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EFFECT OF NANO TITANIUM BLENDED WASTE VEGETABLE OIL ON CI ENGINE WITH VARYING INJECTION PRESSURES

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Abstract: **In the present study, in-depth research is carried out to study the effects of parameters of performance and emissions in CI engine when waste vegetable oil blended with diesel and Nanoadditives are used as fuels at different injection pressures. Experiments were performed to study the changes in the performance and emissions at different injection pressures. Though no significant differences are observed regarding performance, it is found that brake thermal efficiency is the highest for WVO b100 at 220bar and volumetric efficiency for WVO B30 at 240bar. Moreover, it also resulted in reduced CO2, NOx, HC and CO % emissions at all loads and a slight increase in CO for peak loads compared to diesel.**

Keywords: **Nano, WVO, Fuel, EN14214, Engine, NOX**

1. INTRODUCTION

There has been a need for the humanity to search for alternative fuels which are non-depleting and cause less pollution without compromising on the performance of the heat engines used [1, 2, 3]. This is due to an increase in the consumption of fossil fuels which are high pollutants and are depleting in nature [4, 5, 6, 7]. Biodiesel tended to be the solution, but the percentage of contaminants generated from these fuels is higher than the fossil fuels which are undesirable. Research is being carried out to find methods to reduce the portion of the pollutants produced from the combustion of biodiesel [8, 9]. Metal oxides which increased the rate of combustion when used along with biodiesel resulted in decreased emissions with a slight increase in the performance of the engines when compared to diesel [10]. In present work, research is conducted to find out the effect of Waste vegetable oil at different blends with diesel at 30, 100 % composition along with Ti02 metal oxide blends regarding the performance and emissions of the engine at varying inlet pressures in the combustion chamber.

2. MATERIAL AND METHODS

2.1. Fuel properties

Refined Waste vegetable oil satisfies the minimum requirements of EN14214 as a fuel for the engines. The specifications of WVO and the optimum specification of EN14214 are shown in below table 1.

Table 1Properties of waste vegetable oil

Property	**Waste vegetable Oil properties**	**EN 14214 limits min/max**
Ester content (% m/m)	98.3	96.5/-
Density @ 15 C (kg/m^3)	877	860/900
Viscosity @ 40 C (mm^2/s)	3.6	3.5/5
Flash point (C)	133	120/-
Water content (%volume)	0.006	-/0.05
Sulphur content (mg/kg)	2.5	-/10
Total acid number (mg KOH/g oil)	0.781	-/0.80
Cetane number	53	51/-

2.2. Experimental setup

A natural aspirated single cylinder stationary four-stroke direct ignition diesel engine is used for the experiment. The engine specifications are listed in table 2 and its setupis shown in figure 1.

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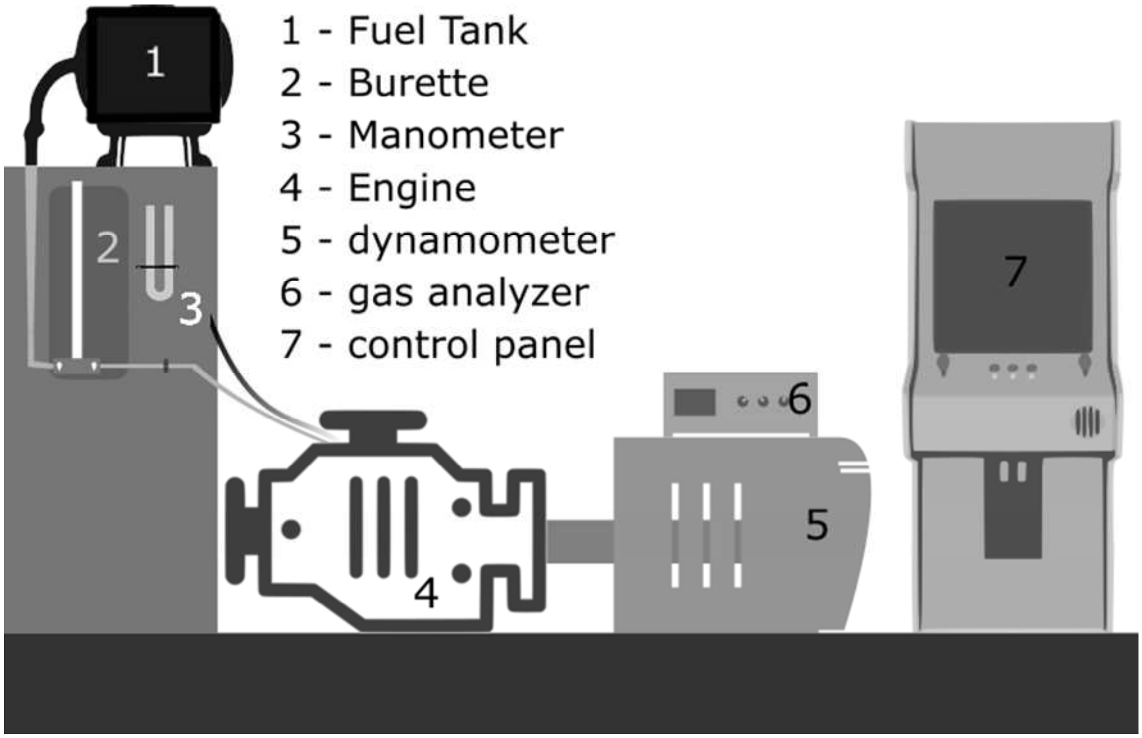

