A Review on Combined Effect of HHO Gas and Compression Ratio on the Performance and Emission Characteristics of Spark Ignition Engine

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Abstract— The reserve of petroleum over the world is limited. It is very important to save petroleum fuels or find some substitutes. The oxygen enriched hydrogen-HHO gas was produced by the process of water electrolysis. Hydroxyl gas was produced by the electrolysis process of different electrolytes (KOH, NaOH, and NaCl) with various electrode designs in a leak proof Plexiglas reactor (hydrogen generator). This review paper presents the concern with the effectiveness of oxygen enriched hydrogen-HHO gas addition on performance and combustion characteristics of a SI engine with variable compression ratio. The effect will be shown on the SI engine of the brake thermal efficiency, un-burn hydrocarbon, NOx emission, carbon dioxide, and carbon monoxide with the use of HHO and a variable compression ratio.

Key words: SI Engine, Electrolysis, Oxygen Enriched Hydrogen-HHO Gas, Performance Characteristics, Electrolyte, Compression Ratio

I. INTRODUCTION

Decreasing supplies of fossil fuels and steadily rising concentrations of atmospheric carbon dioxide concentrations and levels of atmospheric pollutants are some of major challenges to the modern society. The scientific community is addressing these problems by an attempt to replace fossil fuels with cleaner and renewable sources of energy [4]. Hydrogen gas is an example of a renewable energy source that can be used to partially supplement petrol fuel by enriching supply air. Advantages of introducing hydrogen gas include higher net heating value and diffusivity of hydrogen in air when compared to fossil fuels [5]. A more complete combustion can result in the reduction of harmful exhaust emissions such as hydrocarbons (HCs), nitrogen oxides (NOx) and carbon monoxide (CO). In addition, better diffusivity produces a much faster flame velocity that can lead to a better acceleration and torque output from the engine.

II. REVIEW OF LITERATURE

In this paper briefly discusses about the previous work carried out by the researchers in the various fields which are related to the topic and helped one gain to build platform for my work.

Sa'ed Musmar et al(2011)[1] They have used HHO gas in a 197cc single cylinder spark ignition engine. HHO has been introduced as an alternative clean source of energy. They performed their study by varying speed in the range 1000 rpm to 2300 rpm at constant load. Their analysis presented that by using a mixture of HHO, gasoline and air in a single cylinder gasoline engine had led to reduce nitrogen oxide and nitrogen monoxide emission. They also reported about 20% decrease in carbon monoxide emission from engine exhaust gas and also reduction in fuel consumption.

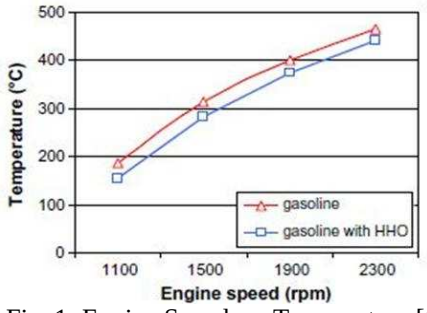

Fig. 1: Engine Speed vs. Temperature [1]

Above Fig.1 the variation of exhaust gas temperature with engine speed. The exhaust gas temperature was almost directly related to the engine speed. Introducing HHO to the intake manifold reduced the exhaust gas temperature.

E. Leelakrishnan et al.(2013)[2] have experimented in his study the performance and emission characteristics of brown gas enriched air in a 100 cc single cylinder air cooled engine at 1500 rpm for various loads. The performance characteristics such as brake thermal efficiency and specific fuel consumption and emission characteristic such as carbon monoxide, Unburnt hydrocarbon, smoke and oxide of nitrogen were studied.

They had concluded that brake power and thermal efficiency for brown gas enriched engine operation givens 5% and 7% higher than conventional engine operation at full load. In this experiment also concluded that total fuel consumption, specific fuel consumption, unburnt hydrocarbon emission, carbon monoxide, oxides of nitrogen and smoke emission for brown's gas enriched operation at full load gives 6%, 11%, 88%, 94%, 58% and 18% lesser than convention engine operation.

