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Performance and Emission Analysis of Diesel-Ethanol-Biodiesel Blend on CI Engine-A Review

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Abstract - *Now a days due to increase in fuel consumption the fossil fuels are continuously depleting hence the biggest challenge is to overcome the problem of energy crises and pollution due stringent emission norms .So there is need to find alternative resources which can reduced the consumption of fossil fuel and emission that get produced due to fossil fuel. The best alternative resources are biodiesel and ethanol as they are produced from renewable feedstock and are unhazardous to environment. This paper reviews performance characteristics like brake power and brake specific fuel consumption and emission characteristic like CO, HC, NOx and CO_2 on CI engine by using ethanol and biodiesel blends with diesel fuel.*

***Key Words*: BP ,BSFC ,CO, NOx ,CO_2 ,Diesel ,Biodiesel, Ethanol.**

1.INTRODUCTION

With increase in transportation and industrialization has increased the consumption of fossil fuel due to this the fossil fuels are depleting at a fast rate. At the same fossil fuel are dominant to global sources of CO_2 emission, greenhouse gases and global warming. So, there is need to find alternative resources which can reduces the consumption of fossil fuels as well as reduces the pollution problem. Lot of research work is done to find alternative fuels among the proposed alternative fuels biodiesel and ethanol are suitable fuels for diesel engines. In country like India which is known as land of agriculture, fuels like biodiesel and ethanol can be best alternative fuels. Since biodiesel can be produced from non-edible oilseeds which can be grown on non cropped marginal lands and waste lands so it will not affect the production of other edible sources. The production of biodiesel from non-edible oilseeds will lead additional income to farmers. Also the ethanol is produced from sugarcane. It is a low cost oxygenate with high oxygen content. The direct used of ethanol blend reduce the particulate matter due to increase in oxygen content also cold flow properties can be improved, but direct use of ethanol fuel lead to many technical barriers due to its low cetane number, low flash point and poor solubility. Also the direct use of biodiesel with diesel fuel lead to many technical barriers due to is high flash point, high viscosity and low calorific value. Thus to improve the solubility of ethanol in diesel fuel biodiesel can be added. This ternary blend can remains miscible for wide range of temperature.

2. LITERATURE REVIEW

A.M. Liaquat et al. [1] investigated the performance and emissions characteristics for direct injection diesel engine using coconut biodiesel blends without any engine modifications. Three fuel samples such as 100% diesel fuel, 5% coconut biodiesel and 95% DF, and 15% CB and 85% DF were used and Engine performance test was carried out at 100% load keeping throttle 100% wide open with variable speeds of 1500 to 2400 rpm at an interval of 100 rpm. Also engine emission tests was carried out at 2200 rpm at 100% and 80% throttle position. After the investigation it was found that torque and brake power decreased while specific fuel consumption was increased for biodiesel blended fuels over the entire speed range compared to pure diesel fuel. While exhaust emissions like HC, CO found to be lowered and CO2 and NOx emissions had been increased for biodiesel blended fuels compared to diesel fuel. Also sound level decreased for both biodiesel blended fuels compared to diesel fuel.

H. B. Quan et al. [2] studied the effect of ethanol blended diesel fuels on emissions from a diesel engine.It was observed that with addition of ethanol to diesel fuel changes the physicochemical properties of the blends which decreased, density, cetane number, kinematic viscosity, high heat value and aromatics fractions of the blends. It was also found that with addition of additive to keep the blends homogenous and stable which improved ignition and cetane number and favorable of the blends were found with 10% and 30% ethanol by volume. At high load there was significant reduction in smoke also Nox and CO2 emissions of the blends were decreased . At low loads there was slight reduction in smoke with the aid of additive and ignition improver, CO, unburned ethanol and acetaldehyde emissions of the blends were decreased moderately.

D.H. Qi et al. [3] studied performance and combustion characteristics of biodiesel–diesel–methanol blend on a direct injection diesel engine under different operating conditions. BD50 was prepared as the baseline fuel and Methanol was added to BD50 as an additive in 5% and

10% by volume. It was observed that the combustion starts later for BDM5 and BDM10 than for BD50 at low engine load, but was almost identical at high engine load.The power and torque outputs of BDM5 and BDM10 were slightly lower than those of BD50.While smoke emissions were reduced for BDM5 and BDM10 as compared to BD50 . Also CO emissions were slightly lower, and NOx and HC emissions were almost similar to those of BD50 at speed characteristic of full engine load

Mario L. Randazzo and Jose R. Sodre [4] investigated exhaust emissions from a diesel powered vehicle fuelled by soybean biodiesel blends with ethanol as an additive .Blends of diesel oil and soybean biodiesel with concentrations of 3% (B3), 5% (B5), 10% (B10) and 20% (B20) were used as fuels. Also, the effects of anhydrous ethanol as an additive to B20 fuel blend with concentrations of 2% (B20E2) and 5% (B20E5) were also studied. The results showed that increasing biodiesel concentration in the fuel blend increases carbon dioxide (CO2) and oxides of nitrogen (NOX) emissions, while carbon monoxide (CO), hydrocarbons (HC) and particulate matter (PM) emissions were reduced. While addition of anhydrous ethanol to B20 fuel blend reduced the NOX and CO2 concentration.

