

## IMPROVING THE PERFORMANCES OF AN INTERNAL COMBUSTION ENGINE USING OXY-HYDROGEN

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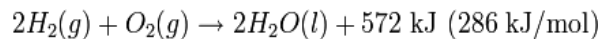
**Abstract:** This paper is presenting a technical solution to produce and use oxy-hydrogen (HHO) as a fuel supplement. Using appropriate equipment, oxy-hydrogen is produced by water electrolysis and immediately transmitted to the engine. The introduction of hydrogen into the combustion chamber increases the efficiency of the combustion process and, therefore, reduces the fuel consumption and the polluting emissions, increasing the power and performance of the engine.

**Keywords:** oxy-hydrogen, fuel, internal combustion.

### 1. INTRODUCTION

Hydrogen is a modern alternative to completing fuel combustion for vehicles equipped with internal combustion engines [1].

The gaseous hydrogen (in the state of a diatomic molecule) is highly flammable and at an atmospheric pressure ignites into the air volumetric at concentrations between 4% and 75% and in contact with pure oxygen between 4.65% and 93.9%. The limits of the occurrence of detonation are between 18.2% and 58.9% into the air, respectively between 15% and 90% in the oxygen. The enthalpy variation of combustion (calorific value, combustion heat) is -286 kJ/mol:



The mixture of oxygen and hydrogen in different proportions is explosive. Hydrogen self-ignites and explodes in contact with the air in concentration situated between 4% and 75%, the auto-ignition temperature being of 560° C. The flame of a pure hydrogen-oxygen mixture emits ultraviolet radiations invisible to the naked eye.

The advantages of using oxy-hydrogen are that it is environmentally friendly, from its combustion resulting into water vapors which also have the aim to clean the internal engine components.

It is known that the efficiency of diesel engines is low because the combustion of the fuel mixture is a slow one, thereby, much gases are unburned appropriately and eliminated. By introducing hydrogen into the engine's inlet, the fuel mixture is enriched, the latter having a more efficient combustion, increasing the performance and the power developed by the engine.

The disadvantages consisted of the great danger of explosion, properties of diffusion into the material, the difficulty in vehicle storing and the lack of any networks of hydrogen fueling stations. One of the most promising technical solutions is represented by the direct conversion of electrical energy into chemical energy and, afterwards, into mechanical energy.

The technical solution presented in this paper, is based on the projection of a hydrogen generator by the electrolysis of water. The disadvantage of explosion was

countered by the fact that the obtained hydrogen is introduced into the engine, immediately after its production, its storage being no longer required.

### 2. THE EXPERIMENTAL SYSTEM

The performed experimental installation (Figure 1) consists of the following elements:

- Hydrogen Generator
- Electronic Block Bubbler
- Car battery
- Engine

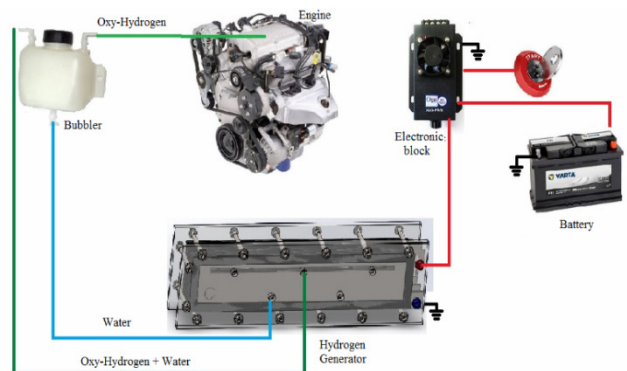
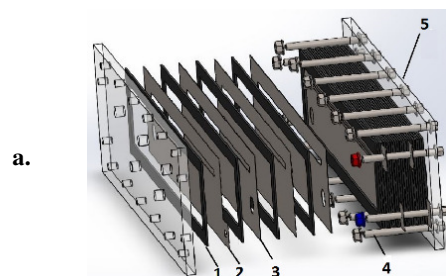


Fig. 1. The experimental installation

The hydrogen generator is intended to transform the electrical energy, into the chemical energy, especially, the production of oxy-hydrogen through water electrolysis.

