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Experimental Investigation of Performance Parameter of Single Cylinder Diesel Engine with Oxidized Canola Oil Biodiesel Blends

Mahendra Shrivastava[1], Ashok Gautam[2], Dr. A.C.Tiwari[3]

[1,2]*Research Scholar, Dept. of Mechanical Engineering, UIT-RGPV, Bhopal, India*

[3]*Professor & Head, Dept. of Mechanical Engineering, UIT-RGPV, Bhopal, India*

Abstract- **Biodiesel is a renewable fuel which is produced by algae, palm, fruits, seeds, waste oils by transesterification process in the presence of alcohol like methanol or ethanol and catalyst NaOH or KOH. Biodiesel reduce harmful environment affects is less as compare to uses of diesel fuel and it's an eco-friendly fuel. The oil used for the preparation of biodiesel is CANOLA OIL (seed oil).In this research paper, oxidized canola oil biodiesel (OCOB), non-oxidized canola oil biodiesel (NCOD) and diesel fuel are taken under the consideration. Two different fuels were tested in a single cylinder, 4-stroke, air-cooled, a constant compression ratio (CR) direct injection diesel engine developing a power of 3.7 kW, at a rated speed of 1500 rpm and various performance parameters calculated they are following specific fuel consumption (SFC), fuel consumption, volumetric efficiency ,thermal efficiency and emissions. The data obtain from the experiment compared with the diesel fuel, which tested on same parameter, and same operation condition. The COBD blended in different proportion with pure diesel and diesel consist 25% (BD25), 50% (BD50), and 100% (BD100) of bio diesel fuel and at each stage of blending load is varying The result obtain by the biodiesel indicates significant reduction in specific fuel consumption, volumetric efficiency, CO emission and unburned HC emission. And also represents increasing in thermal efficiency, fuel consumption, CO2 emission, in both cases (NOBD & OBD) on increasing the percentage of blending (BD25, BD50, BD100).The results were compared with blended NOBD and OBD at different ratio with diesel fuel.**

Index Terms- diesel engine, OCOB, NCOB, performance, blending, load.

1. INTRODUCTION

Diesel fuels play an important role in the development of most of the countries. These fuels play a major part in the transport sector and their consumption steadily increases. Biodiesel is defined technically as "A fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of the American Society for Testing and Materials D-6751". In simple terms, biodiesel is an ecofriendly fuel manufactured from methanol/ethanol and vegetable oil, animal fats, and recycled cooking fats (U.S. Department of Energy, 2006). Biodiesel only refers to 100% pure fuel (B100) that meets the definition above and Specific standards are given by the American Society of Testing and Materials (ASTM) International (D 6751).

OXIDISED BIODIESEL:

Biodiesel oxidation is a very complex process that is affected by a variety of Factor including the composition of the fuel itself and the conditions of storage. The oxidative degradation during long-term storage of biodiesel occurs mainly in the presence of air, heat, light, and pro-oxidants as a result of the formation of contaminants, such as alcohols, acids, aldehydes, peroxides, etc. The degradation reaction pathways for methyl esters derived from naturally occurring fatty oils are determined by the olefinic unsaturation on the fatty acid chain. The quality

Table 1.1: Shows Properties of Neat Diesel and Biodiesel

Characteristics	Canola biodiesel	Petroleum (diesel)
Type of source	Renewable	Fossil
Calorific value (MJ/kg)	39.49	46.8
Gross heat of combustion (KJ/Kg)	38.5	45.8
Cetane level	61.5	53

Flash point (^{0}C)	182	98
Pour point (^{0}C)	11	15
Cloud point (^{0}C)	14	18
Density at 40^{0}C (Kg/L)	0.880	0.823
Viscosity at 40^{0}C (cST)	4.85	4.0
Sulphur content (wt%)	0.04	0.10
Carbon residue (wt%)	0.04	0.14

of biodiesel is designated by several standards, such as EN 14214 and ASTM D-6751 and the oxidation stability (OS) is among the monitored parameters.

2. EXPERIMENTAL SETUP

Engine used for testing and performance of canola oil biodiesel and neat diesel.

