A Comparative study on Performance and Emission Parameters of Neem oil Biodiesel blends and HHO Supplementing Neem oil Biodiesel blend in a Single cylinder compression ignition engine

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Abstract

Rising environmental pollution and depletion of fossil fuels are pushing the researchers to find alternate fuels which would supplement or replace the conventional fuels used in present days. This work deals with the effectiveness of Oxygen Enriched hydrogen-HHO gas addition on performance characteristics of a CI engine. In this work HHO gas is made to supplement with Neem oil ethyl ester (NOEE). The biodiesel is prepared by the process of Transesterification the biodiesel prepared is ethyl ester. Then it is blended with diesel the blend used is B10,B20,B30 Now these blends are used as fuel and then these blend are supplemented with HHO along with intake air and the performance and emission characteristics are noted. The oxygen enriched hydrogen is a mixture of hydrogen (H_2) and oxygen (O_2) gases. Here the Oxygen Enriched hydrogen-HHO gas was produced by the process of water electrolysis. When potential difference is applied across the anode and cathode electrodes of the electrolyzer, water will be converted into Oxygen Enriched hydrogen-HHO gas. The produced gas was sent into the cylinder along with intake air. The main aim of this work is to study the performance and emission parameters of bio diesel and HHO supplementing biodiesel. The results shows that there was a rise in brake thermal efficiency and lesser fuel consumption when HHO is added with biodiesel and increased NO_X emission and lower HC and CO emission when HHO gas is added with bio diesel.

Key words: Biodiesel, CI Engine, HHO oxygen enriched hydrogen (Oxy hydrogen), NOEE Neem oil ethyl ester, Transesterification,

I. INTRODUCTION

The current situation has developed research interest in less polluting non petroleum and renewable fuels. Use of convectional fuels leads to several issues like environmental degradation and health issues. The increasing industrialization and modernization of the world leads to steep rise in demand of petroleum product. Conventional petroleum based fuels are stored in earth there are only limited resource. So there is an urgent need of finding fuel which can replace the conventional fuel. Reduction in engine emission and improvement of engine performance is a major area where researchers are working it out and another problem is day by day increase of fuel price another reason is the fact that large percentage of crude oil is imported from other countries which control the larger oil fields and another major problem is caused by incomplete combustion. This work deals with effectiveness of HHO gas which is produced from water by the process of electrolysis which can be an dual fuel with Neem oil ethyl ester NOEE biodiesel which is made by the process of transesterification from Neem oil and it is blended with diesel the blend used is B10,B20,B30.

II. BIODIESEL

The best way to use vegetable oil as fuel is to convert it into biodiesel [3].Biodiesel is a most precious valuable form of energy which can be used in a

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conventional engine directly or by blending with conventional fuel like diesel. Biodiesel will be a clean burning fuel and biodiesel does not have any toxic emission like conventional fuel it is safer to handle. Biodiesels are extracted from non edible and edible oils such as Neem, sunflower, pongamia, jathropha, mahua, palm etc. Direct use of vegetable oils or animal fats as fuel can cause various engine problems like fuel clogging, incomplete combustion, very low fuel atomization, deposits of carbon, engine fouling and spoiling of lubricating oil because of higher viscosity of vegetable oil so it is necessary to reduce the viscosity of the oil the effectively to reduce the viscosity of the oil we have used the transesterification method [7].

Figure 1. Biodiesel

A) Transesterification process

Transesterification is the process of breaking down heavier molecule of vegetable oil into lighter ones. Transesterification is the process of obtaining Neem biodiesel from crude Neem oil in the presence of Sodium hydroxide as a catalyst and ethanol. The process was carried in a round flask. Neem oil was heated up to 55^0c to 60^0c for 1 hr 45 min. Sodium hydroxide was mixed completely with ethanol to form Sodium ethoxide. This sodium ethoxide solution was mixed with Neem oil and stirred thoroughly to initiate the reaction 500ml of Neem oil is taken with ethanol 100ml and 5gm of Naoh. The mixture was kept in a rotating agitator at 250 rpm. A reaction period of 24hrs was allowed for the formation of Neem oil ethyl ester and Glycerol as a by-product. The entire mixture was placed in a inverted separating funnel which removes the glycerol and separates the NOEE. NOEEE was washed with 5% distilled water to remove impurities. The properties of esterified NOEE are given in table (1)

Figure.2.Glycerol separation

B) Fuel properties

Table.1. Properties of Diesel, Neem oil and its ethyl ester

Fuel Properties	**Diesel**	**Neem oil ethyl ester**	**Neem oil**
Density (gm/cc)	0.830	0.891	0.921
Viscosity (cst) @ 40^0 c	3.7	6.5	35.83
CV (MJ/Kg)	43	39.21	44.65
Cetane number	48	46	-

