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EXPERIMENTAL INVESTIGATION TO DETERMINE THE EFFECT OF HHO BOOSTER ON THE PERFORMANCE OF A TWO WHEELER

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ABSTRACT

This paper presents the recent development of low temperature, fuel cells having high efficiency with better environmental performance leading towards an excellent potential as a future source of energy for all category vehicles. Electrolyte materials in the fuel cell functioning at low temperature (700°C) undergo interfacial reactions with adjoining cell components after continuous and extended operation. The Problem is that the present fuels are not renewable biofuels and their burning results a net increase of CO_2 accumulation in the atmosphere accompanied by toxic by-products. It's aims at an experimental investigation of hydrogen blending by deployment of an Oxy-Hydrogen (HHO) booster in a two wheeler, which involves production of hydrogen from distilled water and blending it with air-fuel mixture through carburetor for improvements. Mileage test has been conducted at 1500 rpm and variations in performance like mechanical, volumetric, thermal efficiencies and emission characteristics due to deployment of HHO booster have been investigated.

KEYWORDS:Hydrogen,Biofuel,Emission,HHO Booster,Mileage Test & Electrolyte

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Original Article

INTRODUCTION

Hydrogen fuel cell vehicles (FCVs) utilize hydrogen produced by nuclear or renewable power to split water molecules as a zero-emission option being prohibitively expensive. Batteries have become a crucial challenge for electric powered transportation. Electrolysis produces hydrogen from water rather than gasification of coal and thermo catalytic decomposition (cracking) of methane or hydrocarbons inspite of being an energy-intensive way. Oxy-hydrogen gases will combust when brought to its auto-ignition or self-ignition temperature. Hydrogen has been blended by a deployment of a hydrogen cell into a two wheeler, leads to the production of hydrogen from distilled water and blending it with the air-fuel mixture through the carburettor. Variations in performance and emission characteristics due to the deployment of the cell have been investigated.

After deployment of HHO booster to the two wheeler tests like mileage test, performance test (brake test) &exhaust gas analysis have been investigated. For a stoichiometric mixture at normal atmospheric pressure, auto-ignition of oxyhydrogen gas occurs at about 570^0C (1065 ^{0}F). Oxygen &hydrogen gas can be produced by t electrolysis process of different electrolytes like (KOH) (aq), NaOH(aq), NaCl with different electrode designs in a leakproof plexi glass reactor fueled as a supplementary fuel in SI and CI Engines. Oxygen &hydrogen exhibits brown color in the form of unseparated hydrogen,oxygen generated by the electrolysis process of water. Measurable CO and HC emissions originating from fuel cells fall below the emissions from hydrocarbon-fuelled engines which can be reduced to almost zero with conventional catalysts [V].

Electrolysis of Water

By providing energy from a battery, water (H_20) can be dissociated into diatomic molecules of hydrogen (H_2) and oxygen (0_2) as shown in Figure 1.

Basic Reaction: $2H_2 + O_2 = 2H_2O + 2e^-$

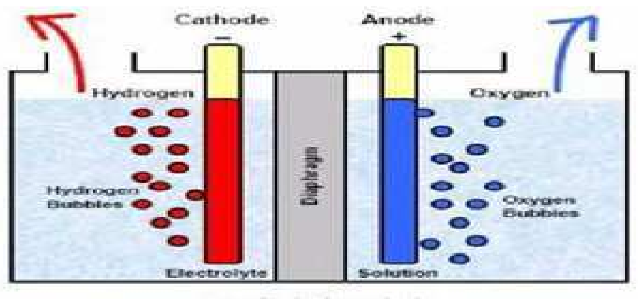

Figure 1: Electrolysis Process of Water for H_2&O_2 [IV]

METHODOLOGY

Working Principle of HHO in I. C. Engine

Hydrogen conversion kits effectively turn the vehicle into a Hydrogen Hybrid by producing and injecting hydroxy gas (HHO) into the vehicle's air intake system. The entire system uses enginevacuum pressure to suck in more oxy-hydrogen gas as the engine speed increases. A water container and electrolyte are placed a inside vehicle to fill it with distilled water. A device gets electricity from the vehicle battery and produces oxyhydrogen gas which is supplied to the engine's intake manifold. Device connects to vehicle battery through ignition switch or other "power on only" input, to prevent oxy-hydrogen gas production when the engine is off.

Oxy-hydrogen gas generated from electrolysis is sucked into the engine's air intake system as shown in Figure 2.