Figure 2.1 4 STROKE SINGLE CYLINDER DIESEL ENGINE

2.1 Specification of Engine:

The engine used for the present investigation is a single cylinder, four strokes, water cooled diesel engine which is coupled to the brake dynamometer. It is provided with a board on which the display units and other measuring instruments like rotameter, U-tube differential manometer, and burette setup are given.

Table 2.1.1: Shows the specification of the engine

PARAMETER	DETAILS
Engine	Vertical engine, Kirloskar
Engine Nature	4 stroke single cylinder direct injection CI engine
Type	Water cooled
Brake power	3.7KW
Number of cylinders	1
Bore	80mm
Stroke	110mm
Rated speed	1500rpm (constant)
Combustion	Compression Ignition
Air flow measurement	Air box
Torque measurement	Brake dynamometer
Radius of dynamometer flywheel	0.16m

The experimental setup has air-box, fuel tank, calorimeter, etc. The loading arrangement is also provided in the experimental setup through brake dynamometer. Diesel is filled in the diesel tank which is placed in above of the panel board. A burette is also placed in the panel board which is used to measure fuel consumption.

3. PREPERATION OF OXIDIZED BIODIESEL

There are two major oxidation reactions which can occur in food stuff containing lipids; auto-oxidation and photooxidation, of which auto-oxidation is the most common. Auto-oxidation occurs in the presence of oxygen and is described as the auto-catalytic generation of free radicals. Here, I take a sample of canola oil biodiesel 250 g was weighed into bottle, the bottle was loosely covered with caps to exclude dust and rain, and were exposed outside a window facing for 23 days. Within 2 or 3 days the samples began to have a slight cloudiness, and after a week or 10 days the insoluble matter formed a cake on the bottom. After 23 days the contents of bottle were oxidized.

4. RESULT AND DISCUSSION

Following curve shows compare between non-oxidized and oxidized canola oil biodiesel, and neat diesel of blending at BD25, BD50, and BD100.

4.1 Specific Fuel Consumption vs. Load:

Figure 4.1: This graph show the SFC is increases to increase the blending of biodiesel. At low Load neat diesel is more efficient to biodiesel but we can