III. EXPERIMENTAL SETUP

This experiment investigation was carried out on a single cylinder naturally aspirated four stroke vertical air cooled engine as given in table (2). The engine was coupled to a DC dynamometer as a loading device. A fuel flow meter was installed to measure the fuel consumption. The engine speed was measured using incremental encoder and an orifice coupled manometer was employed for the measurement of intake air. Crypton five gas analyzer was used to measure HC, CO, and NOx. This analyzer is fitted in the exhaust pipe of the engine. NOEE was blended with diesel in 10%, 20% and 30% blend. Performance and emission analysis were conducted in all the above blends with diesel as the base first the engine is made to run with B1O,B20,B30 as fuel. Then with B10, B20, B30 as fuel HHO gas was made to supplement with

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intake air and then performance and emission are characteristics are noted down. The layout the engine is given in fig (4)

A) Engine specification

Table.2. Specification of the Engine

Engine make	**Greaves**
Model no	5520
Engine type	Single cylinder four stroke vertical air cooled
Bore	78mm
Stroke	68mm
No of cylinders	1
BHP	5hp
Compression ratio	18:1
Speed	3000-3600 rpm
Injection timing	260 BTDC

B) Engine layout

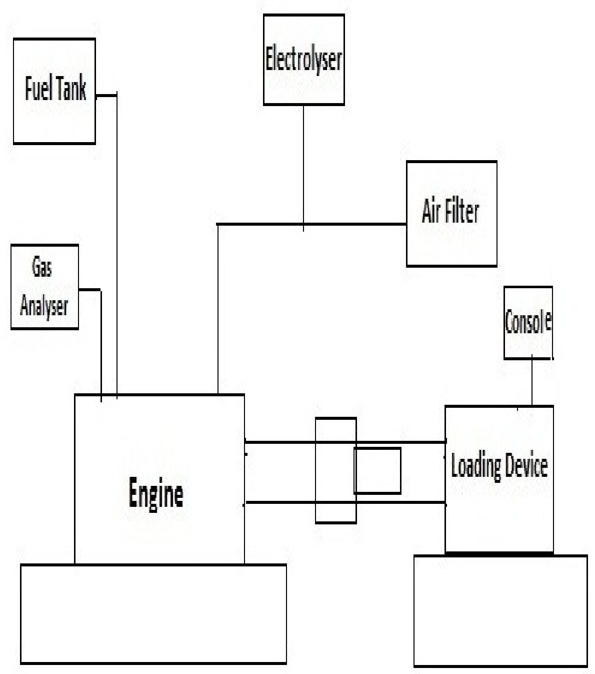

Figure.3. Schematic representation of Engine setup

IV. HHO GAS

Water is a resource which is available in abundant water has hydrogen and oxygen molecule in it.[4] It is in the ratio of 2:1 where hydrogen 2 molecule and oxygen 1 molecule and one advantage of hydrogen is its atomic number it is the lightest element fuel. That can be extracted from water by separating hydrogen and oxygen by electrolysis process. Electrolysis is the process of splitting the negative and positive ions present in water by passing electric current and this gas was sent along with intake air to increase the efficiency and reduce the emission of a the engine. This HHO gas can be mixed with intake air in different proportions according to the engine capacity. The HHO production unit consists of an plexi glass reactor which has an electrode which is placed inside the electrolyte solution and a12volt battery. The solution is nothing but water and potassium hydroxide which is the catalyst. Catalysts are substance which accelerates the speed of reaction. In this production method we have used the catalyst to increase the speed of production rate of HHO gas from water this catalyst is effective in the production of HHO gas from water.