Dattatray Bapu Hulwan and Satishchandra V. Joshi [5] studied the Performance, emission and combustion characteristic of a multicylinder DI diesel engine running on diesel–ethanol–biodiesel blends. The blends used for testing were D70/E20/B10(A), D50/E30/B20(B) ,D50/E40/B10(C) and D100. The blends were prepared to get maximum percentage of oxygen content and also to keep properties such as density, viscosity and cetane index within acceptable limits. Experiments were conducted on a multicylinder, DI diesel engine, whose original injection timing was 13° CA BTDC. It was observed that the engine did not run on blends B and C at the same injection timing and it was required to advance timing to 18° and 21° CA BTDC to enable the use of blends B and C respectively. But by advancing injection timing the result showed that NO emissions were doubled and increased peak firing pressure. The P–h and net heat release diagrams showed that the combustion process of these blends delayed at low loads but approaches to the diesel fuel at high loads. By comparison of results of blends with baseline diesel showed that brake specific fuel consumption was increased, also thermal efficiency was improved slightly, but smoke capacity was reduced remarkably at high loads. Also blend B which replaced 50% diesel and had oxygen content up to 12.21% by weight showed satisfactory performance for steady state running mode up to 1600 RPM.

Zhu Lei. et al. [6] studied combustion, performance and emission characteristics of a DI diesel engine fueled with ethanol–biodiesel blends under five engine loads at the maximum torque and engine speed of 1800 rpm. The results showed that when compared with biodiesel, the combustion characteristics of ethanol–biodiesel blends engine performance was improved slightly with 5% ethanol in biodiesel (BE5). In comparison with Euro V diesel fuel, the biodiesel and BE blends had higher brake thermal efficiency. Also there was reduction of both NOx and particulate emissions of the diesel engine compared to diesel fuel.

Nadir Yilmaz [7] did a comparative analysis of biodiesel-ethanol-diesel and biodiesel-methanol-diesel blends in a diesel engine. The Performance and emission characteristics of the engine fueled with biodiesel-methanol-diesel (BMD) and biodiesel-ethanol-diesel (BED) were compared to standard diesel fuel as the baseline. It was found that biodiesel-alcohol-diesel blends showed a higher brake specific fuel consumption than diesel. As alcohol concentrations in blends was increased CO and HC emissions were increased, while NO emissions were reduced. Also it was found that methanol blends was more effective than ethanol blends for reducing CO and HC emissions, while NO reduction was achieved by ethanol blends.

Yilmaz Nadir et al. [8] studied performance and emissions of CI engine in biodiesel–ethanol–diesel blends as a function of ethanol concentration. Ethanol was mixed with biodiesel–diesel blends and the effect of ethanol concentration on diesel emissions was investigated. Both low and high concentrations of ethanol were studied. Ethanol concentrations were varied at 3%, 5%, 15% and 25% in biodiesel–diesel–ethanol (BDE), while biodiesel and diesel concentrations were maintained equal (BDE3, BDE5, BDE15 and BDE25). Emission characteristics for biodiesel–diesel–ethanol blends were compared to baseline curves of diesel as a function of engine load.

Qiang Fang .et al. [9] studied effects of ethanol-diesel-biodiesel blends on combustion and emissions in premixed low temperature .The biodiesel was used as an additive to prevent the stratification of ethanol and diesel blends. After the experimentation the result were compared with diesel fuel, it was found that ethanol-diesel-biodiesel blends had lower NOx emissions due to lower combustion temperature which leads to the higher HC and CO emissions.Also Smoke emissions for ethanol blends fuel was decreased because of higher oxygen content and longer ignition delay.

Gvidonas Labeckas et al. [10] studied the effect of ethanol–diesel–biodiesel blends on combustion, performance and emissions of a direct injection diesel engine. The test was carried on four-stroke, four-cylinder, naturally aspirated, DI 60 kW diesel engine operating on diesel fuel (DF) and its 5 vol% (E5), 10 vol% (E10), and 15 vol% (E15) blends with anhydrous (99.8%) ethanol (E). An additional ethanol–diesel–biodiesel blend E15B was prepared by adding the 15 vol% of ethanol and 5 vol% of biodiesel (B) to diesel

fuel (80 vol%).The test results were analysed and compared with a base diesel engine running at the same air–fuel ratios of k = 5.5, 3.0 and 1.5 corresponding to light, medium and high loads. The result showed that for same air–fuel ratios the energy content delivered per each engine cycle was almost same for various ethanol–diesel–biodiesel blends. Fuel with blend E15B developed the brake thermal efficiency of 0.362 that was same as a straight diesel running on slightly richer air–fuel mixture k = 1.5 at rated 2200 rpm speed. It was observed adding of the ethanol to diesel fuel reduced the NOx and the HC emissions for richer combustible mixtures .

