. This method is also a little feasible on the car; - The conversion of petrol stations and the production of hydrogen fuel are now 4 times more expensive than gasoline production; - High shipping and storage costs; - The possibility of fire when hydrogen comes into contact with a hot release collector. Therefore, they offer to use rotary engines with a remote location of the intake collector from the graduation; - Hydrogen engines emit significantly more nitrogen oxides than gasoline engines; - Increased release of nitrogen oxides due to higher temperature in the combustion chamber and increases the likelihood of valves and pistons burning for long periods of time at high power; - Hydrogen at the temperatures and pressures that are generated in the engine, is able to react with the engine's structural materials and lubricant, leading to rapid wear and tear; - If they are massively implemented, the amount of hydrogen in the atmosphere will increase dramatically, which can lead to the destruction of the ozone layer; - Ideally, hydrogen-powered IC emits only water vapor into the atmosphere. When it is massive, it also poses a serious risk, as does CO2, is a "greenhouse gas", increases the corrosion of materials, worsens people's well-being, increases the "slipperiness" of the road surface and the amount of fog, which leads to increase the number of accidents;

Table. 1 Advantages and disadvantages of hydrogen a fuel

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Many car owners are looking for ways to save fuel. A hydrogen generator for the car will allow a hydrogen generator to solve this issue. By electrolysis, water is converted into the so-called Brown gas, a rattlesnake gas that is added to the fuel mixture.[2] The main task that this gas solves is to increase the fullness of the combustion of fuel. Hence, the use of this gas in internal combustion engines leads to more efficient combustion of the fuel mixture, reduces the amount of harmful emissions into the atmosphere. A mixture of this gas during combustion emits almost 4 times more energy than when molecular hydrogen is burned.

II.EMISSIONS

The combustion of hydrogen with oxygen produces water as its only product:

$2H_2 + O_2 = 2H_2O$ (1)

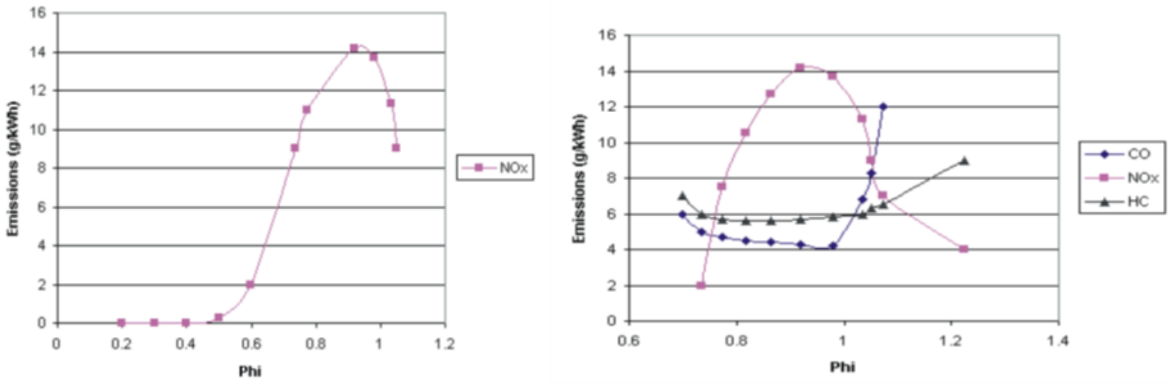
The combustion of hydrogen with air, however, can also produce oxides of nitrogen (NO_x):

$H_2 + O_2 + N_2 = H_2O + N_2 + NO_x$ (2)

The oxides of nitrogen are created due to the high temperatures generated within the combustion chamber during combustion. This high temperature causes some of the nitrogen in the air to combine with the oxygen in the air. The amount of NO_x formed depends on:

- the air/fuel ratio
- the engine compression ratio
- the engine speeds
- the ignition timing
- whether thermal dilution is utilized

In addition to oxides of nitrogen, traces of carbon monoxide and carbon dioxide can be present in the exhaust gas, due to seeped oil burning in the combustion chamber. Depending on the condition of the engine (burning of oil) and the operating strategy used (a rich versus lean air/fuel ratio), a hydrogen engine can produce from almost zero emissions (as low as a few ppm) to high NO_x and significant carbon monoxide emissions. In Figure 2 a, illustrates a typically NO_x curve relative to phi for a hydrogen engine. A similar graph including other emissions is shown in Figure 2 b, for gasoline.[1]



a. b.