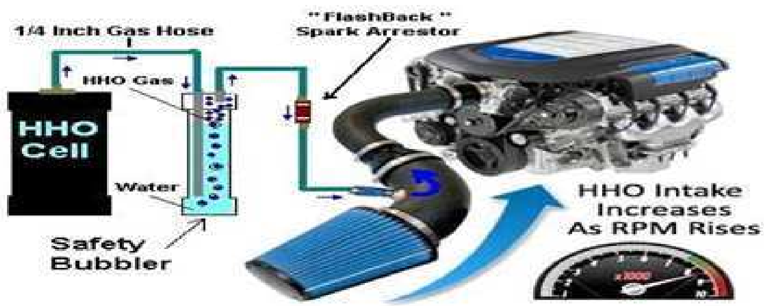

Figure 2: Hydrogen Intake in IC Engine with HHO

The Device by-passes any complication by simply connecting the negative wire to the battery and positive wire to a ignition switch or fuel pump. This ensures that HHO Generator will not activate unless the vehicle is turned on. The entire system is also fully protected by an inline 30 Amp fuse, which will blow to prevent damage to HHO cell.

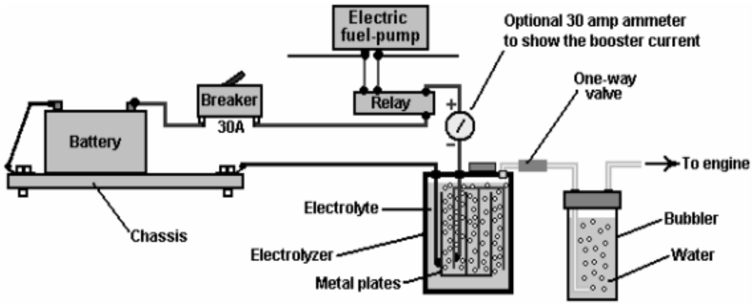

Figure 3: Smack's Booster Line Diagram

It increases the performance of a motorcycle and reduces harmful emissions dramatically with the current from the vehicle's battery to break water into a mixture of hydrogen and oxygen gases called "Oxy-hydrogen" gas. It is then added to the air ,which is being drawn into the engine to improve a quality.

Exhaust Emissions

Products of combustion from I. C Engines contain several constituents like CO, unburned HC (hydro carbons) and oxides of nitrogen (NO_X) that are hazardous to human health.

Testing

Testing has been conducted through the experimentation &mileage test.

Steps of Installation

- Air filter has been removed& a hose pipe is pushed through the air intake duct and pulled out of the air filter duct. Hose pipe reaches the carburetor which passes through air filter.
- Small orifice is made an air filter and hose pipe is pushed through orifice such that there is an interference fit till it reaches the carburettor. An air filter is placed into the air filter duct and closed.
- The other end of the hose pipe is connected to a booster and pushed through the chassis to the desired mounting location of the booster.
- Before mounting, the booster is filled with diluted solution of electrolyte provided alkaline concentrate to 900ml distilled water. This solution can be filled into booster by using a syringe about 50 to 60 ml of electrolyte.
- Booster is mounted to the chassis using a zip tie belt.
- Yellow cable is connected to ignition line and black cable is connected to the negative terminal of battery using a dummy line test if a booster is able to generate HHO gas.
- Now the main hose pipe is connected and the engine is started at 1500RPM

The connections of hose pipe to booster &mounting booster to chassis are shown in Figure 4.& Figure 5.

Figure 4: Hose Pipe to Booster Filled with Diluted Solution of Electrolyte

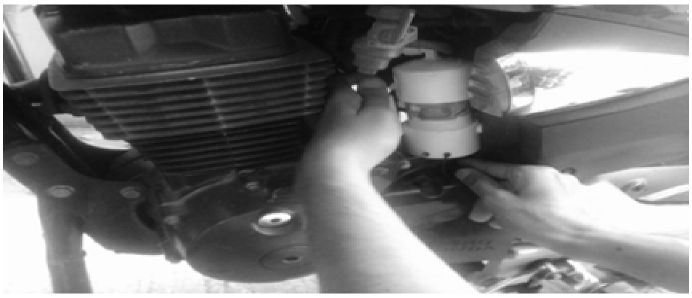

Figure 5: Mounting the Booster to the Chassis Using a Zip Tie Belts

Mileage Test on Road

The driver of vehicle around 75kgweight took the first test drive to explore the test track. After the first test drive, correct amount of fuel supplied has been calibrated and the same amount of fuel is poured into the bottle to reduce vaporization losses. The tests were conducted at constant RPM of the engine starting with 2000RPM and incrementing 1000RPM for every refill of 100ml petrol with booster and without the booster. The booster was refilled with electrolyte just before the tests began so that correct amount of HHO gas is generated. The readings are tabulated as shown in Tables 1,2 &3.