It was made from several components (Figure 2):

1. Rubber seal; 2. Active plate; 3. Neutral plate;
4. Screws; 5. Flange





**Fig. 2. Hydrogen virtual generator (a) and real representation (b)**

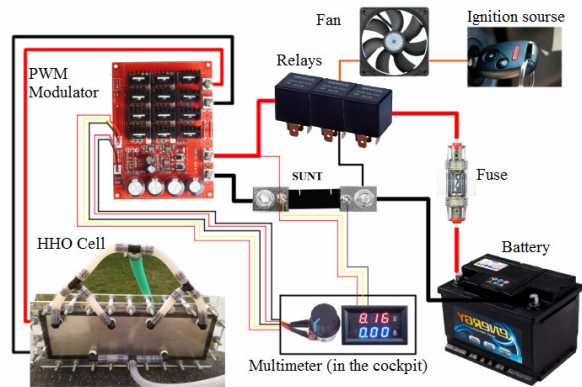
As it is known, water electrolysis can be performed in two ways: the so-called wet and dry electrolysis. In this paper, the generator was designed so as permit water to circulate inside it, without being in contact neither with the surrounding environment, nor with the wires of electricity that feeds it. This method was chosen because it is safer, as the electric current will flow only through the active plates of the generator. So as to satisfy this condition (water not to reach the outside environment) it was necessary to tight the entire system. Thus, it was found the most simple and useful solution, i.e., the worn-out chamber used for the truck tires (1), were cut to create rectangular cross-sectioned gaskets as shown in Figure 2.

The generator has five active plates (2) which the current flows into, three of them were connected to the positive terminal of the battery, two of them being connected to the body. The number of plates has been limited due to ergonomic reasons (because of the relatively narrow space in which it was assembled, in the balk of the vehicle).

In the thematic literature it is recommended the positioning of five neutral elements (3) between two active plates. With this view, for the construction of the generator there have been designed blocks of seven slabs, one active, one passive and the rest of them neutral (two consecutive blocks have an active slab in common), so as the 12 volts which supplies the hydrogen cell, coming from the vehicle battery, to divide into 6 (the spaces between the slabs), resulting into 2 volts per slab. Studies have shown that this value of the better intensity, leading to an optimum ratio between the production of oxy-hydrogen and Joule heating. For the building of all slabs of the hydrogen cell, stainless steel of the brand 1.4303/2BII with a thickness of 0.6 mm was used.

In order for the sealing to take place they were used two flanges (5) made of stiplax with a thickness of 10 mm, a very bending-resistant material, which has at the same time, the property of not transmitting electric current. Also, due to being transparent, the material has brought a plus in the appearance of the generator, providing the opportunity to see what is going on inside the cell. As coupling elements there were used a total of 22 screws-nuts, which ensured clamping force necessary to the tightness of the system.

The electronic block (Figure 3) is composed of a power circuit and one of command and control type.



**Fig. 3. Electronic block**

The power circuit is represented by a fuse (it was particularly chosen the value of 20A), three relays (one was not enough, and for the split of the current as evenly as possible, there were used three - safer taking into account the Joule effect), a PWM modulator (to adjust the amount of current that is absorbed by the cell), a shunt, so as to read the amount of current absorbed by the cell, the cell itself and cables with an adequate thickness in order to avoid melting.

The command and control circuit consists of the vehicle contact (which acts the entire electric block), a fan (to maintain a low temperature in the whole electronic block), an ammeter (which measures the current passing through the shunt and the voltage of the block) and a potentiometer (which belongs to the PWM modulator so as to adjust on/off the amount of current absorbed by the cell). The ammeter and the potentiometer were placed in the passenger compartment of the vehicle to ease the adjustment and to get feedback regarding the amount of current absorbed and the voltage of the entire system.

To reduce fuel consumption, it was necessary to change some signals that are sent by the sensors on the vehicle's air pressure, namely the MAP sensor shown in Figure 4.



**Fig. 4. Intake/inlet air pressure sensor (MAP)**

This sensor reads the pressure of the air supply and the car computer (ECU), based on the received data,

decides the amount of fuel to be introduced in the chamber. Basically, it is a well-established correlation, depending on the air pressure and the fuel injected.

We intervened in the signal sent by MAP, changing its value and setting the optimum ratio between the signal variation and the quantity of oxy-hydrogen. This report will be studied and optimized further on, being the main issue of our further coming research.

The bubbler performs several important aspects, related to the safety in using a cell hydrogen production. The bubbler is filled with water, and the solution from the generator is bubbling into it, thus separating the liquid phase from the gaseous phase.

Another important function that it does have, is that it functions as an "anti backfire", making it an indispensable safety system.

The internal combustion engine has been designed to operate with fuel and air mixture. By introducing oxy-hydroxide in the fuel mixture, it will gain more power and the burning will be uniformly produced as illustrated in Figure 5, the values of pollutants resulting from the explosion being quite small.

