Research Paper Engineering

Performance Characteristics of Constant Speed Diesel Engine by Using of Hho Gas and Varying Injection Pressure

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ABSTRACT

The demand for the fossil fuels is increasing and their availability is less has so, researchers lead to alternative fuels. The combustion quality was improved significantly when use the better design of CI engine and also, altering the parameter of CI engine hence improves the thermal efficiency and indirectly saving in fuel. As a supplementary fuel uses the HHO gas and the HHO gas was produced by the process of water electrolysis. This paper presents the concern with the effectiveness of HHO gas addition and various injection pressures like 160, 180 and 200 bar effect on performance and combustion characteristics of a CI engine. The effect will be shown on the CI engine of the brake thermal efficiency, fuel consumption, indicated thermal efficiency and mechanical efficiency with the use of HHO and variable injection pressure and measure the effect of performance of CI engine.

KEYWORDS CI engine, Electrolyte, electrolysis, HHO gas, Injection pressure, Performance characteristics

INTRODUCTION

The Diesel engines are mostly used for automotive, agriculture applications, transportation, industrial applications and power generation. Many surviving energy systems are based on fossil fuels (hydrocarbons), particularly crude oil, which is crate environmental pollution and also affect the greenhouse effect. Researchers are looking for many other alternative fuels because of insufficient petroleum fuels, which do not satisfy the customer needs. Different type of alternative fuels such like that biodiesel, karanj and ethanol etc are used with HHO gas and improve the performance of CI engine. So researchers are founding the hydrogen fuel for beneficial for various diesel engines. Hydrogen is a cheaper and never pollutes the environment. Hydrogen is long term renewable, non-toxic and wide range flammability. Hydrogen is an explosive fuel and handles it carefully.

The performance characteristics of diesel engines depends on various factors like fuel quantity injected, fuel injection timing, fuel injection pressure, shape of combustion chamber, position and size of injection nozzle hole, fuel spray pattern, air swirl etc. The fuel injection system in a direct injection diesel engine is to achieve a high degree of atomization for better penetration of fuel in order to utilize the full air charge and to promote the evaporation in a very short time and to achieve higher combustion efficiency [1]. When injection pressure is increasing then automation and vaporization is better so, mixing of fuel and HHO gas is good and hence complete combustion.

HHO GENERATION

A mixture of Hydrogen and Oxygen which is a highly EXPLOSIVE GAS if allow to burn in the open air. When contained in a confined space, detonation of the gas would be highly dangerous and could cause serious injury [2]. Various method of hydrogen production is the reforming of natural gas; gasification of coal and biomass; and the splitting of water by water-electrolysis, photo-electrolysis, photo-biological production and high temperature decomposition. For all hydrogen production processes, there is a need for significant improvement in plant efficiencies, for reduced capital costs and for better reliability and operating flexibility [3].

Electrolysis Process:

This is the simplest method of hydrogen production. It is preferred when cheap electric power, ample water is available and high purity hydrogen is desired. Hydrogen and oxygen are split by electric current from the water. If the electricity is from renewable sources, such as solar or wind, the resulting hydrogen will be considered renewable as well, and have numerous emissions benefits [4].

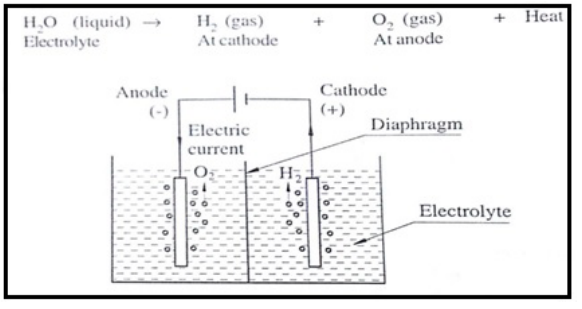

Figure 1 Electrolyte cell [5]

As shown fig., typical electrolyte cell consists of electrodes (nickel plate iron rod- anode and iron plate- cathode) and acid like NaOH or KOH solution in the water as the electrolyte. Direct current decomposes water into H2 and O2 which are released at the cathode and anode respectively. The electrolysis method is the most suitable when primary energy is available as electrical energy [5].