RESULTS & DISCUSSIONS

Total Fuel Consumption (TFC) was raised with brake power without booster, but comparatively reduced by implementation of booster @ 7-15%. Variablites consistently was increased over Brake power &more pronounced at higher brake power, hence HHO implementation improved the TFC characteristics as shown in Figure 6.

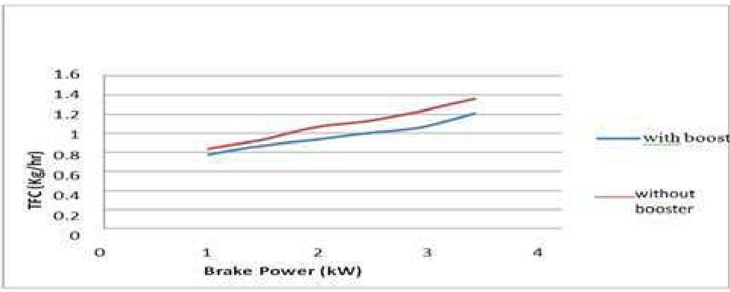

Figure 6: Brake Power Vs Total Fuel Consumption @ 1500 RPM

Specific Fuel Consumption (SFC) was reduced over increase in brake power which was consistent at all loads. Variation was between 7-12%. Hence HHO blending improved SFC characteristics at higher brake power as shown in Figure 7.

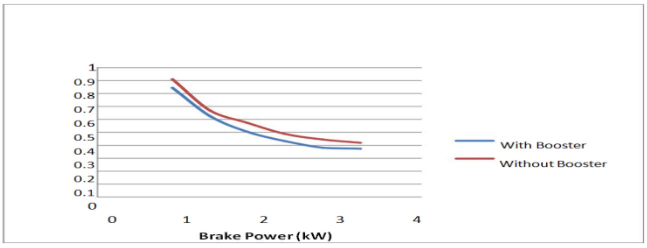

Figure 7: Brake Power Vs. Specific Fuel Consumption @ 1500 RPM

Mechanical efficiency was almost independent of the implementation of a booster. Booster improved only thermal characteristics of the system. Mechanical efficiency followed the standard trend&increased at higher brake power as shown in Figure 8.

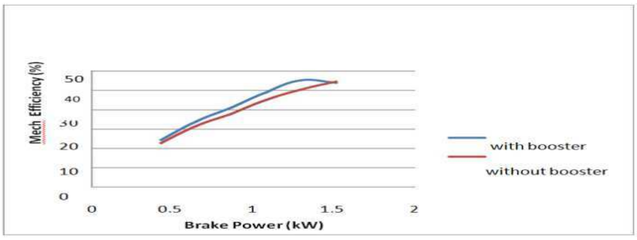

Figure 8: Brake Power Vs. Mechanical Efficiency @ 1500 RPM

Volumetric efficiency was reduced between 2 kw and 3 kw of brake power. Variation was about 7-10%. Implementation of booster further reduced the efficiency. Performance was although unaltered as the booster supplemented some amount of oxygen as shown in Figure 9.

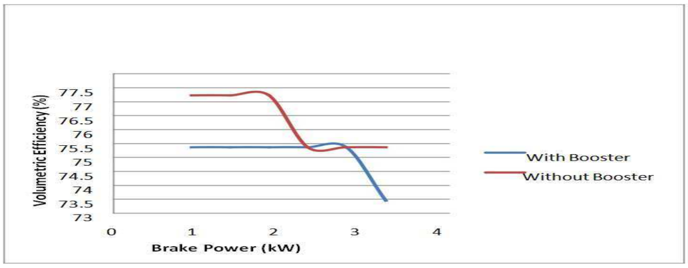

Figure 9: Brake Power Vs. Volumetric Efficiency @ 1500 RPM

Brake thermal efficiency was improved considerably with implementation of the booster for overall brake powers. Variation was between 5-12%. Brake thermal efficiency gradually increased at higher loads as shown in Figure 10.