replace NOBD25 in place of neat diesel because it gives good

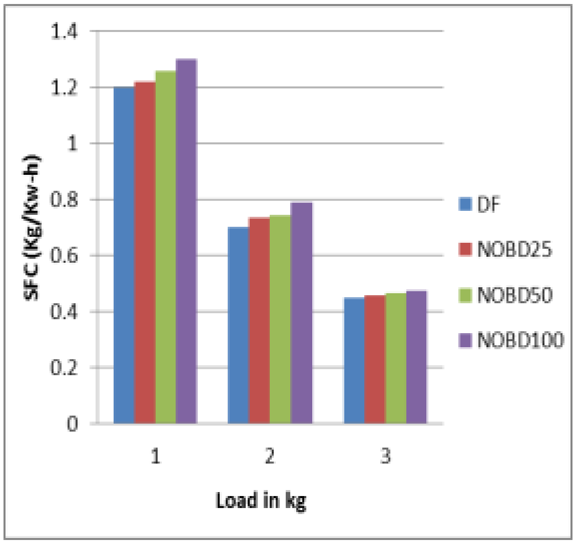

Figure 4.1: Variation of SFC vs. Load of Neat Diesel and Non- Oxidized Biodiesel

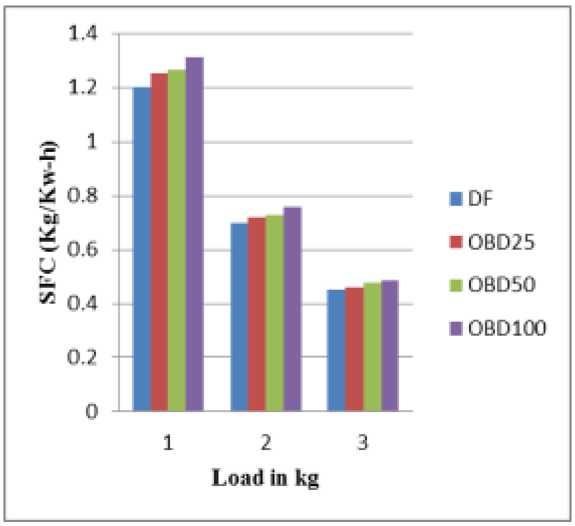

Figure 4.2: Variation of SFC vs. Load of Neat Diesel and Oxidized Biodiesel

SFC in comparison to other biodiesel. At high load NOBD100 gives good SFC, now we can use NOBD100 in high load. Figure 4.2: This graph show the SFC is increases to increase the blending of biodiesel. At low Load, neat diesel is more efficient to biodiesel but we can replace OBD25 in place of neat diesel because it gives good SFC in comparison to other biodiesel. At high load, OBD100 gives good SFC, now we can use OBD100 in high load

4.2 Thermal Efficiency vs. Load:

Figure 4.3: The thermal efficiency indicates the ability of the combustion system to accept the investigational fuel and provide comparable means of evaluating how efficiently energy in the fuel can be converted

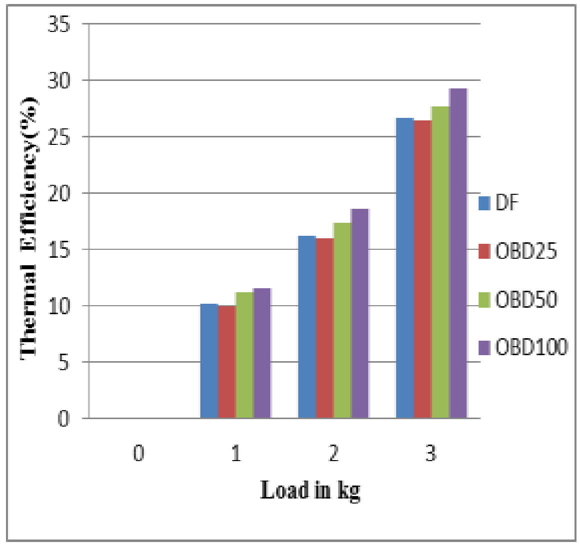

Figure 4.3: Variation of TE vs. Load of Neat Diesel and Non – Oxidized Biodiesel

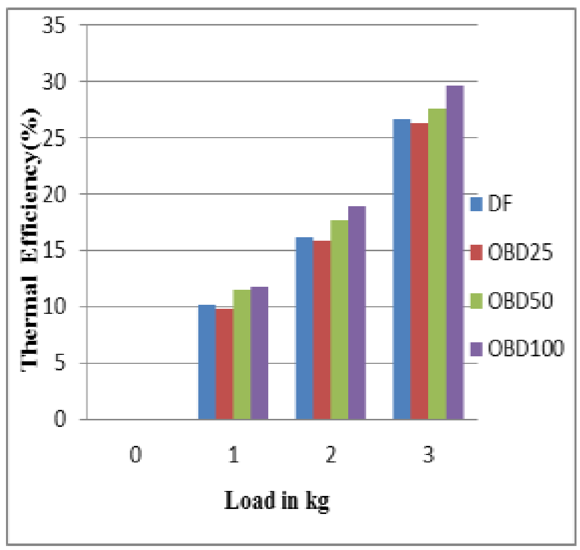

Figure 4.4: Variation of TE vs. Load of Neat Diesel and oxidized Biodiesel

into mechanical productivity. This graph indicates increase the thermal efficiency on increasing canola oil percentages in biodiesel. At high load thermal efficiency of NOBD100 is show maximum. Figure 4.4: This graph indicates increase the thermal efficiency on increasing canola oil percentages in biodiesel. At high thermal efficiency OBD100 is show maximum.

