

## STUDIES AND RESEARCHES CONCERNING THE POSSIBILITY OF USING HYDROGEN IN TURBO ENGINES

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### Abstract

*The paper aims to study the main aspects related to using Hydrogen as fuel in thermal engines, the advantages and disadvantages of using it as fuel and the technical possibilities of adjusting it, Hydrogen used as supplement at the main fuel and Hydrogen used as working fluid. As a perspective, it can be considered using Hydrogen as thermal agent in a closed energetic flux with thermo-chemical compression of Hydrogen in a hybrid heat changer, based on the heat of burning products of thermal engines. The experiments made showed that using such a way of using the heat of burning products of turbo engines can assure the increase of power and efficiency of the whole installation with 20 %, which make us consider Hydrogen as a viable and advantageous alternative of fuel to be used in turbo engines and other engines.*

**Key words:** efficiency, Hydrogen, turbo engine

### INTRODUCTION

The quest of new sources of energy is one of major importance in our days, due to the situation of classic fuels, which would be exhausted in a near future. Among the new sources of energy, a special attention is accorded to the renewable sources of energy, such as the so called “green sources” of energy, of the wind, the sun, and Hydrogen. Hydrogen is considered to be the energy of the future, because it has very low pollution and the energetic efficiency is very high. In this respect, we studied the possibility of using Hydrogen in thermal engines, because the present engines fuelled with classic fuels are the most pollutant for the environment.

In order to use Hydrogen for turbo engine we must consider some important aspects, which are presented in the following lines.

The development of turbo engines emphasized the necessity of using fuels which fulfill the following basic aspects [2] :

- The powerfull release of heat in a reduced volume, in order to mantain in resonable limits of engine weight and dimensions
- The qualities of anti-pumping, such as the fuel flow to assure a stable burning at very low temperatures

-A very quick and sure start at low temperatures. In the case of a stop, the restart must be easy and sure

-The thermal power of fuel must be as high as possible considering the consumption

-The waste of combustion must not have a harming effect on the engine elements and on the environment

-The fuel must have characteristics which can assure a good stability in functioning

-The fuel must be available in sufficient quantities. This aspect has a special importance and explain the evolution of the last 10 years for fuels

-The fuel price, which counts directly and considerable in companies exploitation rentability to be decreased

The advantages of using Hydrogen are considerable, but the main disadvantage consists in the modifications which are required to the thermal engines, which are fuelled with classic fuels [3].

### MATERIALS AND METHODS

In this section are presented the main ways and particularities of using Hydrogen in turbo engines.

The perspective of using Hydrogen in engines

can be studied in the following hypothesis:

- Hydrogen used as supplement to the main oil fuel
- Hydrogen used as basic fuel
- Hydrogen as working fluid.

### The use of Hydrogen as additive

In the first case researched, Hydrogen is used as additive in the conventional fuel used in the engine usually. In this case, Hydrogen added to hydrocarbons is used in order to improve the exploitation characteristics of engines through [1] :

- Reducing of emissions of pollutant and carcinogen substances
- The extension of stable functioning zone of the burning chambers in the case of cooling the mixture fuel- air



Fig.1. The engine fuelled without Hydrogen compared to the engine with Hydrogen intake

In Fig. 1, in the left side is presented the classic engine and in the right side, the engine fuelled with Hydrogen. As we can observe, the power in case of using Hydrogen as fuel is 90 %, compared to 60 % in the case of classic engine. Also, the fuel consumption at 100 km is much lower in the case of using Hydrogen.

- The increase of economy and durability of the engine
- The consumption reducing of traditional hydrocarbons

In order to calculate the equilibrium composition of the dissociated burning products are usually used the following hypothesis:

- the burning products represent an ideal burning fluid which is obeyed to the state equation of the ideal gas and is in energetic, chemical and phase equilibrium

- the components enthalpies of the dissociated mixture, their specific heat and the equilibrium constants do not depend on pressure

- the burning is adiabatic and stationary, being characterized through the homogeneity of parameters in cross section of burning chamber and the complete release of heat.