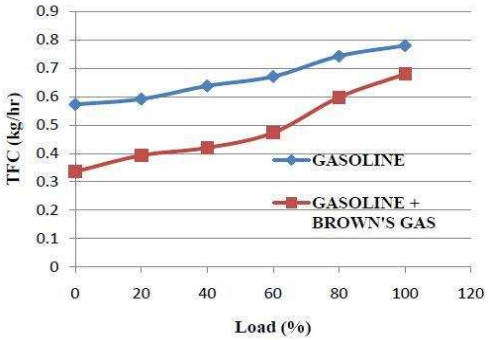

Fig. 2: Load vs. TFC [2]

Fig. 2 the characteristic curves of load with Total fuel consumption for gasoline and gasoline with Brown's gas fueled engines. Graph shows the decrease in Total fuel consumption of the engine for Brown's gas enriched fuel than gasoline fuel.

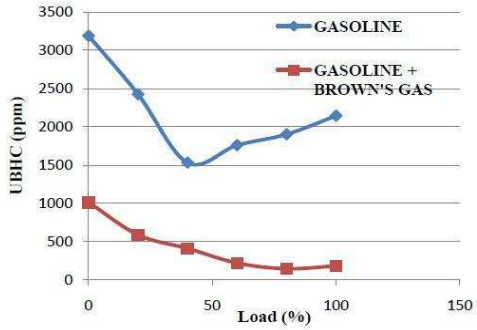

Fig. 3: Load vs. UBHC [2]

Figure 3 the curves between load and Unburnt Hydrocarbons at various loads. It was inferred from the graph that the Hydrocarbon emissions was reduced for the engines operating on gasoline with Brown's gas.

B.Ramanjaneyulu et al.(2013)[3] have experimented in his study the using conventional petrol, LPG, and HHO gas in Hero Honda cd100cc. Their study has shown that the Improved the engine performance in terms of brake power, mechanical efficiency, indicated power and knocking characteristics. They have concluded that the brake thermal efficiency increases and carbon monoxide, unused oxygen, hydrocarbons and smoke reduces with the increase of rice bran oil in diesel-biodiesel blends, the rice bran oil biodiesel can be used as an additive to mix higher percentages of diesel-biodiesel- blends for a diesel engine

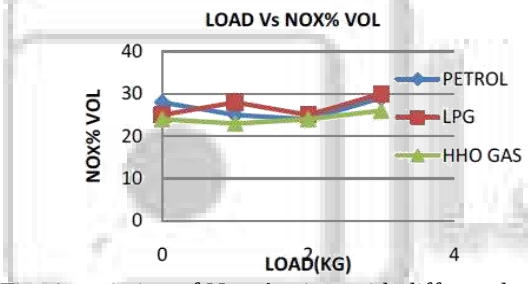

Fig. 4: variation of Nox Against with different load [3]

The percentage of No_X% of volume increases against load in case of LPG only when compared with the HHO and petrol, which is shown in figure 4.

G.Ajay Kumar and G.Vankateswara Rao (2013)[4] in their study performance of characteristics of Oxy-Hydrogen Gas on two stroke petrol engine. They have produce Oxy hydrogen gas by electrolysis process and producer gas by pyrolysis. Three phase AC power source is required for the generation of producer gas using pyrolysis process. Oxy hydrogen gas module requires only 12 V DC supply from the battery. Both the alternative fuel mixed with fresh air before the entering the combustion chamber. BSFC, brake thermal efficiency, speed and load were observed. They have concluded that due to presence of hydrogen in the blend, combustion efficiency increase with both alternative fuels.

Daniel M. et al.(2014)[5] four stroke petrol engine of ford (1490m^3) is used in this study. For test rig engine speed is ranging from 1000 to 3500rpm while check parameters such as the power output, exhaust gas emissions and fuel consumption. They have indicated a decrease in hydrocarbon emissions and an increase in power output with an increase in the HHO gas for certain engine operating conditions. Into the intake manifold HHO 0.45% by volume introduced.