6.3 Volumetric vs. Load:

Figure shows Volumetric efficiency indicates the breathing ability of any air borne engine. It relates the actual and theoretical amount of mixture sucked to engine. This chart indicated volumetric efficiency of diesel is higher as

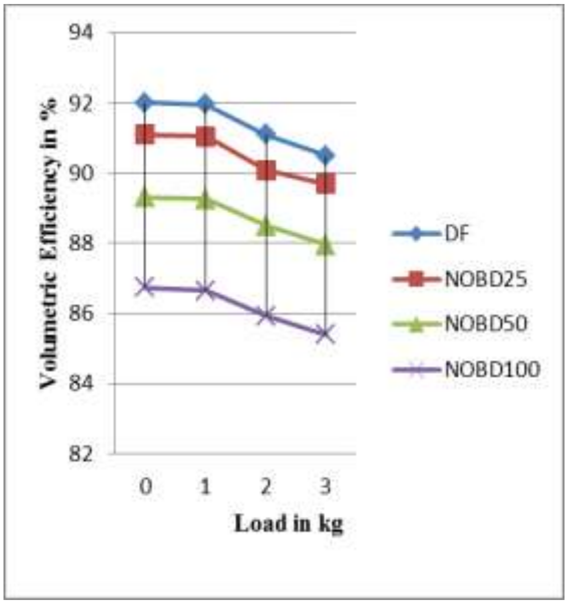

Figure 4.5: Variation of Volumetric Efficiency vs. Load of Neat Diesel and Non-oxidized Biodiesel

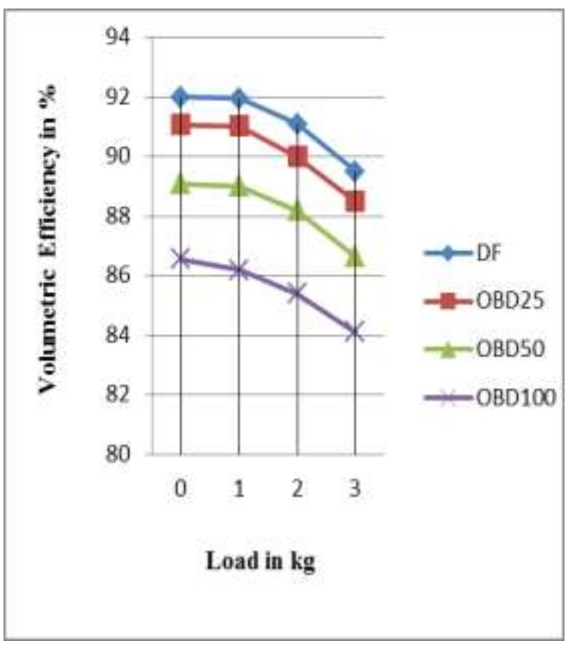

Figure 4.6: Variation of Volumetric Efficiency vs. Load of Neat Diesel and Oxidized Biodiesel

Compare to NOBD & OBD. This occurs due to presence of higher oxygen percentage by weight in Biodiesel as compare to diesel. As the load is increased, volumetric efficiency decreases continuously.

6.4 Fuel Consumption vs Load:

Figure shows fuel consumption of the engine is increased with the increase of load. This increase in fuel consumption is due to the lower energy contents in the blends with higher biodiesel content as well as high density and high viscosity of biodiesel.

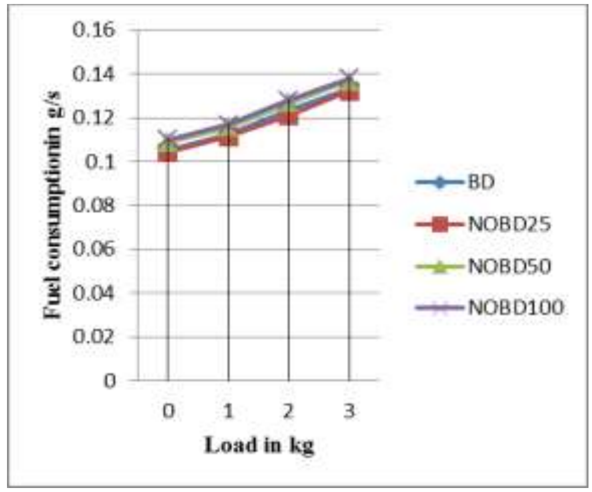

Figure 4.7: Variation of Fuel Consumption vs. Load of Neat Diesel and Non-Oxidized Biodiesel