Figure 1 Experimental setup

Table 2Technical specifications of the Engine

Make	Kirloskar
Model number	AV1
Bore X Stroke	80 X 110 mm
Cubic Capacity	0.553 Ltr
Compression Ratio	16.5:1
Rated Output	3.7 KW
Rated Speed	1500 rpm
Torque at full load	0.024 KN-m
Overloading Capacity	10% of rated output

The engine is run at its rated speed of 1500 rev/min whose flywheel is directly coupled to an eddy current dynamometer to permit engine motoring partially or entirely. The engine and dynamometer are directly controlled from the control panel. The volume of air consumed is measured with the help of manometer connected to the orifice and the fuel consumption is measured by determining the volume flow at each time interval and multiplying it with its specific gravity. A multi-gas analyzer is used to log emissions from the engine. Biodiesel blends are prepared by mixing WVO, diesel and ti02 metal oxides at definite proportions of 30%, 100% using magnetic stirrer. Sodium deoxycholate, a cationic surfactant is also combined with nanoblends to control the particle sedimentation. A known quantity of equal proportion of additive and surfactant are added to biodiesel blends and stirred to form a stable nanofluid.

2.3. Engine Test procedures

The tests are carried out at the engine's rated speed with three different loads at 220, 240 bar injection pressures. At each test condition, a cooling period was given to stabilize the engine and readings are logged from the control panel. WVO B100 and its blends were tested and compared with diesel fuel respectively.

3. THEORETICAL ANALYSIS

$$\text{Brake Power(BP)} = \frac{(V * i)}{1000 * \eta_{gen}} \text{ KW}$$

$$\text{Mass of Fuel Consumed (mfc)} = \frac{X * \rho * 3600}{1000 * t} \text{ kg/hr}$$

$$\text{Specific Fuel Consumed} = \frac{\text{mfc}}{\text{BP}} \text{ kg/KWH}$$

$$\text{Volume of air sucked } V_A = C_d * A * \sqrt{2gH} * 3600 \frac{m^3}{hr}$$

$$H = \frac{\delta w * h}{\delta A * 1000} \text{ m}$$

$$\text{Swept Colume } V_S = \frac{\pi d^2 * L * N * 60}{4}$$

$$\text{Volumetric Efficiency } \eta_v = \frac{V_A}{V_S} * 100 \%$$

$$\text{Brake Thermal Efficiency } \eta_{BT} = \frac{BP * 3600 * 100}{\text{mfc} * C_v}$$

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4. RESULTS AND DISCUSSIONS

4.1. Performance

It is observed that there were no notable changes regarding the performance in the engine other than in Brake thermal efficiency and Volumetric efficiency.

The figures 2, 3 show the brake thermal efficiency for WVO blends at all loads. A decreasing tendency can be observed as the load increases from partial load to full load. The average brake thermal efficiency attained is highest for WVO B30 at 220bar of 25% and 26% for WVO B100 at 220bar.