M. Mofijur et al. [11] studied performance and emission of Moringa oleiferan biodiesel with 10% and 20% by-volume blends (B10 and B20) in comparison with diesel fuel (B0) in a multi-cylinder diesel engine at various speeds and full load conditions. It was observed that B10 and B20 fuels reduced brake power and increased brake specific fuel consumption compared with B0 for entire range of speeds. Also carbon monoxide emission were reduced by 10.60% and 22.93% while hydrocarbon emission were reduced by 9.21% and 23.68% for B10 and B20 fuels blends respectively compared with B0 .But nitric oxide emission were increased by 8.46% and 18.56% respectively compared with B0.

.Liaquat Ali Memon and S.M. Ashrafur Rahman [12] studied Performance and emission analysis of Jatropha curcas and Moringa oleifera methyl ester fuel blends in a multi-cylinder diesel engine. The comparison of physico-chemical properties of J. curcas and M. oleifera methyl esters was done with 10% by volume blends (JB10 and MB10) with diesel fuel (B0).It was observed that JB10 and the MB10 fuels produced slightly lower brake powers and higher brake specific fuel consumption compared to diesel fuel over the entire range of speeds. While for JB10 and MB10 fuel blends there was reduction in emission of carbon monoxide by 14% and 11% respectively and hydrocarbons by 16% and 12% respectively. But there was slightly increased in nitrous oxides emissions by 7% and 9% respectively and carbon dioxide by 7% and 5% respectively for JB10 and MB10 fuels compared to B0.

H.K. Rashedul et al. [13] studied the effect of additives on properties, performance and emission of biodiesel fuelled on compression ignition engine. It was observed that fuel additives can contribute towards fuel economy and emission reduction either directly or indirectly. The additives used were metal based additives, oxygenated additives, antioxidants, cetane number improvers, lubricity improvers and cold flow improvers. The study concludes that the use of additive in biodiesel fuel is inalienable both for improving properties and for better engine performance and emission control.

Murari Mohon Roy et al. [14] investigated the performance and emissions of a direct injection (DI) diesel engine with three fuel series: biodiesel–diesel, biodiesel–diesel-additive and kerosene–biodiesel. Engine performance and emissions were investigated at engine speed of 1800 rpm under three different loading conditions (low, medium and high) .The test result showed that the bsfc increased with the increase in biodiesel in the blends of biodiesel–diesel and biodiesel–diesel-additive. While CO and HC emissions were reduced efficiently with both biodiesel–diesel and biodiesel–diesel-additive blends at low load and medium load conditions. While NOx emissions was reduced using kerosene–biodiesel blends at all load conditions . But it was observed that NOx increased with the increase of biodiesel in the blends of biodiesel–diesel and biodiesel–diesel-additive up to medium loads.

G. Sakthivel et al. [15] did a comparative analysis of performance, emission and combustion parameters of diesel engine fuelled with ethyl ester of fish oil and its diesel blends . It was observed that there was a reduction in NOx , HC and CO emission along with a marginal increase of CO2 and smoke emissions with the increase in biodiesel proportion in the fuel. The brake thermal efficiency was found to be higher compared to diesel for the entire load. Also the ignition delay, maximum heat release rate and combustion duration were lower for biodiesel–diesel blends compared to diesel.

Tutak Wojciech et al. [16] studied Alcohol–diesel fuel combustion in the compression ignition engine . Fuels were added by injection into an intake manifold consisting of 20%, 50%, 75% and 90% with respect to total diesel fuel–methanol or diesel fuel–E85 blends. It was observed that with increase in methanol or E85 peak combustion temperature decreases as well as temperature of the mixture at the end of compression stroke that affects combustion duration. For methanol or E85 two characteristic peaks in the heat release rate profile were observed. Also slight increase in brake efficiency was observed.There was 16% increase in NO x emission when 20% methanol or E85 were added.

T. Ashok Kumar et al. [17] studied the performance and emission characteristics of esterified pinnai oil on VCR engine. The blend ratios of B10 and B20 of the fuel were used for testing on VCR engine and compression ratio of the engine was varied from 15:1 to 18:1 and the torque was adjusted from zero to 22 Nm. Based on the performance results and investigation, it was observed that the brake power of biodiesel was little more than that of standard diesel for all compression ratio in part load operation also the brake specific energy consumption of the blended fuel was very close to the diesel fuel and the combustion duration of the biodiesel was decreased by increase of compression ratio, also there was significant reduction in emissions of blended fuel for all compression ratios.

3. SUMMARY

1) It is observed that with increases in concentration of ethanol and biodiesel blend in diesel fuel there is decrease in brake power.
2) The Brake specific fuel consumption increases with increase in concentration of ethanol and biodiesel blend in diesel fuel.
3) Also the emission like HC and CO decreases with increase in concentration of ethanol and biodiesel blend in diesel fuel.
4) While CO_2 and NOx emission increases with increase in concentration of ethanol and biodiesel blend in diesel fuel.

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