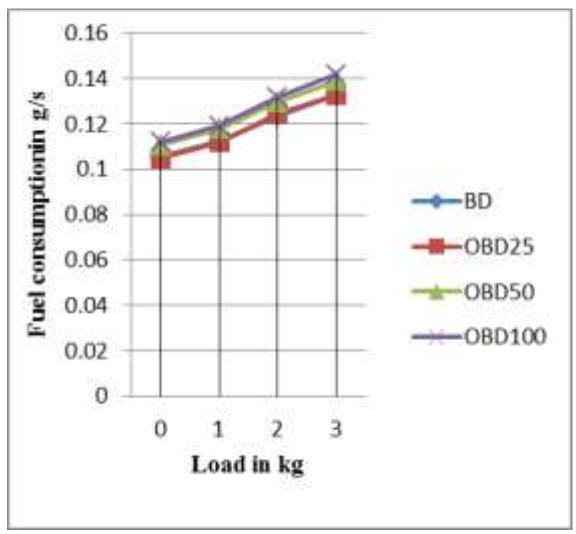

Figure 4.8: Variation of Fuel consumption vs. Load of Neat Diesel and Oxidized Biodiesel

4.5 HC Emission vs. Load:

Figure 4.9: This chart indicated HC emission of neat diesel is higher as compare to biodiesel in different brake power. Biodiesel content higher oxygen percentage by weight to diesel and also higher cetane no., which leads to better combustion in

combustion chamber. At low load, NOBD100 emits less HC emission as compare to neat diesel and at high load also NOBD100 emits less HC emission.

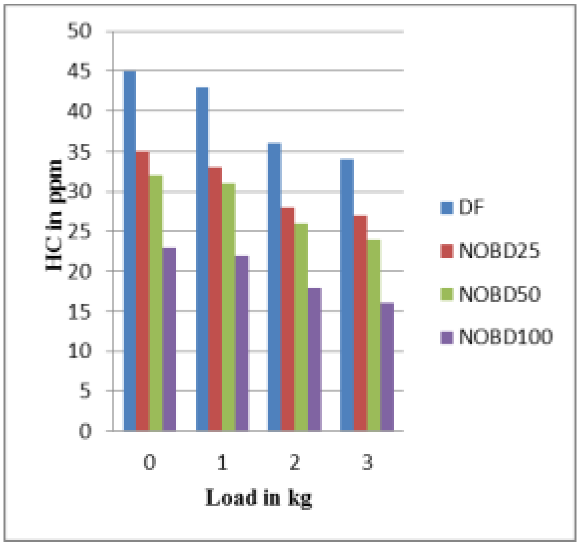

Figure 4.9: Variation of HC Emission vs. Load of Neat Diesel and Non-Oxidized Biodiesel

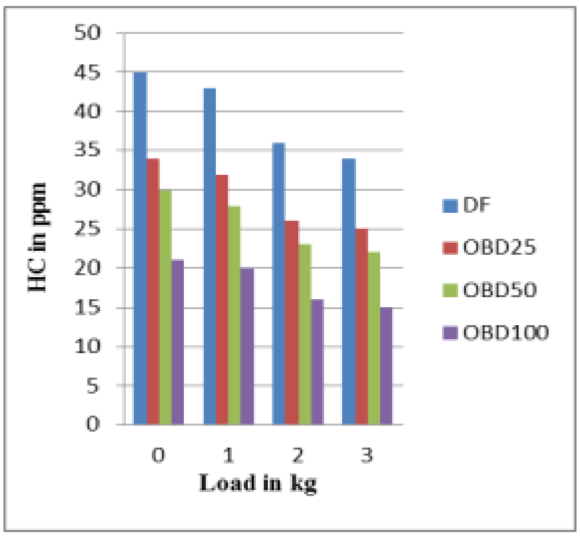

Figure 4.10 Variation of HC Emission vs. Load of Neat Diesel and Oxidized Biodiesel

Figure 4.10: This chart indicated HC emission of neat diesel is higher as compare to biodiesel in mono fuel mode indifferent brake power. Biodiesel content higher oxygen percentage by weight to diesel and also higher cetane no., which leads to better combustion in combustion chamber. At low load OBD100 emits less HC emission as compare to diesel and at high load also OBD100 emits less HC emission.