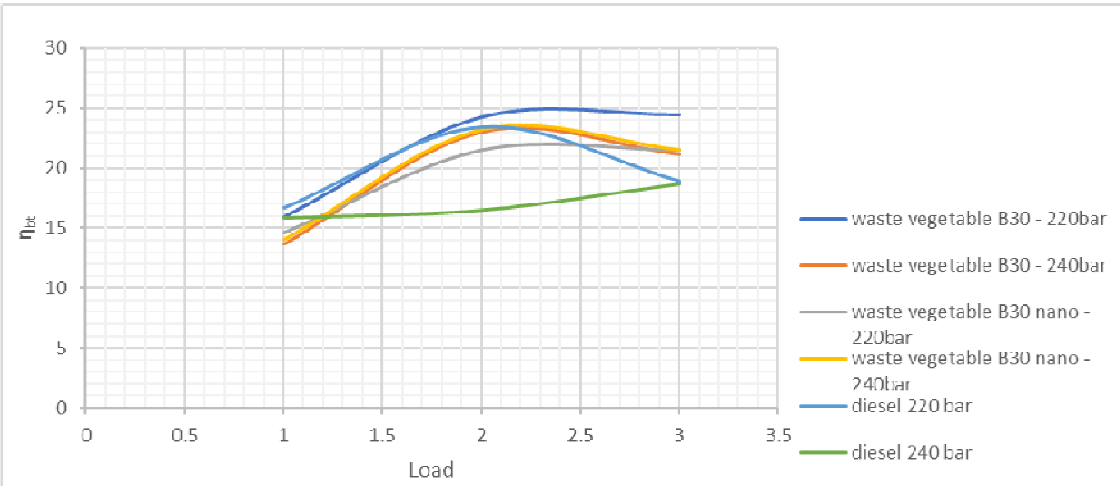

Figure 2 Load vs BTE for WVO B30

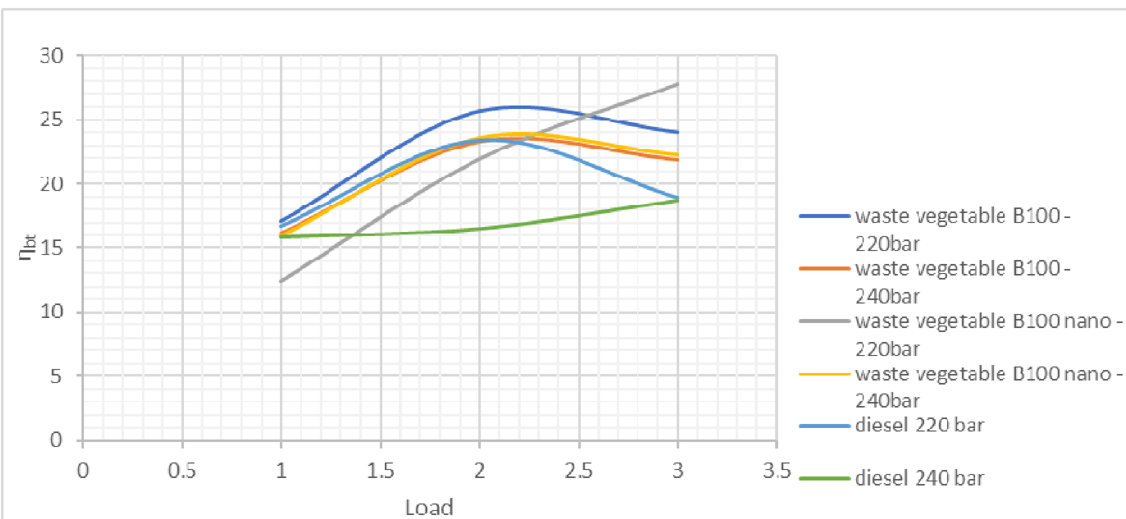

Figure 3Load vs BTE for WVO B100

The figures 4, 5 show the volumetric efficiency for WVO blends at all loads having an increasing tendency as the load is increased. The efficiency obtained is highest for WVO B30 at 240bar of 69% and 50% for WVO B100 at 240bar.

