

EFFECT OF DI-TERT BUTYL PEROXIDE ON DIESEL ENGINE PERFORMANCE FUELLED BY BIODIESEL BLENDS

ABSTRACT

This study is motivated by the fact that the vegetable oils are being considered as the fuel of the future for the internal combustion engines, especially the compression ignition engines which are working with diesel as fuel. Different approaches for using the vegetable oils in CI engines as fuel are either to modify the oils to match with that of diesel to run successfully with these oils. Fuel additives are compounds formulated to enhance the quality and efficiency of the fuels used in motor vehicles. There are several benefits associated with the use of fuel additives. Di-tert butyl peroxide (DTBP) is effective to enhance the quality and efficiency of the fuels used in CI engine. The investigation was to check the feasibility of di-tert butyl peroxide as an additive in different blends of diesel and jetrophabio-diesel on engine performance. The short-term tests on an unmodified diesel engine were conducted using the bio diesel and di-tert butyl peroxide blends (0, 10, 20, 30, 40, 50, and 100 per cent and 0, 0.5, 1.0, 1.5, 2.0, 2.5 per cent) with diesel. The engine performance and emission characteristics were measured during the short-term test. In all types of fuel, with increased percentage of load, brake specific energy consumption (BSEC) of the engine was observed to be decreased, on the other hand brake thermal efficiency, fuel consumption rate, sound level (db.), exhaust temperature, and the engine exhaust emissions like CO₂, CO, HC and NO_x was increased, respectively.

Keywords: *Bio diesel, Transesterification, CI engine, Di-tert butyl peroxide*

1. INTRODUCTION

Fuel and energy crisis and the concern of the society for the depleting world's non-renewable energy resources led to a renewed interest in the quest for alternative fuels. The increased industrialization and motorization of the world in recent years has resulted in great demand for petroleum products. Petroleum is the largest single source of energy, which has been consumed by the world's population, exceeding the other energy resources such as natural gas, coal, nuclear and renewable. The main consumers of energy are the electricity generation and transportation sectors. The diesel engine forms a vital part of both of these

sectors throughout the world. Diesel fuel has versatile applications because of its high fuel efficiency compared to gasoline. Fuel crisis and environmental concerns have renewed interest of scientific community to look for alternative fuels of bio-origin such as vegetable oil. Bio-diesel was found as the best alternate fuel, technically and environmentally acceptable as well as easily available. Biodiesel consists of methyl/ethyl esters of fatty acids and is suitable for use in diesel engines (Mahesh *et al.*, 2010).

General findings of almost all researchers are that CO, HC, SO_x and particulate matters of engine emissions decreased with increasing proportion of bio-diesel in diesel-biodiesel mixture with some increase in emission of NO_x. Presence of oxygen in bio-diesel is reported to be the reason for more complete combustion of carbon and hydrocarbon, while low sulfur content of biodiesel was responsible for reduction of SO_x (Behcet, 2011).

2. MATERIALS AND METHODS

2.1 Production of bio-diesel

Fresh oil was extracted from *Jatropha Curcas* seed using a mini oil expeller. Bio-diesel of *Jatropha Curcas* oil was prepared as per the procedure recommended by Gupta, 1984. Various steps involved in this procedure are shown in Fig. 1. Moisture free methanol was used in the methanol oil molar ratio of 6:1 (for 100 ml oil, 20 ml methanol and sodium hydroxide (1% by weight of oil) was used as catalyst. A homogenous mixture of methanol and sodium hydroxide was made.

The method basically involved five steps:

- i. Heating of oil 60°C (oil temperature kept below the boiling point of methanol i.e. 65°C).
- ii. Mixing of heated oil and alkaline methanol. The mixing was done in a stainless steel container, as stainless steel is inert to the corrosive action of sodium hydroxide and to the action of organic solvent methanol.
- iii. Separation of glycerol (which settles at the bottom) and fatty acid methyl esters.
- iv. Decanting of prepared ester and its washings with water (3-4 times) to remove any impurities left. Separation of ester from water by 2nd decantation.
- v. Heating of decanted ester to remove all the traces of moisture.