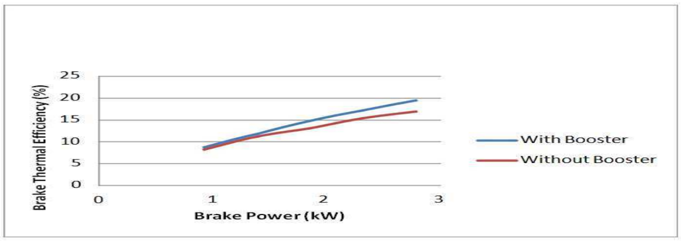

Figure 10: Brake Power Vs. Brake Thermal Efficiency @ 1500 RPM

Indicated thermal efficiency, increased with the implementation of the Booster. Variation was significant over 2 kW of brake power and was between 5-12 %. It was more pronounced at higher loads. Hence HHO blending improveed the indicated thermal efficiency characteristics as shown in Figure 11.

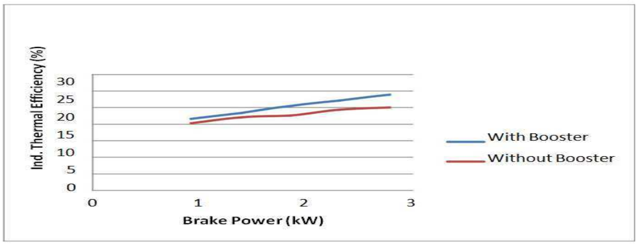

Figure 11: Brake Power Vs. Indicated Thermal Efficiency @ 1500 RPM

Air fuel ratio (A/F) decreased over increase in Brake power. Implementation of the Booster increased the A/F comparatively. Variation was about 5-10%. Increase of A/F ratio that lead to leaner combustion,which was a sign of reduction in fuel consumption resulted in an increase in thermal efficiency characteristics as shown in Figure12.

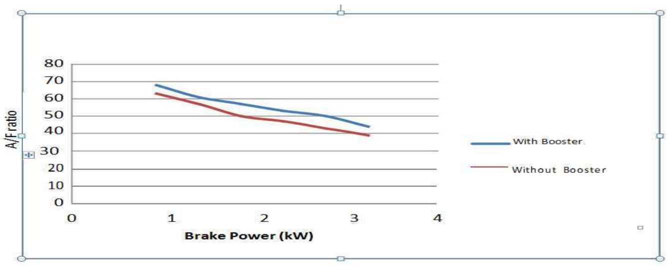

Figure 12: Brake Power Vs. A/F Ratio @ 1500RPM

CO emissions were lowered over brake power with consistent trend where further reduced by implementation of the Booster. The influence of the booster was observed more between 1 kw and 3 kw of brake power as shown in Figure 13.

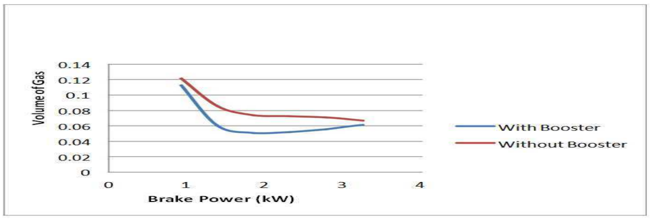

Figure 13: Co Emission Comparison @ 1500 RPM

Increase of NO_x emissions occured over brake power, but implementation of booster reduced NO_x emissions due to leaner combustion due to improvement in A/F ratio at higher loads as shown in Figure 14. [I]

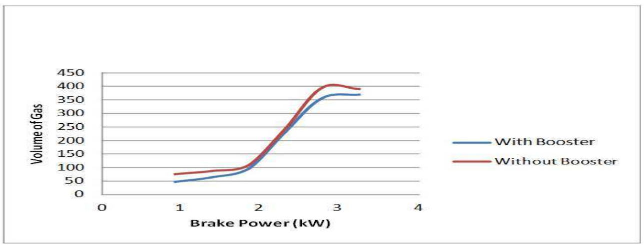

Figure 14: Nox Emission Comparison @ 1500 RPM

CO_2 Emissions were found to be increased from 1kw to 3 kw brake power. However above 3 kw of brake power,the emissions were found to be slightly decreased with booster implementation which was a sign of better characteristics as shown in Figure 15.

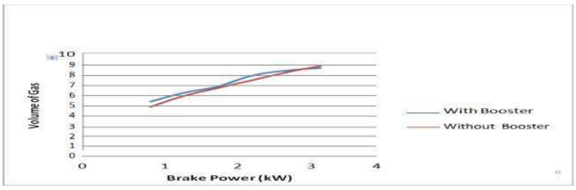

Figure 15: Co_2 Emission Comparison @ 1500 RPM

Unburned Hydrocarbon emissions were reduced with the increase in the load. In this case Booster made very little influence in comparison to the condition without booster. However Unburned Hydrocarbon emissions were found to be reduced in both the cases over the increase of load as shown in Figure 16.