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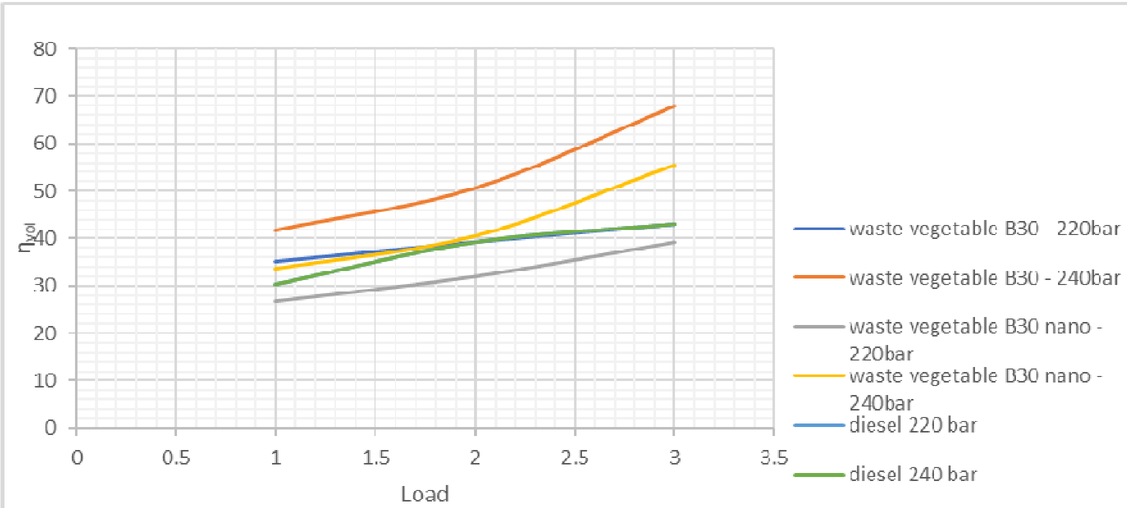

Figure 4 Load vs Volumetric efficiency for WVO B30

4.2. Emissions

The figure 6, 7 shows that CO% increases as the load applied to the engine increases, it can be observed that the % of CO emitted from the engine is overall less when compared to diesel other than for WVO B30 at 240bar and WVO B100 Nano at 220bar. However, the WVO B30 at 220bar showed the least percentage of CO emissions.

The figure 8, 9 shows the percentage of CO_2 emitted from the engine which shows increasing tendency as the load applied to engine increases. When compared to diesel all WVO blends have very less CO2 emission percentage with a difference of 140% with no significant difference with each of their blends.

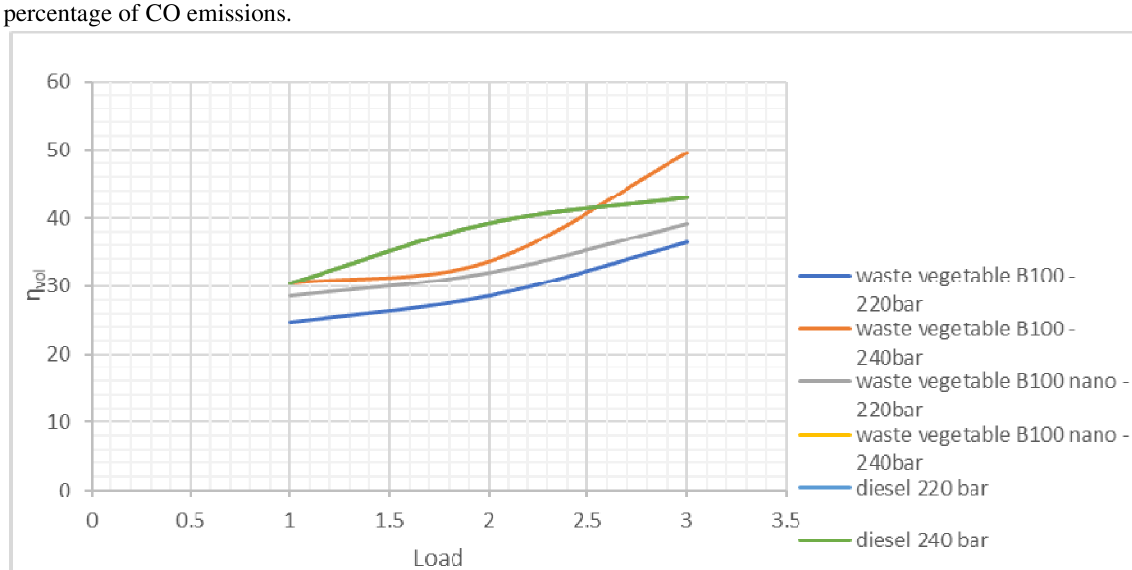

Figure 5Load vs Volumetric efficiency for WVO B100

Figures 10, 11 show the NOX emissions from the engine in ppm. It is observed that the NOX from the engine are significantly lower for all WVO blends when compared to diesel. WVO B30 at 220bar and WVO B100 Nano have the least value of NOX emissions with 78% decrease when compared to diesel.

