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Effect of HHO gas on combustion, emissions and performance of an S.I. Engine: A Review

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Abstract

This research paper is about study related to HHO generator and its implementation on S.I. Engine. With increasing petrol prices & depletion of its sources, it's harmful environmental effects. To deal with these researchers are working on alternative and supplementary fuels. HHO gas can be used as supplementary fuel with petrol to reduces consumption of petrol. This technology can be directly be used in present engine without any major changes in engine. It's effects on engine performance, fuel consumption and environmental effects are investigated by researches.

Keywords: *HHO, electrolyte, electrode, brown gas, emissions, BHP, torque, HHO generator.*

INTRODUCTION

HHO gas also called BROWNGAS. It contents two parts of hydrogen and one part of oxygen. It can be obtained by electrolysis of water. Using HHO as additive to petrol we can take advantage of properties of both fuels. There are two types of electrolysis units called WET CELL & DRY CELL. Electricity for electrolysis is taken from external sources. Hydrogen flame speed is five times more than speed of any other hydro car-bon fuel speed, which helps in reduction of combustion periods. Hydrogen is more diffusive so more efficient air fuel mixture is obtained. Hydrogen auto ignition temp is approx 858K. HHO gases can also combust with lean mixtures, which means more oxygen in the engine. HHO gas reduces peak combustion temp which helps in NOx reduction. Lower ignition temperature also helps to easily cold start an engine. Hydrogen has diffusion coefficient of 0.61cm2/s, adiabatic flame speed around 237cm/s, flame range limit of hydrogen is around 4.1%-75% by volume. Using hydrogen we can obtain better fuel economy and more complete combustion

LITERATURE

Andrea, Henshaw & D.S.

used 570cc 4S petrol engine, 20HP, compression ratio 8.5.they supplied air which was a mixture of 98% air & 2% hydrogen by volume, and then this was mixed with petrol [1]. According to them hydrogen should be less than 4% by volume of air supplied to engine to prevent self-ignition of gas mixture. Hydrogen fuel cell pressure was 2 psi. They observed increase of torque from 0.4-1 Nm for 1% hydrogen supply & from 1-5Nm increase in torque for 2% supply of hydrogen [2].

Sudarmanta, Farsopuspito & Sungkono

used Sinai 20 engine, 2clyinder 4S 650cc, compression ratio 9,57Nm torque, multiport injection with liquid cooled system. They observed increase in performance such as torque by 6.55%, power by 7.65%, BMEP by 15.50%, decrease in bsfc by 22.06%. They used stainless steel 316L plates as electrode of fuel cell. They connected HHO generator to engine battery as power source for electrolysis [3].

Changwei Ji & Shuofeng Wang
used 1.6L, port fuel injection, 4cylinder, 4S petrol engine by BEIJING HYUNDAI MOTOR they used 0%,3% & 6% hydrogen supply with air through intake manifold pressure 61.5KPa pressure. And for each percent variation of hydrogen petrol will also vary. Spark time was set to 22degree crank angle BTDC [4]. They observed BMEP decreased with increase in hydrogen supply. Brake thermal efficiency without hydrogen is upto 14-26.4%, with 3% hydrogen its around 27-28%, and with 6% its around 29.2%-31.6%. there is reduction in exhaust gas temp with increase of hydrogen content. In cylinder pressure reaches its peak value with a quicker rate. Using 6% hydrogen reduces HC emissions by 45-50% than that of original engine [5].

Hameed, Nassem, Nasir, Faiz & Sajid
used a 70cc 4S HONDA Atlas engine, Compression ratio 8.8 they supplied 0.47 LPM of hydrogen gas to the engine. They observed HC emissions reduced by 39.9, carbon monoxide by 53%. They also found that HHO generator can be easily used for any carbureted engine [6].

Pratik, Piyush & Prof.Deshmukh
used Crompton Greaves MK, 256cc engine, Compression ratio 7. Engine was operating at 1500 rpm, fuel cell was gas given supply by 12V DC supply [7]. Current was varied at1amp, 2amp, 5amp& 6amp. They found CO emission reduced by 38.8%, HC emission reduced by 40.27%. They observed. They also observed reduction in combustion period [4].

Ammar & Al-Rousan
used a 197cc air-cooled engine. They designed HHO generator for their engine. Testing was done at 1000-2500 rpm [8]. They observed increase in brake thermal efficiency by 3%-8%. 20%-30% reduction in primary fuel consumption. Exhaust gases temperature also reduced [9].

Leelakrishnan & Suriyan
studied the effects HHO gas enriched air on performance of single cylinder engine [10]. The carburetor is modified to allow proper mixing of HHO gas with air. She observed 5% increase in brake power, 7% increase in thermal efficiency of engine, 88% reduction in amount of un burnt hydrocarbon, 94% reduction in CO& 54% reduction in NOX. This value was obtained at full load [9].

N Patil, C Chavan, A More, P Baskar
used HONDA GX-160CC engine , 4 stroke, water cooled, 4.68Hp at 300 rpm . Stainless Steel 304 was used as electrode of HHO generator [11]. Plates were arranged in4 pairs of electrodes. Gap of 1.6 mm was maintained between them. Water + KOH were used as electrolyte. 12 volt supply was given to HHO generator [12]. On testing, they observed 2.36%-10.801% increase in brake thermal efficiency; by vary current from 6A-9A. Fuel consumption was decreased by5.41% to 10.83% [11].

