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Design and Fabrication of Hydrogen Powered IC Engine

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Abstract

Owing to the depletion of the natural resources, nowadays gasoline has become costlier and its extensive usage makes them exhaust in upcoming years. Due to the strict environmental regulation and to minimize the carbon foot prints, hydrogen is considered as an alternative fuel for automobile. Due to the small quenching distance and high auto ignition temperature, hydrogen is suggested in internal combustion engine as an alternate fuel instead of gasoline. This work discuss about the, modification to be done for running a hydrogen powered engine.

Keywords: Hydrogen; IC engines; Fuel.

1. Introduction

India is a very vast country in terms of area. Hence majority of the people use the various modes of transport which demands more amount of fuel. India is a country which is having less amount of fossil fuel. Nowadays fossil fuel reserves are exhaustible. Thus there is a need for an alternative source where hydrogen is to be used. The hydrogen can be used as a fuel both fuel cell and internal combustion engine. Hydrogen is used extensively in the space program since it has the best energy-to-weight ratio of any fuel. Liquid hydrogen is the fuel of choice for rocket engines. Hydrogen powered internal combustion engines, however, are considered as able to possibly close the gap between a carbon-based and a hydrogen-based economy. An improved operation concerning power, efficiency and emissions compared to conventionally fuelled engines, demands hydrogen as an alternate fuel thereby increases the mobility. Compared to biofuels, the yield of final fuel per hectare of land for different biomass derived fuels, and of hydrogen from photovoltaics or wind power. The results show that the energy yield of land area is much higher when it is

used to capture wind or solar energy. Compared to electricity, using hydrogen as an energy carrier is advantageous in terms of volumetric and energy storage density(Mazloomi and Gomes, 2012).

The attractiveness of hydrogen lies in the variety of methods to produce hydrogen as well as the long-term viability of some of them . Due to the high specific energy, high flame speed, wide range of flammability, and clean burning characteristics, it is suggested for its high performance in internal combustion engines (ICE). The incentives for a hydrogen economy are the emissions, the potentially CO2-free use and the sustainability.

2. Literature Review

Water splitting by electrolysis was a well-known laboratory phenomenon. Otto, in the early 1870s, considered a variety of fuels for his internal combustion engine, including hydrogen. In 1924 Ricardo conducted the first systematic engine performance tests on hydrogen. He used a one cylinder engine and tried various compression ratios. At a compression ratio of 7:1, the engine achieved a peak efficiency of 43%. Several attempts have been made to the effect of using hydrogen in internal combustion engines [1-5]. Das (2000)evaluated the potential of using hydrogen for small horsepower SI engines and compared hydrogen fuelling with compressed natural gas (CNG). Another study dealt on certain drawbacks of hydrogen fuelled SI engines, such as high NO_x emission and small power output determined the performance, emission and combustion characteristics of hydrogen fuelled SI and CI engines(Das,2002). Karim(2000) reviewed the design features and the current operational limitations associated with the hydrogen fuelled SI engine. Li and Karim(2004) investigated the onset of knock in hydrogen fuelled SI engine applications

3. Materials and Methods

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

$$2H_2 + O_2 \rightarrow 2H_2O$$

High temperature combustion fuels, such as kerosene, gasoline, or natural gas, with air can produce oxides of nitrogen, called as NOx emissions. Although these are only produced in small quantities, research has shown that the oxides of nitrogen are more harmful as a greenhouse gas than carbon dioxide. Hydrogen is preferred due to its following properties.

1. Wide range of flammability
2. High auto ignition temperature
3. Small quenching distance
4. High flame speed
5. Low density
6. High diffusivity

The theoretical or stoichiometric combustion of hydrogen and oxygen is given as:

2H2+ O2=2H2O

Moles of H2for complete combustion =2 moles Moles of $O_2$for complete combustion =1 mole.

Because air is used as the oxidizer instead oxygen, the nitrogen in the air needs to be included in the calculation:

Moles of N2in air = Moles ofO2x (79% N2in air / 21% O2in air) = 1 mole of O2x (79% N2in air / 21% O2in air)

= 3.762 moles N2Number of moles of air
= Moles ofO2+ moles ofN2
= 1 + 3.762 = 4.762 moles of air Weight of O2
= 1 mole of O2x 32 g/mole = 32 g Weight of N2
= 3.762 moles of N2x 28 g/mole
= 105.33 g

4. Modifications to be Done

The differences between a hydrogen IC engine and a traditional gasoline engine are the hardened valves and valve seats, stronger connecting rods, a higher voltage ignition coil, fuel injectors designed for a gas, stronger head gasket material, modified intake manifold, having high temperature engine oil. The burning of hydrogen fuel is similar to that of gasoline. Hydrogen cannot be used directly in a diesel (or "compression ignition") engine since hydrogen's auto Ignition temperature is too high.

5. Conclusion

Hydrogen can be used advantageously in internal combustion engines as an additive to a hydrocarbon fuel. Hydrogen is most commonly mixed with high pressure natural gas for this purpose since both gases can be stored in the same tank. If hydrogen is blended with other fuels, it usually has to be stored separately and mixed in the gaseous state immediately before ignition. Hydrogen is a very good candidate as an engine fuel. Appropriate changes in the combustion chamber together with better cooling mechanism would increase the possibility of using hydrogen across a wider operating range. The authors are currently working in the modifications.

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