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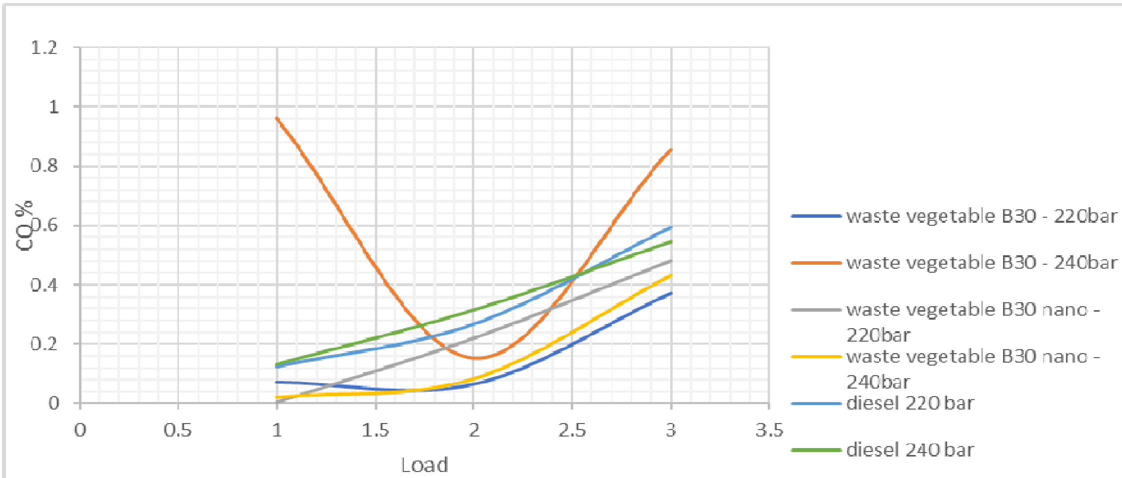