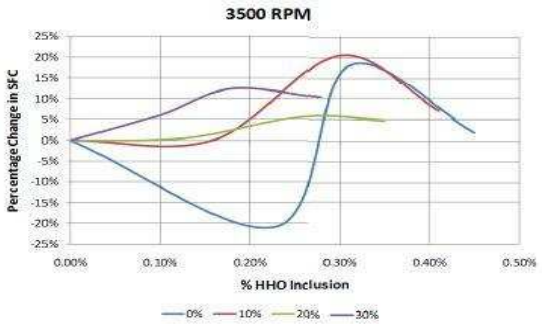

Fig. 5: Effect of HHO at 3500 rpm Specific Fuel Consumption [5]

The SFC is more than 20% lower under 0% load conditions at 0.2% HHO inclusion, which is shown in figure 5.

Pranay N. Patel et al.(2014)[6] experiment on 4 stroke SI engine. With the different electrolyte such that NaCl, KOH, NaOH are used for production of HHO. NaOH is the most appropriate catalyst. This experimental they have study of critical speed 2800 rpm. Under the critical speed (2800rpm) for this experimental study turned advantage of the HHO system into disadvantage for engine torque, carbon monoxide and hydrocarbon emission and specific fuel consumption. The HHO system integrates with engine without any modification increased engine torque, reduced HC and CO emission, reduced in SFC. Hydroxy electronic control unit (HECU) was designed and manufactured to decrease HHO flow rate by decreasing voltage and current automatically by programming the data logger to compensate disadvantages of HHO gas on SFC, engine torque and exhaust emissions under engine speed of 2800 rpm.

Syed Yousufuddin et al.(2012)[7] have experimented in his study the performance and emission characteristics of a Hydrogen Ethanol Fuelled Spark Ignition Engine. This experimental they have investigation to evaluate the exhaust emission characteristics of dual fuel combination of 80% hydrogen and 20% ethanol at varying equivalence ratio, at the variable compression ratio of 7:1, 9:1 and 11:1 with 1500 rpm.

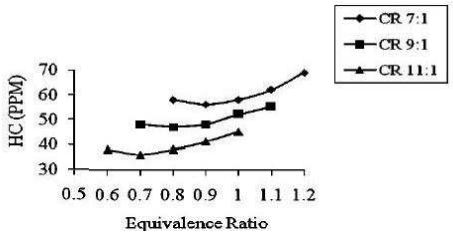

Fig. 6: Fig HC vs Equivalance Ratio (80% of Hydrogen) [7]

In a figure 6 The percentage reduction in HC emission at an equivalence ratio of 1.0 when the compression ratio was increased from 7:1 to 11:1 was around 22.4%.

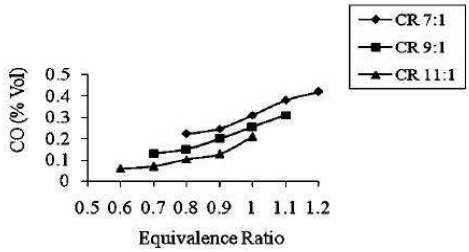

Fig. 7: Fig CO vs Equivalance Ratio (80% of Hydrogen) [7]

In a figure 7 The percentage reduction in CO emission at an equivalence ratio of 1.0 when the compression ratio was increased from 7:1 to 11:1 was around 32.58%.

III. CONCLUSION

From this study, shown that the effect of the operating parameter, compression ratio on the Spark ignition engine.Also shown that the effect of using hydrogen as a supplementary fuel in the engine.

For the complete combustion of petrol fuel, the brown's gas(HHO) was helped. HHO gas was reduced the release of harmful gas. These papers are studied various methods of hydrogen production.

The compression ratio increasing until the certain limit increases brake power and brake thermal efficiency, deceasing specific fuel consumption and decrease emission of carbon oxides, oxides of nitrogen and unburnt hydrocarbon.

From this study will investigate the combine effect of HHO gas and various compression ratios on petrol engine.

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