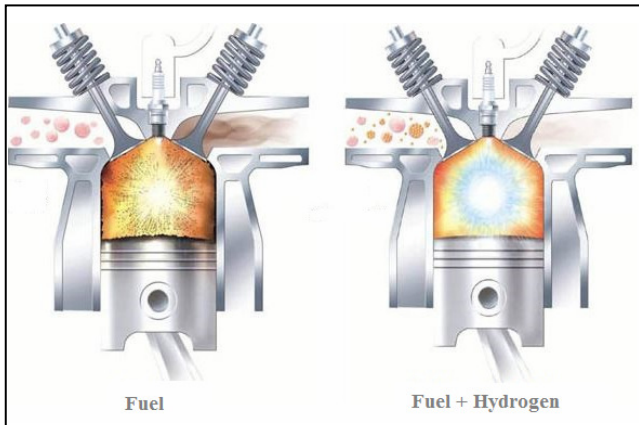


Fig. 5. The combustion chamber of the internal combustion engine, before (a) and after (b) introducing hydrogen [2]

Potassium hydroxide KOH was used as electrolyte, because it leads very well the electric current, it is not corrosive and the efficiency of the hydrogen cell is optimal. Initially, in experiments it was also used the cooking salt NaCl, but its presence has enhanced the corrosion phenomenon, attacking the stainless steel plates.

### 3. EXPERIMENTAL RESULTS

In the conducted studies, the opacity value of the exhaust fumes was experimentally determined and its variation diagram was drawn, as shown in Figure 6.

A device for measuring the exhaust gases opacity, called opacimeter of CAP3200 type, was used to determine the values that were displayed in Figure 5. Studies have been conducted on a diesel engine with a capacity of 1998 cm<sup>3</sup>.

The opacity value in the two situations was measured, calculating in each case an average of the resulted values, as follows:

- Before placing oxy-hydrogen,  $K_{average\_fuel} = 2.29 m^{-1}$ .
- By improving the fuel and oxy-hydrogen mixture, hydrogen  $K_{average\_with\_oxy-hydrogen} = 1.76 m^{-1}$ .

where:

$K$  - the opacity of the exhaust gases [ $m^{-1}$ ].

It should be noticed that the opacity and, automatically, the number of carbon particles decreased by approximately 23%.

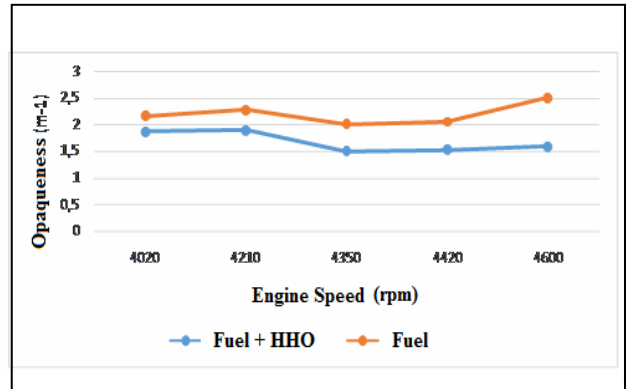


Fig. 6. The diagram outlines the decrease in its opacity by using oxy-hydrogen in the fuel mixture based on the engine speed

### 4. CONCLUSION

In the tests conducted, it was found that the use of the electronic circuit for changing the signal transmitted to the computer of the automobile (ECU) by the supply pressure sensor (MAP) with the use of oxy-hydrogen in the combustion chamber, led to a decrease of 9% of the fuel used for the propulsion of the vehicle, reducing the fuel consumption resulting into reducing its spending.

The use of oxy-hydrogen led to improving the engine efficiency: more power due to the increase of the fuel combustion capacity, as well as achieving a smoother engine.

Moreover, it was discovered the reduction of pollutant emissions due to more complete carbon combustion, a phenomenon that led to the elimination of carbon deposits inside the engine.

### REFERENCES

- [1]. <http://ro.wikipedia.org/wiki/Hidrogen>
- [2]. <http://www.carblog.co.uk/are-ford-cars-easy-to-convert-into-hho-hybrids/>
- [3]. <http://www.scribtub.com/tehnica-mecanica/DEPOLUAREA-MOTORULUI-DIESEL51139.php>
- [4]. [http://www1.eere.energy.gov/hydrogenandfuelcells/tech\\_validation/pdfs/fcm03r0.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/tech_validation/pdfs/fcm03r0.pdf)
- [5]. B. Rever, Renewable Energy World, Review Issue 2001–2002 ed. by James x James, vol.4, no 4, p.177.