V. RESULTS AND DISCUSSIONS

A) Engine performance

Brake thermal efficiency

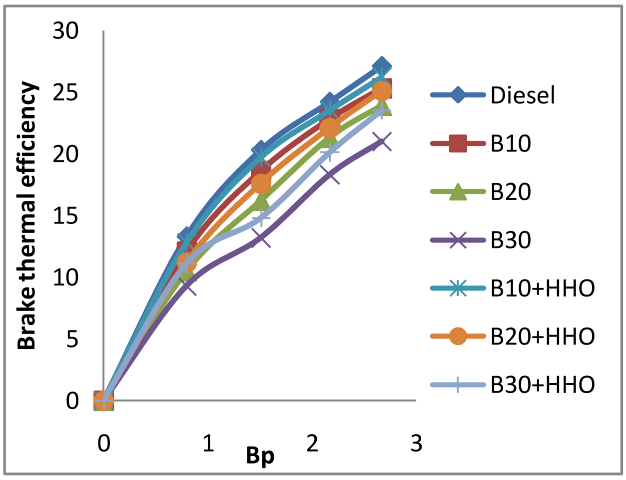

Figure.4. Variation of Brake thermal efficiency

Brake thermal efficiency is a significant factor, to measure the efficiency of an engine. Brake thermal efficiency can be defined as the ratio between the useful power available at the crankshaft of the engine to the input energy given to the engine in the form of chemical energy available in the fuel. The variation and the comparison of brake thermal efficiency with brake power is shown in figure (4-5). The maximum efficiency was obtained when diesel is used as fuel at full load the maximum efficiency was around 27% The efficiency decreased while using Neem oil blends it dropped around 21%at full load. When HHO gas is made to supplement with Neem oil blends the efficiency of the engine increased nearly to 3 to 4% when Compared to straight biodiesel

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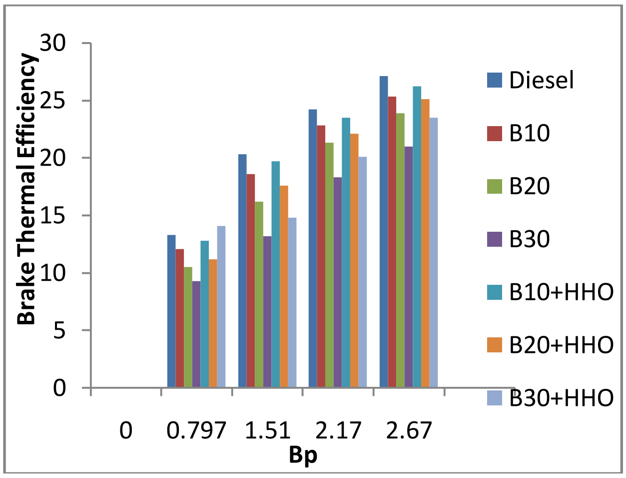

Figure 5 Comparison of Brake thermal efficiency

Specific fuel consumption

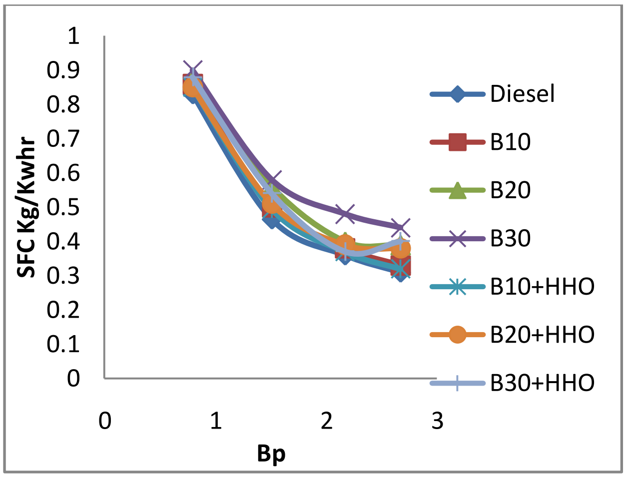

Figure.6. Variation of Specific fuel consumption

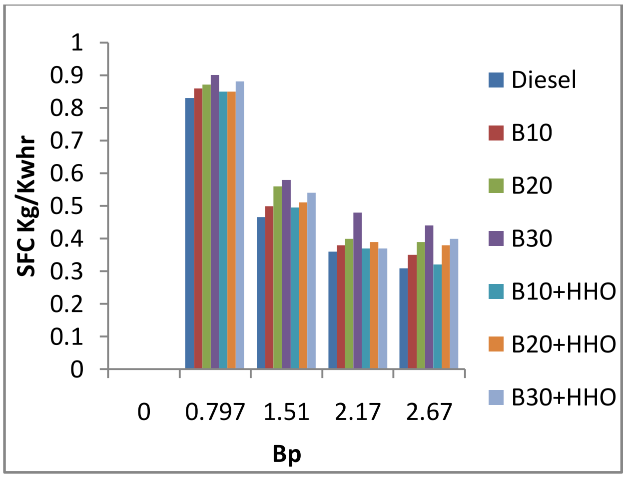

Figure.7.Comparison of Specific fuel consumption

The specific fuel consumption of an engine can be generally expressed in terms of specific fuel consumption in kilogram per kilowatt hour. It is an important parameter that indicates how good the engine performance is .It is inversely proportional to the thermal efficiency of the engine .As it is seen in the figure (6) the diesel curve has the least values and followed by Neem oil blend with HHO and Neem oil blend. The fuel consumption reduced for Neem oil blends when HHO gas is made to supplement with an average reduction of 10% compared to biodiesel. The decline in SFC is due to uniform mixing of HHO with air. Since HHO has high flame speed and wide flammability the addition of hydrogen would help the fuel to burn faster and more completely at high speed.