4.6 CO Emissions Vs Load:

Figure shows variation of CO emission vs. Load of neat diesel and biodiesel. This chart indicates when brake power increases to reduce the CO emission. Neat Diesel is shows always higher CO emission in comparison of biodiesel. Biodiesel gives minimum CO emission because biodiesel contains higher oxygen by weight, which takes complete combustion. Biodiesel has a lower stoiciometric ratio, so need of air is less that biodiesel take place in complete combustion in combustion chamber. Moreover, the faster injection timing and higher cetane number of biodiesel shorten the ignition delay, and this reduction is related to a decrease in the fuel-rich zone during the combustion process.

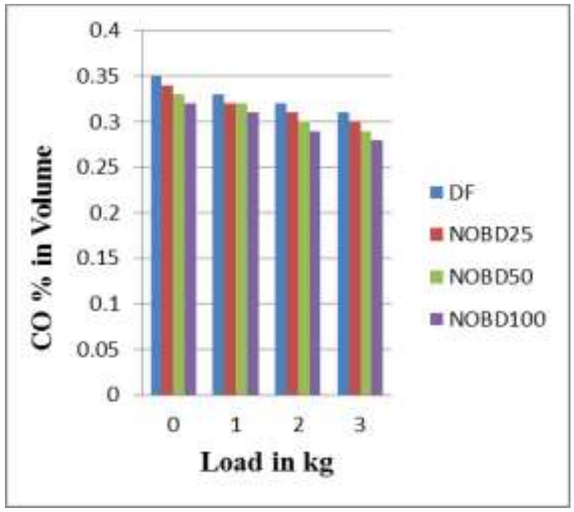

Figure 4.11: Variation of CO Emission vs. Load of Neat Diesel and Non-oxidized Biodiesel

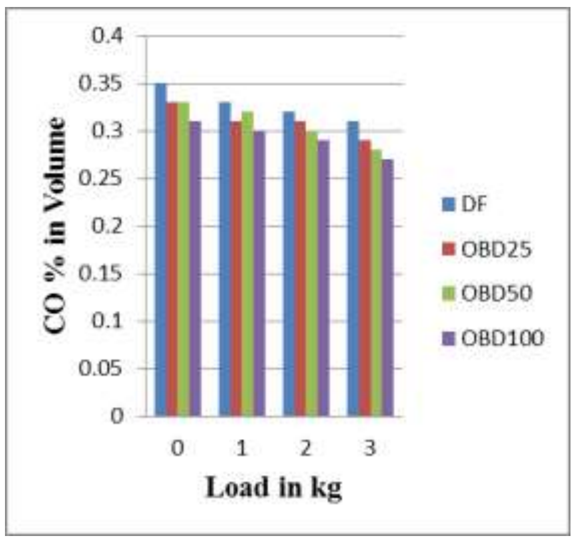

Figure 4.12: Variation of CO Emission vs. Load of Neat Diesel and Oxidized Biodiesel

4.7 CO2 vs. Load:

Figure shows the variation of CO_2 emission vs. Load of neat diesel and biodiesel. This chart indicated that when increasing Load, CO_2 emission increases continuously due to incomplete combustion of fuel at high load. At high load, require more amount of fuel as compare to low load, availability of air is not enough to perform complete combustion at high load. Biodiesel combustion emits higher amount of CO_2 as compare to mineral diesel combustion because biodiesel contain some amount of oxygen, in combustion chamber biodiesel take place complete combustion and also CO is oxidized into CO_2, so biodiesel emits higher concentration of CO_2.