Shashikant Jhadav
used a 250cc S.I. Engine, 4strkoes, and single cylinder. Speed was kept constant, load was varied .HHO generator was given 12volts supply and variable current from 1-3Amps. Results were recorded at 3Amps [13]. He observed reduction in fuel consumption about 18.87%, brake thermal efficiency was increased by 3.72%, HC emissions reduced by 28.33%, CO emissions were reduced by 1.42%. They said the main reason presence of oxygen in HHO gas leads to more clean and complete combustion [14].

Shivaprasad K V
used high speed petrol engine. He supplied engine with various hydrogen and petrol blends and studied its effects on engine performance. He used com-pressed hydrogen from storage tank for hydrogen gas supply [15]. He modified engine such

that it had two separate injection systems one for petrol and other for hydrogen gas. He used exhaust gas analyzer for check pollutant levels. He performed test at 2000-4000 rpm with constant increase in speed by 500 rpm. He used variable hydrogen gas supply for test like 5%,10%,15%,20%, 25% by volume of engine. He observed slight increase in brake thermal efficiency. HC, CO and NOX emissions were reduced with increase in percent-age of hydrogen. Smooth combustion process was observed [12].

Taun, Khanh, Houng & Tai
used a 100cc petrol engine for test , carbureted single cylinder, compression ratio 9 Test were carried with 3 throttle positions 30%, 50%, 70% with different speed range [16]. HHO was introduced in just after carburetor using injector just before entering intake manifold. HHO gas was in mixture of 1.95% by volume of all. HHO was supplied from storage tanks. They observed increase in engine power by 2,35%-2.78%. They also recorded reduction in Hydrocarbon emission such as CO & C02. Slightly reduction NOX also observed [14].

M. El-Kassaby, A. Eldrainy, E.Khidr & I. Khidr
used dry HHO fuel cell made up of 16 electrodes of 2mm thickness. They used Skoda Felicia 1.3 GLXi1.3 L engine, inline 4 cylinder engine, multi point fuel injection system, compression ratio 9.7, 67.66Hp , 102Nm of torque. HHO generator was connected directly into intake manifold. Engine test speed will be 1500, 2000, 2500 rpm. They recorded rise in thermal efficiency of engine by 10%, the NOX emission was reduced by 15%, CO was reduced by 18%, HC emissions were reduced by 14%. Engine's brake thermal efficiency was also increased [17].

Chiriac, Apostolescu & Dica
used 1.4L petrol engine, 4stroke, 4cylinider, compression ratio of 9.5. Hydrogen is supplied from electrolyser. Hydrogen was supplied at 2bar. Test is performed at two speed 1600rpm and 2500rpm. They observed 7.4% increases in brake thermal efficiency. Net in dictated effective pressure increased by 5.6%. HC, CO emissions were reduced by great extent [8].

Amirul, Nor Hayati, Nik Nur Afiqah & Farrahshaida
used1.6LCAMPRO 4Stroke, engine. HHO gas was supplied by HHO generator having 16 Electrodes of stainless steel 316L, electrolyte used is water +KOH (1% by mass). 12-14.6V is supplied to the HHO generator. Their data showed 18% reduction in consumption of fuel. Emission of CO2 and HC gas also reduced to 15% and 20% respectively. Combustion period was reduced. Thermal efficiency of engine was also increased. Exhaust gases temp was also slightly reduced.

Ali Jemni, Gueorgi Kantchev & Salah Abid
used a 100cc SHX2000 engine-generator, compression ratio 8.5, single cylinder, 4 stroke . HHO is produced from HHO WET CELL of size 2.5L, electrolyte used is a water + KOH. Engine load is kept be-tween 0-1.5KW. They observed 26.5%-34.6% reduction in HC emission. CO emission was also reduced by 32.1%-45.9%. CO2 was reduced by 13.6%-27.3%. Brake specific fuel consumption was decreased by 14.5% [13].

F.Yuksel & M.A. Caviz
used a modified FORD MVH-418, 4Cylinder, compression ratio 10, water cooled engine. Hydrogen is supplied from cylinder. Speed range is from 4500-1000 rpm. It's changed in steps of 500 rpm. Hydrogen flow rate 0.129, 0.168 & 0.208 kg/h. hydrogen supply increases air ratio by13.81%. Heat loss in cooling water

and unaccounted losses are reduced by 36% and 30% [16].

CONCLUSIONS

1. For carbureted engine we can easily connect HHO generator to the engine for HHO gas
2. supply without any major changes.
3. HHO gas can also be supplied from storage tanks.
4. There is increase in brake thermal efficiency of the engine to great extent.
5. Primary fuel (petrol) consumption also reduces.
6. For engine with fuel injection system we can also add a additional injection system for hydrogen, but for that changes have to be made in ECU of the vehicle
7. There is reduction in emissions of CO, HC, CO2 & NOX .
8. Smooth combustion will take place even with lean mixtures
9. HHO generator can of two types Wetcell & Drycell
10. 9. Electrode generally used is Stainless Steel 316L and electrolyte used is water +KOH.
11. This method can be used for any petrol engine i.e. from single cylinder to mutli cylin-der. Its can be used for both carbureted as well as injection fuel system.
12. Electrodes and electrolyte must me changed after a certain period of time

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