EXPERIMENTAL SETUP AND PROCEDURE

The setup consists of single cylinder, four stroke, engine connected to eddy current type dynamometer for loading. The injection pressure can be varied without stopping the engine. Instruments are provided to interface airflow, fuel flow, temperatures and load measurements. The setup has a stand-alone panel box consisting of air box,

two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and hardware interface. The Rotameters are provided for cooling water and calorimeter water flow measurement. A battery, starter and battery charger is provides for the engine electric start arrangement. The setup enables study of VCR engine performance for brake power, indicated power, frictional power, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, and specific fuel consumption [7].

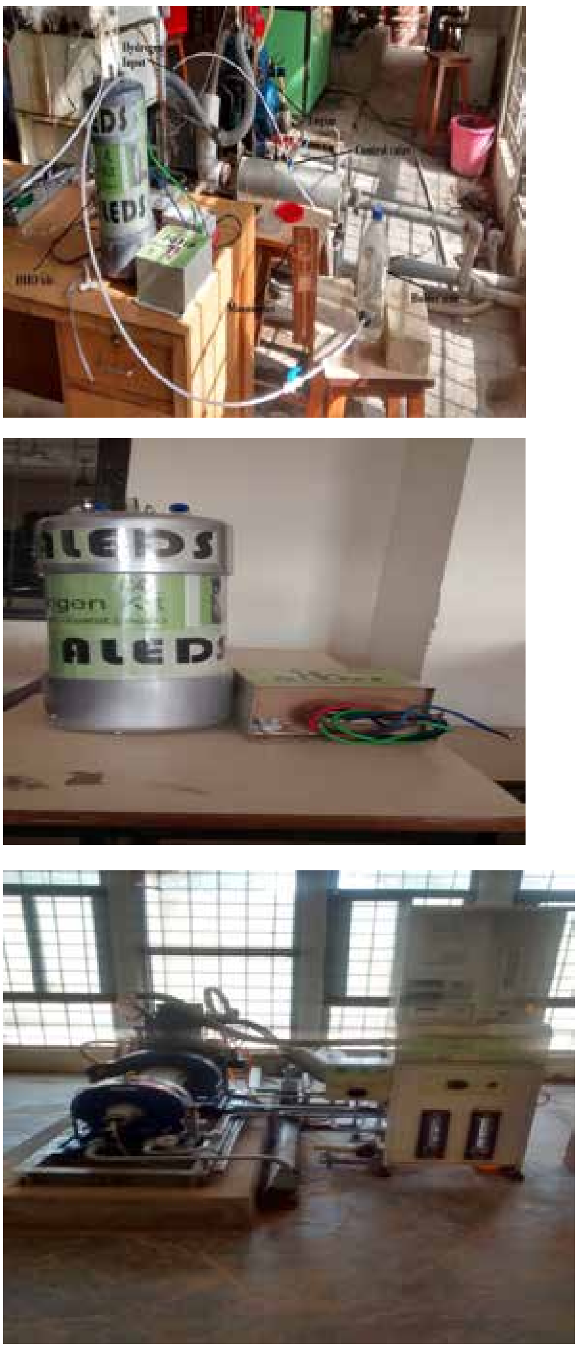

Figure 2 Experimental setup

Table 1 Technical specification of the engine.

No. of cylinder	Single cylinder
No. of strock	4
Cylinder dia.	87.5 mm
Stroke length	110 mm
C.R. length	234 mm
Orifice dia.	20 mm
Dynamometer arm length	185 mm
Fuel	Diesel
Power	3.5 kw
Speed	1500 rpm
C.R. range	12:1 to 18:1
Inj. Point variation	0 to 25 Btdc

Table 2 Technical specification of HHO kit

Electrode (anode- cathode)	316L stainless steel plates
Voltage and current	12 V- 10 A
Electrolyte	NaoH
Reactor container volume	2.5 L

Experimental Procedure:

- Start the engine and wait for the steady state condition.
- Start the HHO kit and wait for hydrogen production and wait for steady state condition of it.
- After the steady state condition, readings are taken for conventional diesel for various injection pressures (180, 160, 200 bar) and loads (1, 3, 5, 7, 9 kg).
- Now, hydrogen introducing with diesel and wait for the steady state condition and constant flow rate of hydrogen.
- And then taken readings for various injection pressures (180, 160, 200 bar) with varying load (1, 3, 5, 7, 9 kg).
- Then, from the reading calculate the performance and plot the graphs.