Figure 6Load vs CO % for waste vegetable B30

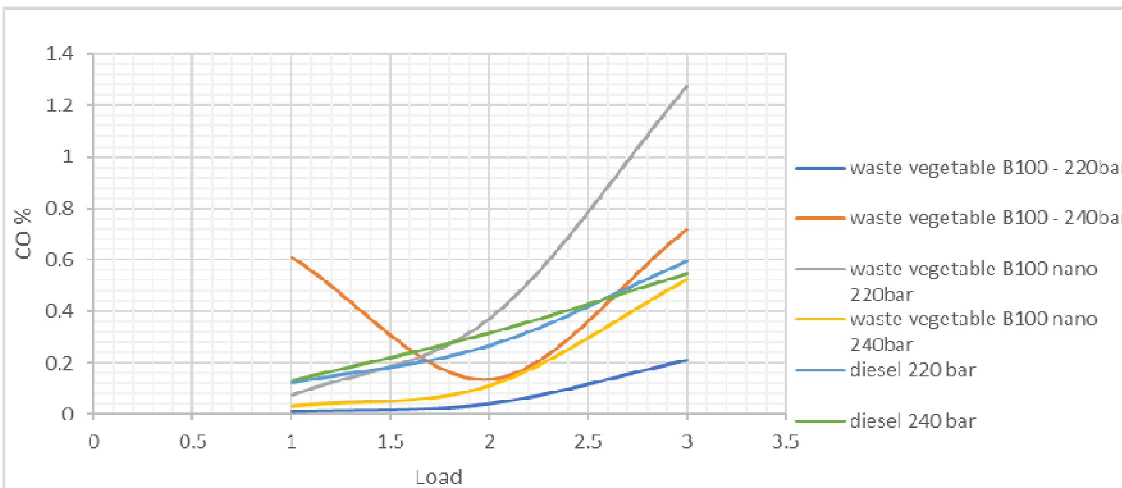

Figure 7Load vs CO % for waste vegetable B100

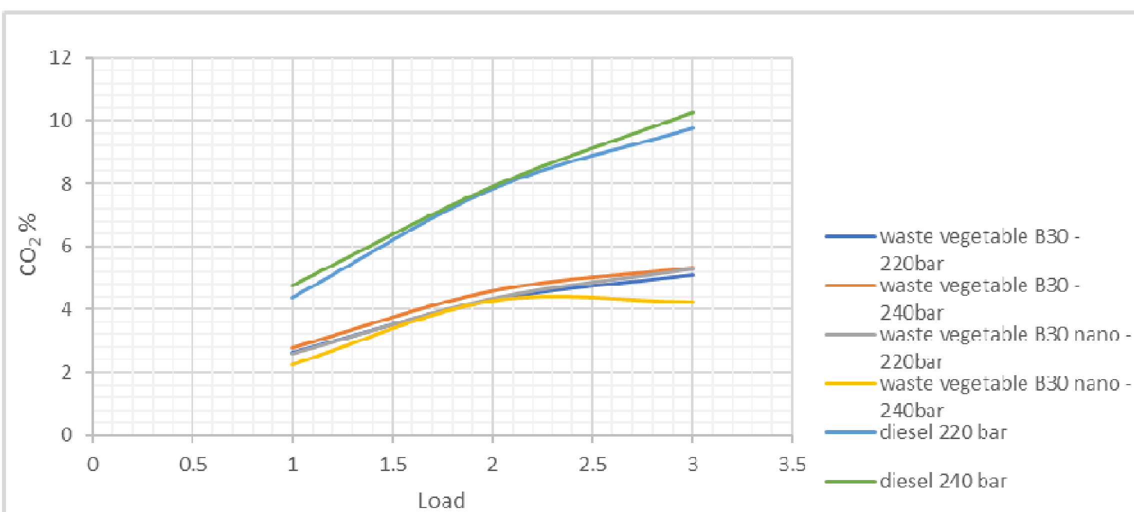

Figure 8Load vs CO_2 % for waste vegetable B30

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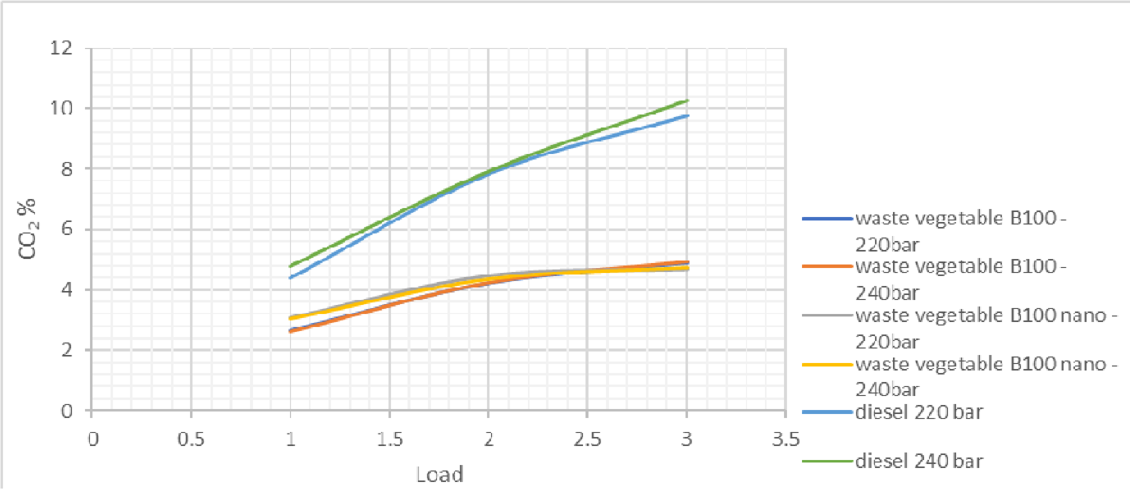