B) Engine emission

CO Emission

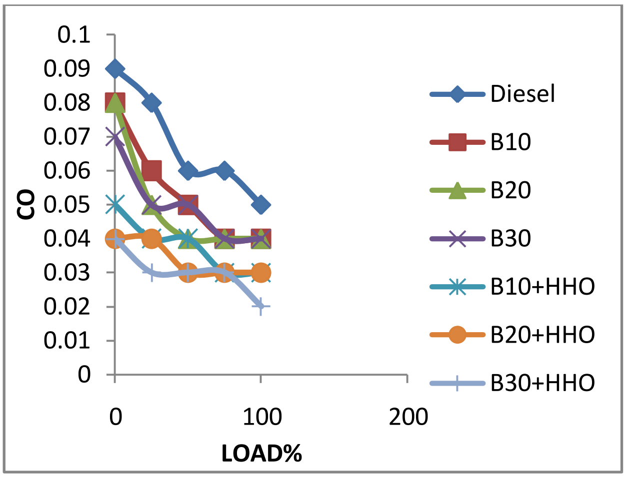

Figure.8. Variation of Carbon monoxide emission

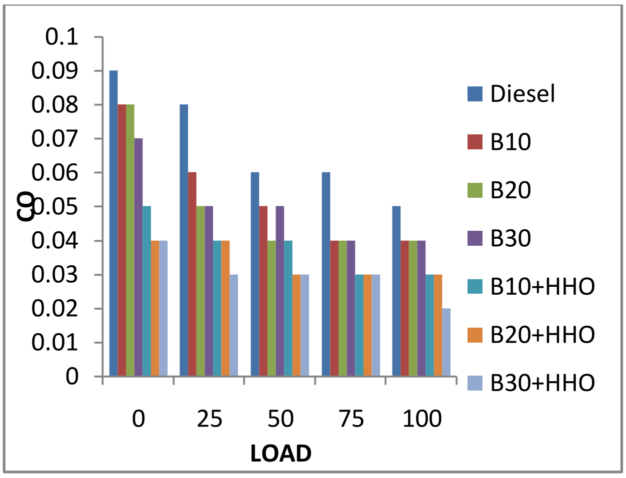

Figure.9.Comparison of Carbon monoxide emission

CO is formed when there is not enough oxygen to convert all carbon to CO_2 it is an colorless poisonous gas.

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As seen in the figure (8) the emission gradually reduced the major reason for reduction of CO is the oxygen content in HHO and also biodiesel. There was reduction .When the fuel blends are supplemented with HHO gas.CO emissions were less while using biodiesel further decreased when HHO was used. The variation and comparison of CO emission is shown in figure(8-9)