## RESULTS AND DISCUSSIONS

### The use of pure Hydrogen

The use of Hydrogen as fuel in turbo engines allows to be realized compact burning chambers with more uniform thermal field at exit. At a given engine power, the function with Hydrogen is characterized through much more reduced values of gases temperature in the turbine, as a result of a much higher specific heat of gases, compared to the functioning with classic hydrocarbons.

The use of liquid Hydrogen in the cooling systems of the most thermal exposed parts can afford the substantial increase of the maximum temperature of gases in front of the turbine and the reducing of fuel. The Hydrogen burning is characterized through a reduced capacity of radiation and the absence of soot, which means that in the exploitation conditions characteristic to engine is not deteriorate in time and the life spam, compared to the functioning with hydrocarbons increases.

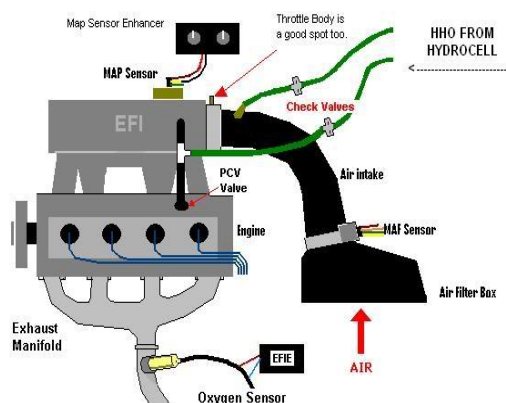


Fig.2. The scheme of engine fuelled exclusively with Hydrogen [4]

### The use of atomic Hydrogen

The biggest traction of the engine can be

obtained through the chemical energy of free radicals of the substances which are in instable chemical state. The molecules dissociation in free radicals leads to energy absorption. The atomic Hydrogen is an accelerator of chemical reactions, and in particular of the fuel oxidation reactions with Oxygen.

In present, the obtaining and maintaining of atomic Hydrogen with high concentration and in big quantities represents a very difficult technical problem.

### The use of Hydrogen as thermal agent

As a perspective, Hydrogen can be used as a thermal agent in closed energetic stream with the thermo- chemical compression of Hydrogen in a hybrid heat changer, based on the heat of burning products of thermal engines. The experiments showed that the use of such a way of using of the heat of burning products of turbo engines can assure the increase of power and the economy of the whole installation with 20 %.

If we look at using Hydrogen as fuel from the efficiency point of view, regarding the profitability and cost [6], [7], we will find that Hydrogen is a good choice.

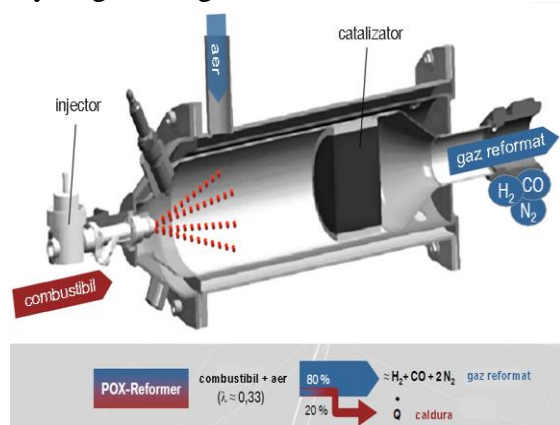


Fig.3. Heat recover from the rear bumper gases [5]

## CONCLUSIONS

### Achievements and perspectives

The main problems related to the use of Hydrogen as fuel are the engine adaptation and the assuring of service.

The first problem displays the following aspects:

A first advantage is that at equal volumes,

Hydrogen weights 10 times less than gasoline, which is an important factor to be considered.

- Hydrogen is an ideal fuel, which does not request but minor modifications to the existent engines. Such engines will have a life spam with 25 % longer than that of the present engines, needing with 25 % less time of maintaining

- Hydrogen has a burning temperature bigger than gasoline and thus has the possibility of obtaining bigger power

- Hydrogen presents the advantage that can be also used as a cooling agent of engine and of heated parts

- The main advantage of using Hydrogen as fuel in turbo engines is that it removes almost completely the environment pollution, compared to the pollution produced by the oil fuels.

Considering these aspects exposed above, Hydrogen can be a competitive fuel both from the efficiency point of view and the environment friendly fuel point of view. That is why the researches on using Hydrogen as future fuel are worth to be continued.

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