Figure 9Load vs CO_2 % for waste vegetable B100

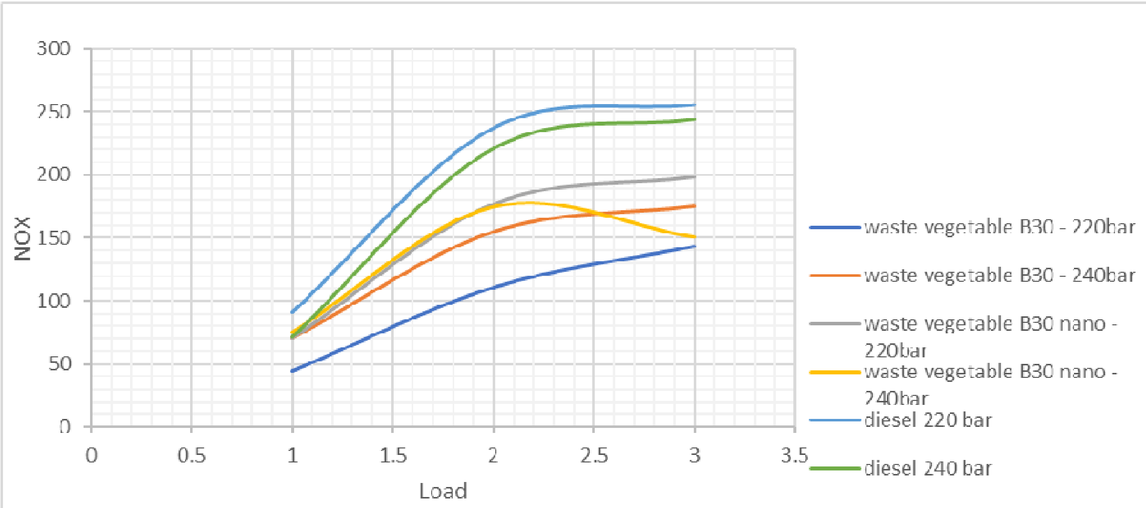

Figure 10Load vs NOX for waste vegetable B30

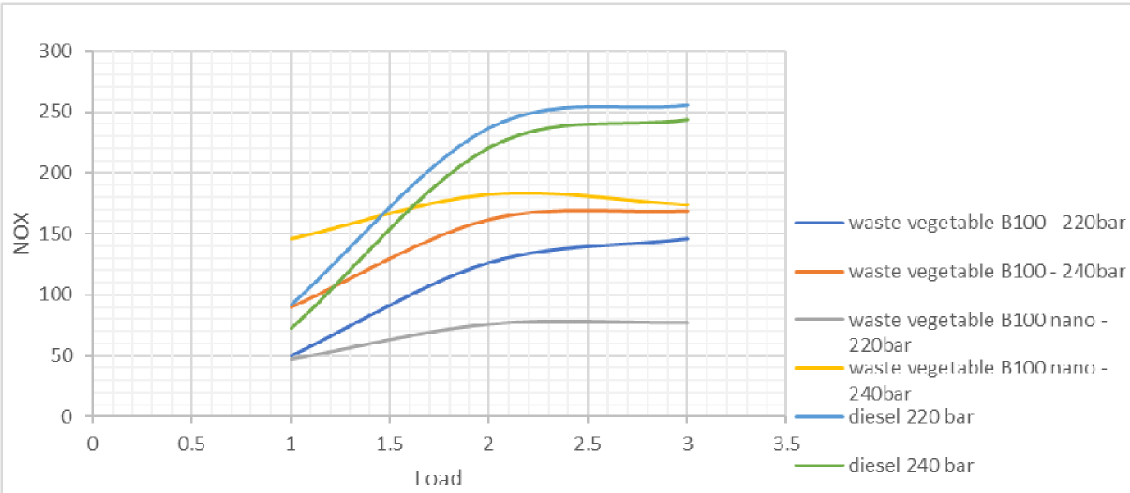

Figure 11Load vs NOX for waste vegetable B100

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5. CONCLUSION

In this study, the effect of Waste vegetable oil and its blends with diesel along with added additives on CI engine is examined. Important conclusions are summarized as follows: brake power, Specific fuel consumption was almost same for diesel, waste vegetable oil and its blends.
Brake thermal efficiency, volumetric efficiency was increased when compared to diesel.
CO, CO2, NOX emissions for Waste vegetable oil have decreased when compared to diesel.
Waste vegetable oil blend with diesel at 30% has least emissions when compared to other blends and diesel.

Abbreviations

V	Voltage
i	Current
η_{gen}	Efficiency of generator
X	Burette reading in CC
ρ	Density of fuel
t	time taken in seconds
Cd	Co-efficient of Discharge
A	Area of orifice
g	Acceleration due to gravity
h	Manometer reading in mm
δw	Density of water
δa	Density of air
D	diameter of Bore
L	length of stroke
N	Speed
C_v	Calorific Value
B30	canola 30 % and Diesel 70 %
B100	canola 100 %
BP	Brake Power

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