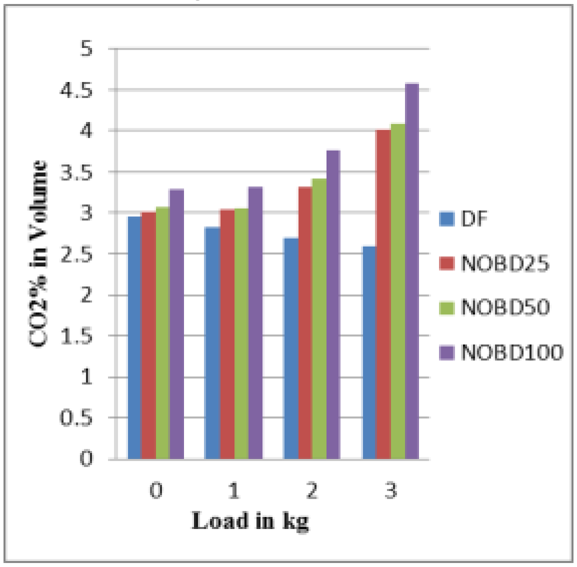

Figure 4.13: Variation of CO_2 Emission vs. Load of Neat Diesel and Non- Oxidized Biodiesel

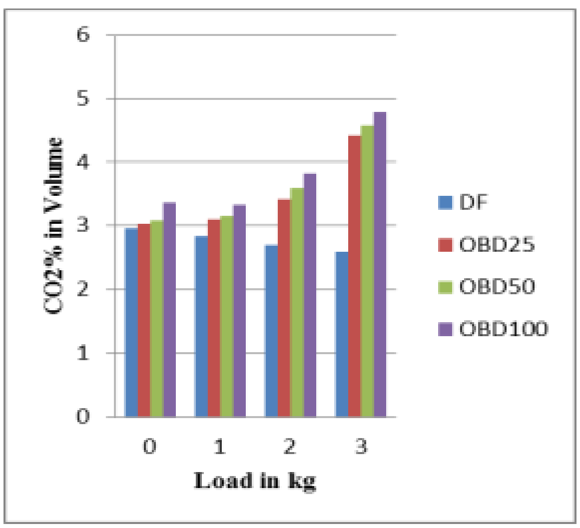

Figure 4.14: Variation of CO_2 Emission vs. Load of Neat Diesel and Oxidized Biodiesel

5. CONCLUSION

The performance and emission characteristic of a single cylinder, four stoke, water cooled, diesel engine having a power output of 3.7 kW at a constant speed of 1500 rpm, 100% NOCOBD and OCOBD, NOBCOBD and OBCOBD have been analyzed and compared with diesel. The following are conclusions:

1. Specific fuel consumption (SFC) of the engine is decrease with load. SFC of NOBD/BD100 increased by 6% at 3kg load as compare to neat diesel. But in case of OBD, SFC is 2% more than SFC of NOBD.
2. Thermal efficiency increase on increasing the percentage of blending at all condition of brake power of engine and OBD has 1% higher thermal efficiency than NOBD and neat diesel.
3. Volumetric efficiency decreases by 1.5% NOBD and 2% in OBD comparison to neat diesel on increasing the load (0-3kgs).
4. The fuel consumption increase continuously on increasing the percentage of blending of biodiesel in both cases OBD and NOBD. At 0kg load, fuel consumption was found increasing 4.28% & 6.2% for NOBD and OBD respectively. Whereas, at 3kg load rise observed was 4.6% & 6.6% for NOBD and OBD respectively.
5. The emission of CO decrease continuously on increasing the percentages of blending of biodiesel in both cases OBD and NOBD. At 0kg load, CO emission was found decreasing 8.57% & 11.42% for NOBD and OBD respectively. Whereas, at 3kg load fall observed was 9.67% & 12.93% for NOBD and OBD respectively.
6. The emission of HC decrease continuously on increasing the percentage of blending of biodiesel in both cases OBD and NOBD. At 0kg load, HC emission was found decreasing 48.88% & 53.34% for NOBD and OBD respectively. Whereas, at 3kg load fall observed was 53.5% & 55.94% for NOBD and OBD respectively.
7. The CO_2 emission is more in case of OBD in comparison to NOBD. At 0kg load, CO_2 emission was found increasing 2.71% & 3.1% for NOBD and OBD respectively. Whereas, at 3kg load rise observed was 5.71% & 6.1% for NOBD and OBD respectively

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