HC Emission

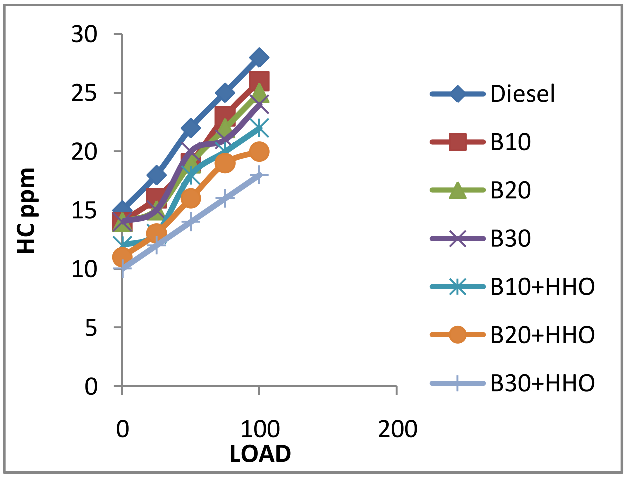

Figure.10. Variation of Hydrocarbon emission

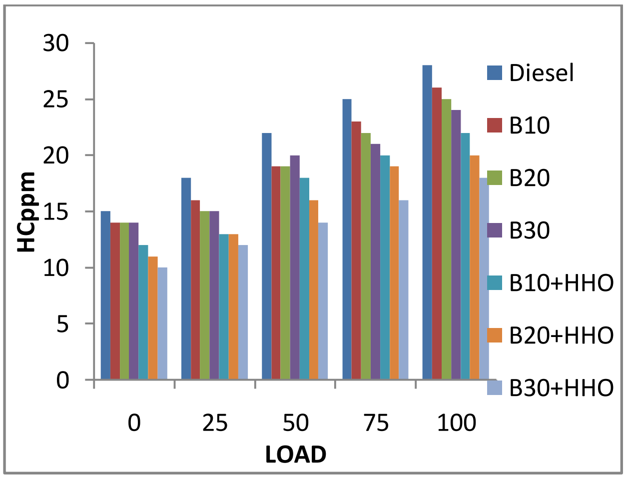

Figure.11. Comparison of Hydrocarbon emission

The variation and the comparison of HC emission is seen in the figure (10-11) there was an average reduction in HC emission were low in HHO biodiesel compared to bio diesel The oxygen content in HHO yields better combustion which reduces the HC emission.

NO_X Emission

NO_X is created mostly from nitrogen in air nitrogen and the operating temperature of the engine. Figure(12) shows the variation of NO_X emission from the engine. The

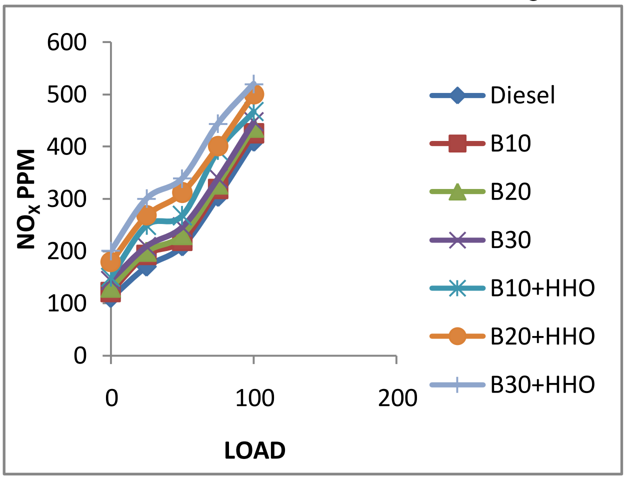

Figure.12. Variation of Nitrogen oxide emission

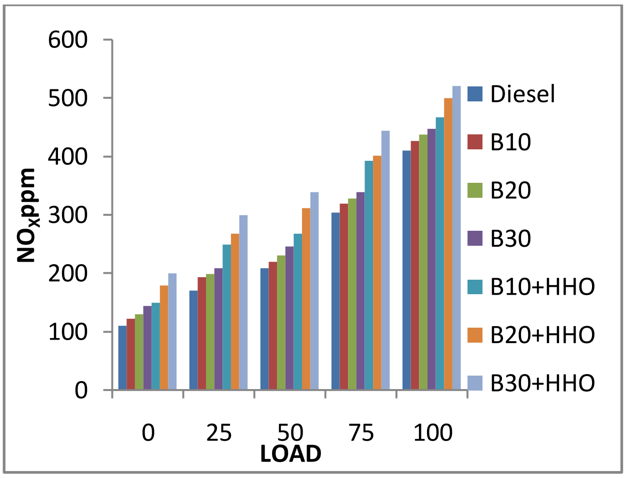

Figure.13. Comparison of Nitrogen oxide emission

NO_X emission were low in straight diesel compared to bio diesel and bio diesel with HHO at full load and it raised to 447 ppm when bio diesel blends is used and it raised further to 520 ppm when HHO was supplemented This is because of rise in temperature of combustion due to increasing amount of oxygen. When the amount of oxygen increases the temperature also increases due to this result of temperature rise NO_X emission is increased. In HHO gas as well as biodiesel oxygen is present this is reason for rise in NO_X emission as seen in the graph that the diesel curve remains at the bottom and the graph increases or remains at a same point in some point of engine operation. There was rise in NO_X emission when HHO is added to biodiesel than biodiesel. The comparison of NO_X emission is shown in figure (13).

VI. CONCLUSION

The main aim of this work is to study the performance and emission parameters of bio diesel and

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HHO supplementing biodiesel. When HHO is made to supplement with biodiesel there was rise in brake thermal efficiency and reduced fuel consumption when compared to biodiesel blend.

But in terms of emission CO and HC emissions were low or same at some points of engine operation. High burning velocity and oxygen content in HHO has reduced CO and HC emissions. But the NO_X emission were high in HHO supplementing biodiesel than biodiesel blends this is because of rise in temperature due to increasing quantity of oxygen.

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