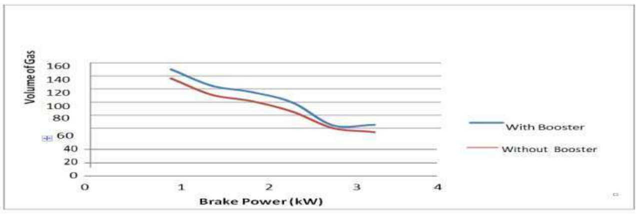

Figure 16: Unburned Hydrocarbons In Emission @ 1500 RPM

Table 1: Mileage Test Without Booster

Sl. No.	RPM	Fuel Qty. (Ml)	Distance (Km)	Mileage (Km pl)
1	2000	100	6.5	65
2	3000	100	5.5	55
3	4000	100	4.7	47
4	5000	100	4	40

Table 2: Mileage Test With Booster

Sl. No.	RPM	Fuel Qty. (Ml)	Distance (Km)	Mileage (Km pl)
1	2000	100	7	70
2	3000	100	6.2	62
3	4000	100	5.4	54
4	5000	100	4.5	45
5	6000	100	3.9	39

Table 3: Percentage Change in Mileage

Sl. No.	RPM	% Change
1	2000	7.69
2	3000	12.72
3	4000	14.89
4	5000	12.5
5	6000	11.42

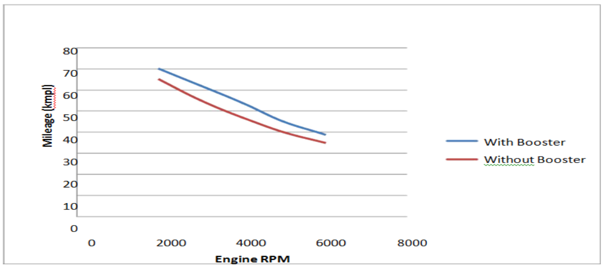

Figure 17: Mileage Test Vs. Engine RPM

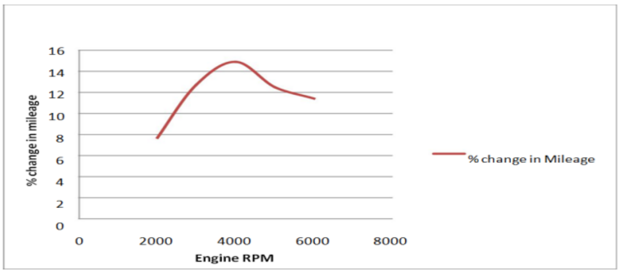

Figure 18: Percentage Change in Mileage

Change in mileage was observed maximum at around 4000 RPM, which was consistent with the CBZ XTREME optimum mileage as specified by the OEM (HERO HONDA). An increase between 8-15% of mileage which reflected a clear picture about the decrease in consumption of fuel as shown in Figure 17 and Figure 18.

CONCLUSIONS

With installation of HHObooster

- Mechanical efficiency remained unchanged, but brake thermal efficiency, indicated thermal efficiency, fuel efficiency and mileage was increased considerably.
- NO_X-CO_2emissions were lowered reasonably.
- A/F ratio decreases over increase in Brake power without booster, but an overall increase of 5-10% was observed with booster implementation which is a sign of reduction in fuel consumption and increase in thermal efficiency.

FUTURE SCOPE

- Implementation of Fuzzy Logic Controller for load variation to fuel cell can be implemented. The chemical activity of fuel cell can also be considered as the other controllable parameter by the Fuzzy Logic Controller.
- Fuel Cell technology is extensible for large scale and small scale standalone systems. Digital controllers for Shunt active power filter, hysteresis current controller using field programmable gate array can be designed as an integral part of standalone modules of fuel cells so as to develop automated fuel cell.
- In future when cost falls down due to development, it can be modeled for use in any size of irrigation system with adequate suction heads.

Electric energy generation from natural gasboth with simple fuel cell plants &integrated gas turbine/steam turbine–fuel cell systems will come up in future. High temperature exhaust gas from Solid Oxide Fuel Cell (SOFC) can be utilized in other cycles, i.e. Rankine, Brayton for additional power generation or for heating purpose (cogeneration/trigeneration)as the consumption of fuel reduces and mileage increase results in lower costs.

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