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(Research article)

Performance & Improvement of the Hydrogen Engine

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Abstract

This paper brings out the performance of the "hydrogen engine". The onset of increase in the automobile led to exploitation of fossil fuels, which results in environmental problems such as pollution. Due to constant increase in depletion of fossil fuels and its consequent effect on the environment and ecology. A hydrogen engine vehicle is an automobile, which uses hydrogen as its primary source of power. There is no change in the operation of vehicle; it works like a traditional gasoline engine. The specialized fuel injection system is to be needed.

Keywords: *Hydrogen engine, Performance, Emission*

1. Introduction

The world reserves of fossil fuels are getting depleted, and the experts expect they will be exhausted in the 2nd half of the 21st century. In view of the incessant decrease of the reserves and limited capacity of the world source of petroleum the world prices are going on increasing. This leads to production of energy will be expensive. The automobile industry solves two basic and contradictory problems, concerning the useful value of the vehicles (output, price, effectiveness) and the questions that are of interest to the whole society(pollution of the atmosphere, noise, waste products in combustion). The above two problems solve by employing hydrogen as fuel. This paper presents detailed information on hydrogen engine and its emissions and benefits also.

1.1 Combustion properties of hydrogen

The properties that contribute to its use as a combustive fuel are its Wide range of flammability, Low ignition energy, Small quenching distance, High auto ignition temperature, High flame speed at stoichometric ratios, High diffusivity, Low density. Hydrogen engine can run on A/F ratios of 34:1 to 180:1.

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1.2 Fuel delivery system

Fuel delivery system mainly classified into three types
Central injection system
Port injection
Direct injection

1.2.1 Central injection system

This is the simplest method of delivering fuel to hydrogen engine by a Way carburetor. This injection system forms the fuel air mixture during the intake stroke. The injection is at the air intake manifold. This is more advantageous a hydrogen engine. It need not require the hydrogen supply pressure is as high as other methods. Carburetors are used on the gasoline engine, so convert a standard gasoline engine to a hydrogen engine. But there is a chance of pre ignition.

1.2.2 Port injection system

In this fuel delivery system injects the fuel directly into the intake manifold at each intake port. In port injection, the air is injected separately at the beginning if stroke to dilute hot residual gases and cool the hot spots. So pre ignition is less severe. But inlet supply pressure is higher for a central injection system. The port injection system also sub classified as

1.2.3 Direct injection system

More sophisticated hydrogen engines use direct injection, which directly inject the fuel into the combustion chamber during compression stroke. This system completely avoid pre ignition. By this injection the power output is 20%more than gasoline engines.

2. Engine design

The most effective means of controlling pre-ignition and knock is to redesign the engine for hydrogen use, specifically combustion chamber and cooling system. A disk shaped combustion chamber (with a flat piston and chamber ceiling) can be used to reduce turbulence with in the combustion chamber. To accommodate the wide range of flame speeds that occur over a greater range of equivalence ratios, two spark plugs are needed. The cooling system must be designed to provide uniform flow to all Locations that need cooling. Additional measures to decrease the probability of preignition are the use of two small exhaust valves as opposed to a single large one, and the development of an effective scavenging system, that is, means of displacing exhaust gases from the combustion chamber with fresh air.

2.1 Ignition Systems

Due to hydrogen's low energy limit, ignition of hydrogen is easy and gasoline ignition systems can be used. At very lean air/fuel ratios (130:1 to 180:1) the flame velocity is reduced considerably and the use of dual spark plug system is preferred. Ignition systems that use a waste spark system should not be used for hydrogen engines. These systems energize the spark each time is at the top dead centre whether it is in compression stroke or in exhaust stroke. For gasoline engines waste systems work well and are less expensive than other systems. For hydrogen engines waste spark plug are source of preignition.

2.2 Crankcase ventilation

Crankcase ventilation is even more important for hydrogen engines than for gasoline engines. As with gasoline engines, unburnt fuel can seep by the piston rings can enter into the crankcase. Since hydrogen has a lower energy ignition limit than gasoline, any unburnt hydrogen entering the crankcase has greater chance of igniting. Hydrogen should prevent from accumulating through ventilation. Ignition within the crankcase can be just a starting noise or result in engine fire. When hydrogen ignites with in the crankcase, a sudden pressure rise occurs. To relieve this pressure, a pressure relief valve must be installed on the valve cover. Since hydrogen exhaust is water vapour, water can condense in the crankcase when proper ventilation is not provided.

3. Thermal efficiency

The theoretical thermo dynamic efficiency of an Otto cycle is based on the Compression ratio of the engine and the specific heat ratio of the fuel.