RESULT AND DISCUSSION

Fuel Consumption

Figure 3, 4, and 5 shows the load Vs. fuel consumption graph which indicate the effect on fuel consumption at 180, 160 and 200 bar injection pressure for diesel fuel and HHO.

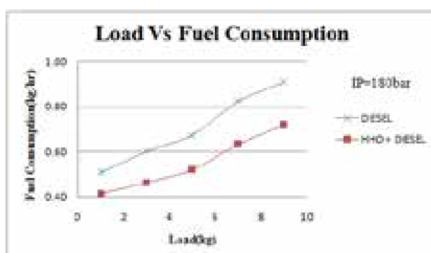

Fig. 3 Load Vs Fuel Consumption at 180 bar

As the load is increased then the fuel consumption increases for DIESEL Engine and HHO+DIESEL Engine. The Fuel Consumption is reduced because of HHO take part in the combustion and also its calorific value is high which help to complete combustion. When injection pressure 180 bar the optimum fuel consumption is decreases because of better mixing of fuel in combustion chamber.

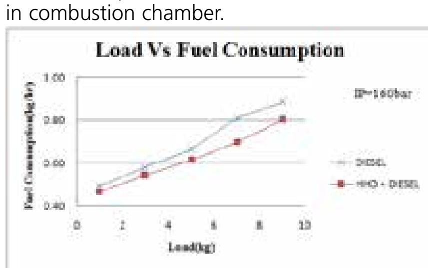

Fig. 4 Load Vs Fuel Consumption at 160 bar

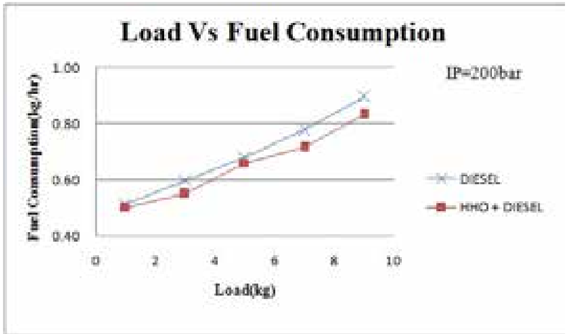

Fig. 5 Load Vs Fuel Consumption at 200 bar

Indicated Thermal Efficiency
Figure 6, 7, and 8 shows the load Vs Indicated Thermal Efficiency graph which indicates the effect on Indicated Thermal Efficiency at 180, 160 and 200 bar injection pressure for diesel fuel and HHO.