Figure 1. a) Emissions for A Hydrogen Engine, b) Emissions for A Gasoline Engine[1]

III. MAIN CONTENTS

The principle of hydrogen generators on IC is based on the electrolysis process. The system is activated only during the ride and uses battery power to generate hydrogen from water. Hydrogen does not accumulate, that is, produced gas quickly enters the engine, mixing with traditional fuel: gasoline; diesel fuel, gas.[2]

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The mixture of fuel and hydrogen burns more efficiently, reducing fuel consumption and the number of pollutants released into the air. This state-of-the-art hydrogen technology reduces fuel consumption by 20-60 percent, providing a significant reduction in the number of co-emissions; NOx; CO2; HC. [3,4]
There are very simple systems used to produce hydrogen and oxygen due to water electrolysis. The point is that technology is used to produce sufficient gas without additional chemicals and electrode erosion. You can try to make electrodes out of copper, but this material reacts with water and emits a lot of pollution, so this option is not suitable.

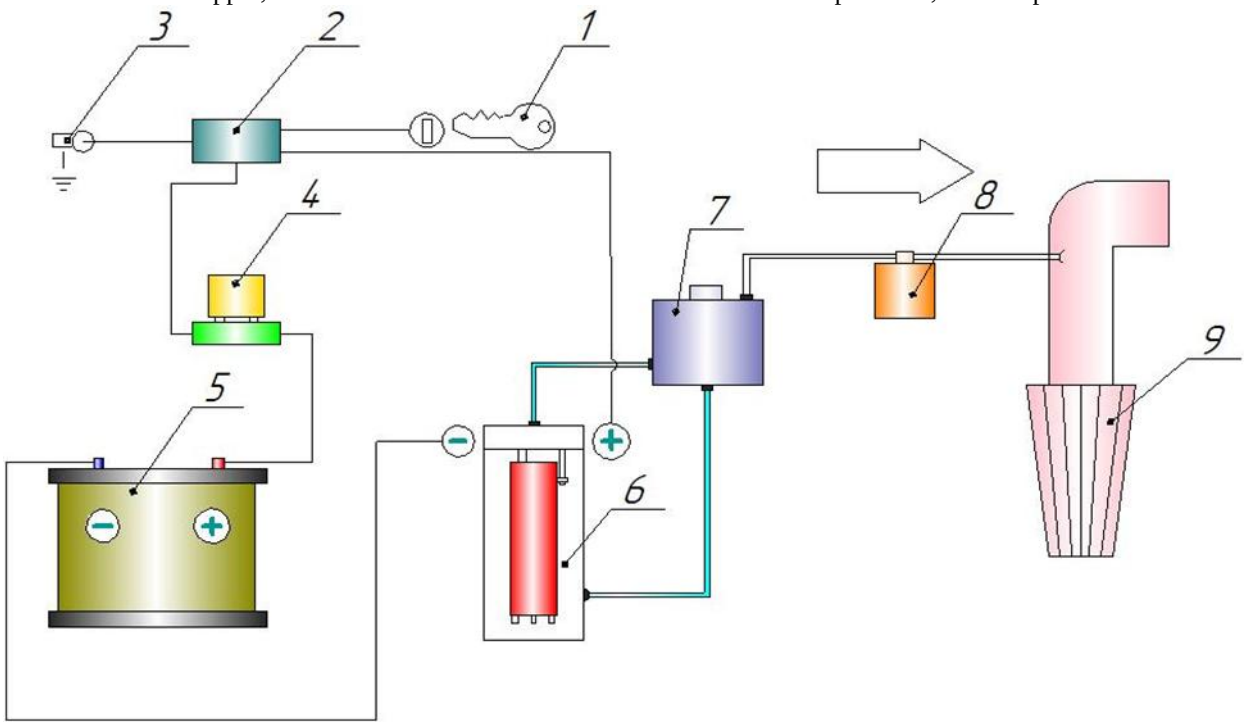

Figure 2. The concept of a hydrogen electrolyzer.
1-Key, 2-Relay, 3-Mass, 4-Fuse, 5-Accumulator, 6-HHO Generator, 7-Tank, 8- Waterproof, 9- Air filter