ç=1-(1/r) ^ã-1

Where r =compression ratio and ã =specific heat ratio

The higher compression ratio and specific ratio, higher will be the indicated thermodynamic efficiency of the engine. The compression ratio limit of an engine is based on the fuel's resistance to knock. A lean hydrogen mixture is less susceptible to knock than conventional gasoline and therefore can tolerate higher compression ratios. The specific heat ratio is related to the fuel's molecular structure. The less complex molecular structure, higher the specific heat ratio. Hydrogen has a much simpler molecular structure than gasoline and therefore its specific heat ratio is higher than that of conventional gasoline. In case of single cylinder hydrogen, spark ignition engine, the break thermal efficiency is 45%.

4. Emissions of the Hydrogen Engine

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

$2H_2+O_2=2H_20$

The combustion of hydrogen with air however can also produce oxides of nitrogen (NOx)

$H_2+O_2+N_2=H_2O+N_2+NO$

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

- Air/fuel ratio
- Engine compression
- Engine speed
- Ignition timing
- Emissions of hydrogen engine Emissions of gasoline engine

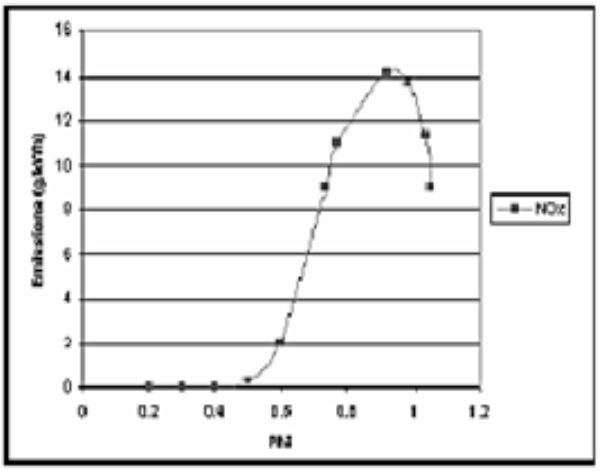

Fig.1 Emission of Hydrogen Engine

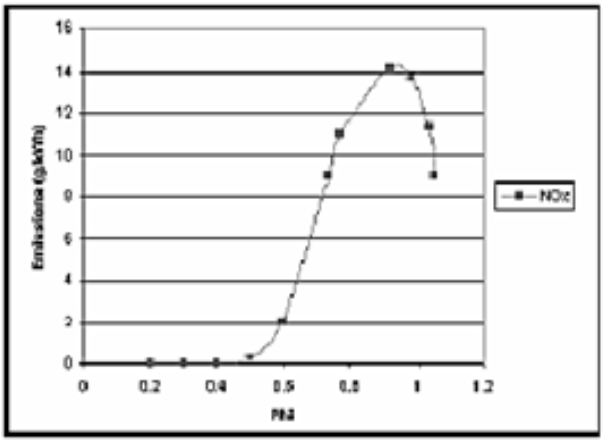

Fig.2 Emission of Gasoline Engine

4.1 Power output

The theoretical maximum power output from a hydrogen engine depends on the air/fuel ratio and fuel injection method used. The stoichiometric air fuel ratio of hydrogen is 34:1. At this air/fuel ratio, hydrogen will displaces 29% of the combustion chamber leaving only 71% of space for the air. As a result, the energy content of this mixture will be less than it would be gasoline. If hydrogen engine is operated with a central or port injection system the maximum power output is limited to approximately 85%of the gasoline engine. For direct injection system, which mixes the fuel with air and injects directly into the combustion chamber, the maximum power output is 15%more than the gasoline engine. Depending upon the type of fuel injection system the power output limited to 15%more or less than the gasoline engine at stoichiometric system. At stoichiometric air/fuel ratio the combustion temperature is very high as a result it will form a large amount of nitrogen oxides (NOx), which is a criterion for pollutant.

Advantages

1. The elimination of pollution caused by fossil fuels. It not produces any carbon dioxide pollutants. So there are no greenhouse gases.
2. Highest flame velocity & low ignition energy.
3. Better all-around engine performance, more mileage per given weight of fuel, i.e. 15 – 28%of increase in mileage.
4. The calorific value of hydrogen is more than other fuels like gasoline, diesel.
5. The hydrogen can be produced anywhere that we have electricity and water.

Disadvantages

1. The hydrogen needs 4 times the volume for a given amount of energy.
2. It needs special type of fuel delivery systems.

5. Conclusion

In piston combustion engine, combusting hydrogen as the source of renewable energy can be used. It is a very good alternative of ecological drive of vehicles. The concept of injecting the gas fuel into the cylinder of engine directly makes emphasis upon the specific characteristics of hydrogen. The research has confirmed that this concept is feasible. The results of measuring on the single cylinder engine have provided a useful source of information that has been of help in the construction of an engine with several cylinders.

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