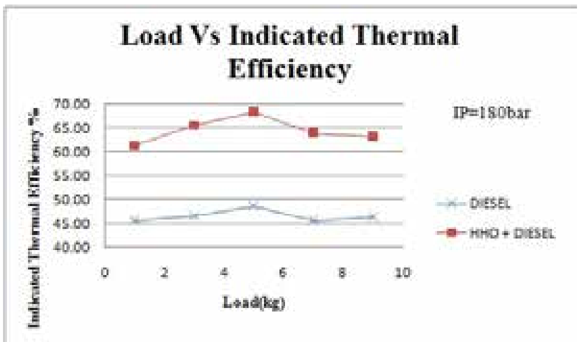

Fig. 6 Load Vs Indicated Thermal Efficiency at 180 bar

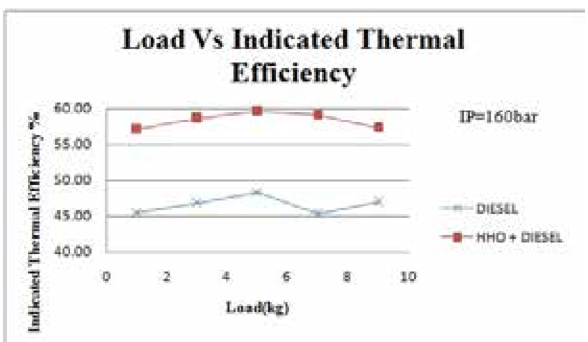

Fig. 7 Load Vs Indicated Thermal Efficiency at 160 bar

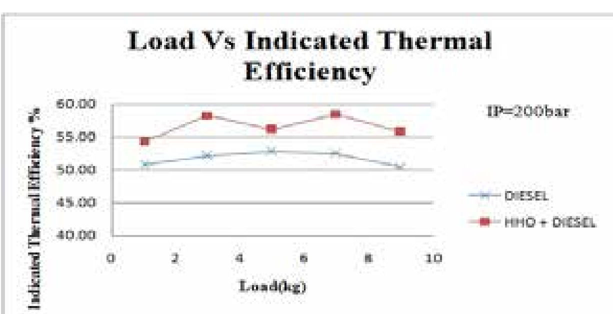

Fig. 8 Load Vs Indicated Thermal Efficiency at 200 bar

When introducing the HHO in diesel engine with constant flow rate, increase in Indicated Thermal Efficiency compared to DIESEL Engine.

As load and injection pressure is increases, drastic change in indicated thermal efficiency which is indicates on above graphs.

Brake Thermal Efficiency
Figure 9, 10 and 11 shows the load Vs Brake Thermal Efficiency graphs which indicate the effect on Brake Thermal Efficiency at 180, 160 and 200 bar injection pressure for diesel fuel and HHO.

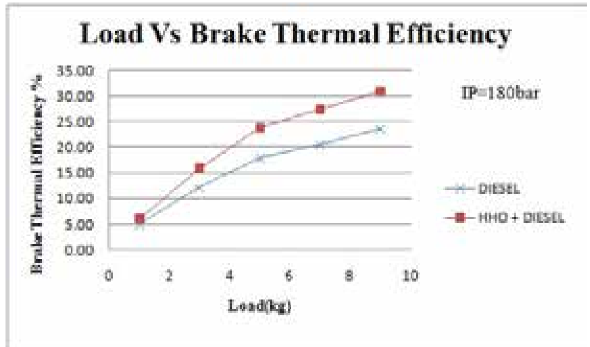

Fig. 9 Load Vs Brake Thermal Efficiency at 180 bar

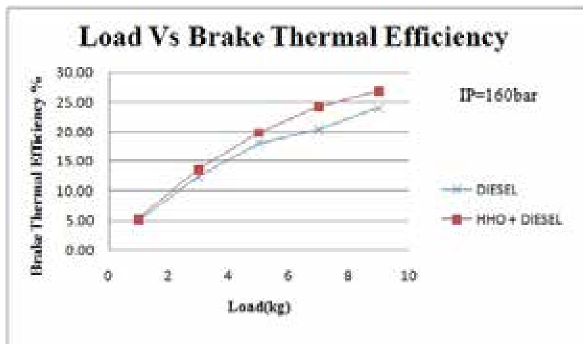

Fig. 10 Load Vs Brake Thermal Efficiency at 160 bar

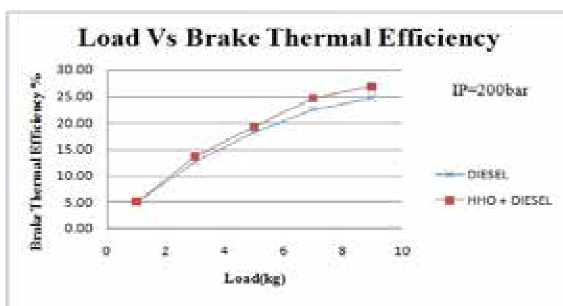

Fig. 11 Load Vs Brake Thermal Efficiency at 200 bar

As load is an increase than the Brake Thermal Efficiency increases for DIESEL Engine and HHO+DIESEL Engine. When introducing the HHO in diesel engine with constant flow rate, in starting load condition, minor change in Brake Thermal Efficiency than more change in Brake Thermal Efficiency as load increase compare to DIESEL Engine.