IV. PROPOSED HYPOTHESIS

We recommend making stainless steel electrodes since this metal does not react as easily as copper does during electrolysis. The main problem, in this case, is the search for high-quality stainless steel. The amount of gas produced is proportional to the charge that passes through the water. Thus, the higher the current, the more gas. The distance between the electrodes for this should be as small as possible, but gas bubbles should easily move between them. In Fig. 2. a schematic diagram of a hydrogen electrolyzer is provided. For plates, use good stainless steel, which has a minimal risk of corrosion. Stainless steel does not conduct electricity as well as copper, so electrode plates are made of sheets about 2 mm thick.
This will reduce resistance. The higher the quality of the metal, the more difficult it will be for you to make electrodes (the material is more difficult to cut). We recommend to make the electrode plates in layers, and the distance between them can be adjusted with nylon washers or washers from some other dielectric material. Plates should be placed in a variable position so that the pluses alternate with the minus ones. Fasteners must also be made of stainless steel so that the materials match each other. It is important to achieve a snug fit of all elements, which eliminates sparking.
We should not forget that we are dealing with combustible gas. In our particular case, we assemble a system of 6 plates with a distance between them of about 1 mm. The large surface area, plate thickness, and bolts allow higher currents to pass through the system without resistive heating of the metal. The total capacitance of the electrodes is -1nF when measured in air. Such a set of electrodes can be used in plain tap water up to 25A.
Gas collection electrodes must be placed inside a container with hermetically sealed connectors, a lid, and other connections. The container should initially be food-grade and resistant to high temperatures. If the container is metal, the electrodes should be fixed on a plastic base to prevent short circuits. Two connectors can be installed on both sides

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of the copper and brass fittings that are used to extract gas. Fittings and connectors are firmly attached using silicone sealant to make the sealed container completely leakproof.
The gas produced is an explosive mixture of hydrogen and oxygen, so it must be used with extreme caution. The container contains a lot of gas, there is a possibility of its ignition, and with overpressure, even an explosion can occur. To avoid gas detonation inside the hydrogen generator, pipes from the container should be connected to another container half full of water. In case of fire at the exit, the flame does not penetrate back into the device.
This safety device is absolutely necessary and must be installed. By electrolysis, water is converted into the so-called Brown gas, which is added to the fuel mixture. The main task that this gas solves is the complete combustion of fuel. This serves as an increase in power and a decrease in fuel consumption by a decent percentage.

V. CONCLUSIONS

Under the influence of electric current, the water molecule begins to decompose into two hydrogen atoms and one oxygen. This gas mixture during combustion emits almost 4 times more energy than when molecular hydrogen is burned. Therefore, the use of this gas in internal combustion engines leads to more efficient combustion of the fuel mixture, reduces the number of harmful emissions into the atmosphere, increases the power and reduces the amount of fuel spent.

REFERENCES

[1]A. Lanz, “Hydrogen use in internal combustion engines,” Hydrog. Fuel Cell Engines, 2001.
[2]K. Shalbaev, D. S. Uralov, V. P. Ladnorg, R. A. Torgaev "The materials of XLI international scientific and practicalconference KazATK M.Tynyshbayev on "Innovative Technologies on Transport: Education, Science, Practice" (April 3 - 4, 2017), Volume 1," pp. 383-388, 2017.
[3] V.F. Kamenev, V.M. Fomin, N.A. Khrypach "Theoretical and experimental studies of engine work on diesel-hydrogen fuel compositions," International Scientific Journal "Alternative Energy and Ecology" AEE, No.7 (27), 2005.
[4] E.K.Lutikova, Y.I.Kiryukhin, L.L.Antonova, K.V. Fedyshina, D.I.Samoilov, C.G. Mostloch, V.N.Fateyev"Developing resistant to SO electrocatalysts for solid-polymer fuel cells" /"International Conference "Electrocatalyst in electrochemical energy": Tez.dokl. -M., 2003, p. 21
[5] http://rus.delfi.ee/archive/novaya-tehnologiya-polucheniya-chistogo-vodoroda.

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