Brake Thermal Efficiency can be defined as the ratio between the brake power available at the crankshaft of the engine to the heat supplied given to the engine in the form of chemical energy available in the fuel. The increase in efficiency is because of higher-calorific value of hydrogen present in the gas mixture, its high flame velocity and also due to the presence of atomic hydrogen, which results in efficient combustion and higher Brake Thermal Efficiency than a diesel engine [6].

Mechanical Efficiency

In Figure 12,13 and 14 shows the load Vs. Mechanical Efficiency graph which indicates the effect on Mechanical Efficiency at 180, 160 and 200 bar injection pressure for diesel fuel and HHO.

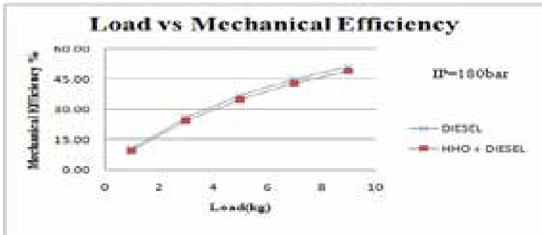

Fig. 12 Load Vs Mechanical Efficiency at 180 bar

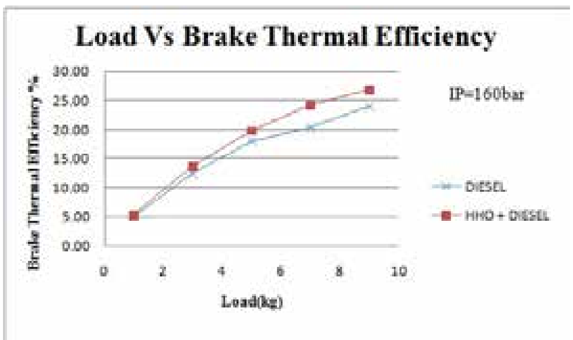

Fig. 13 Load Vs Mechanical Efficiency at 160 bar

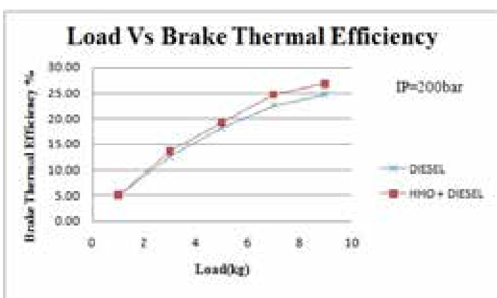

Fig. 14 Load Vs Mechanical Efficiency at 200 bar

As the load is increased then the Mechanical Efficiency increases for DIESEL Engine and HHO+DIESEL Engine. When introducing the HHO in diesel engine with constant flow rate, in starting load condition, no change in Mechanical Efficiency than a minor increase in Mechanical Efficiency compared to DIESEL Engine.

Mechanical efficiency is increased because of indicated power reduce with respect to brake power. As injection pressure increase, indicated power is reduced so, mechanical efficiency increase indirectly. At higher injection pressure, better mixing of HHO gas and diesel so, increase mechanical efficiency.

CONCLUSION

HHO gas is taken for experimental but it is secondary fuel which could help in increase the performance of CI engine. In this experiment HHO gas is take as a secondary fuel with conventional diesel and also change in injection pressure and measure the effect on CI engine.

When injection pressure increase, spry characteristic like that atomization, vaporization and evaporation is better which help in complete combustion and indirectly change in performance.

This experiment measure the effect at different injection pressure 160, 180 and 200 bar.

For 160 bar injection pressure fuel consumption is decrease and drastic change in indicated, brake thermal and mechanical efficiencies.

For 180 bar injection pressure fuel consumption is decrease and indicated and brake thermal efficiencies are increase with increasing in load.

For 200 bar injection pressure fuel consumption decrease in stating load condition then no effect in fuel consumption with increasing in load. Indicated thermal and mechanical efficacies are decrease and increase respectively at 200 bar injection pressure.

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