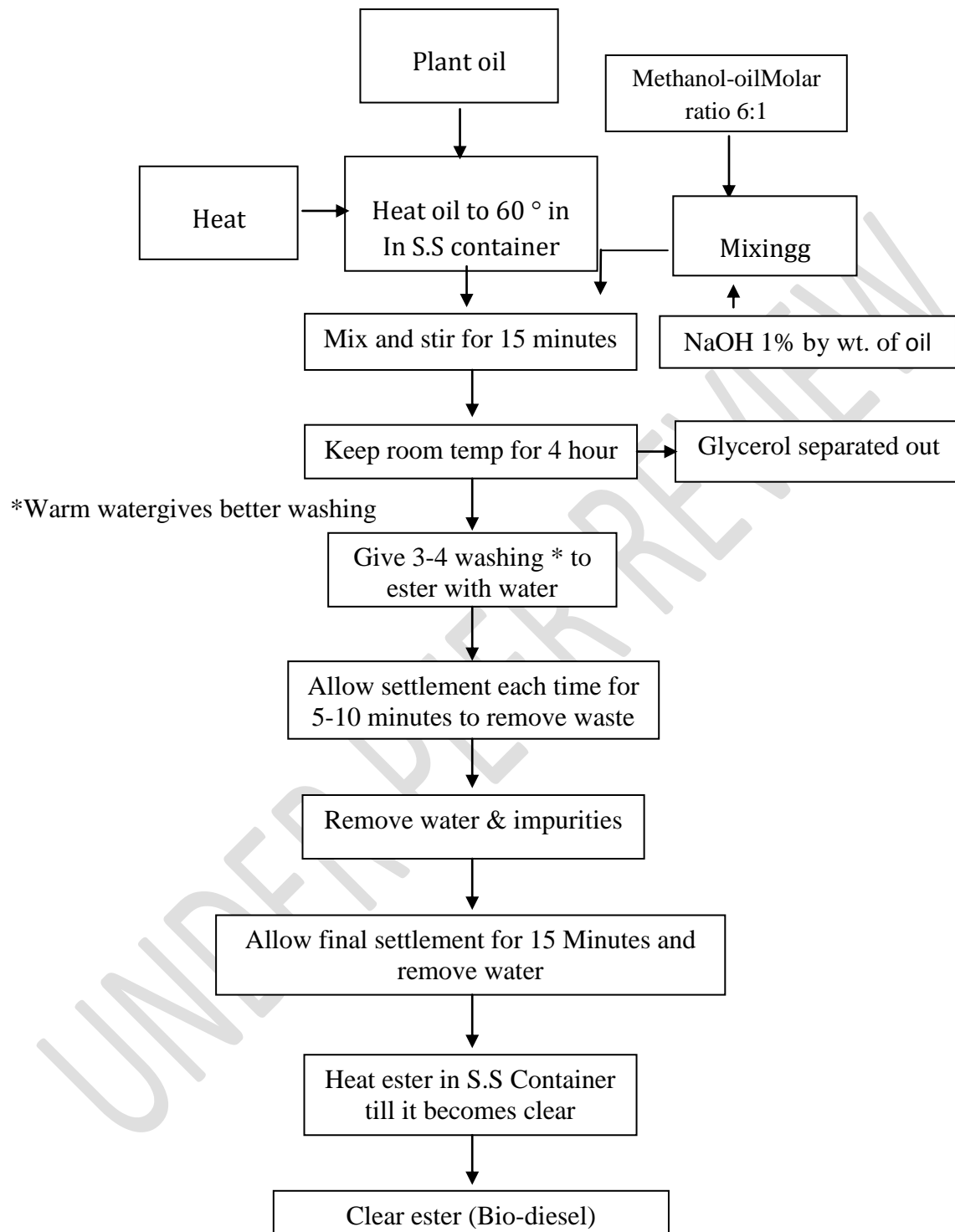


Chart 1. Simplified procedure for batch level esterification of plant oils

2.2 Fuel characterization of bio-diesel and its blends

Characterization of diesel and biodiesel was done at Department of Renewable Energy Engineering, Anand Agricultural University, Godhra, as per the ASTM standards (ASTM-1983). The following characteristics were determined for the said fuel.

1. Kinematic viscosity
2. Density
3. Flash and fire point
4. Cloud and pour point
5. Calorific value

Methods used for determination of different characteristics of fuels are as per standard.

2.3 Experimental set- up

An experimental setup was prepared in the Biofuel laboratory of Department of Renewable Energy Engineering, CAET, AAU, Godhra. The set up was comprising of one single cylinder engine with 5 kW load resistance for power measurement device, exhaust gas temperature sensors fitted at exhaust of the engine, sound level meter and digital microprocessor based exhaust gas analyzer and NO_x analyzer.

The equipped sub systems in the engine set up were:

- i) Engine coupled to a generating set.
- ii) Fuel supply and measuring unit.
- iii) Electrical loading device.
- iv) Power measuring unit.

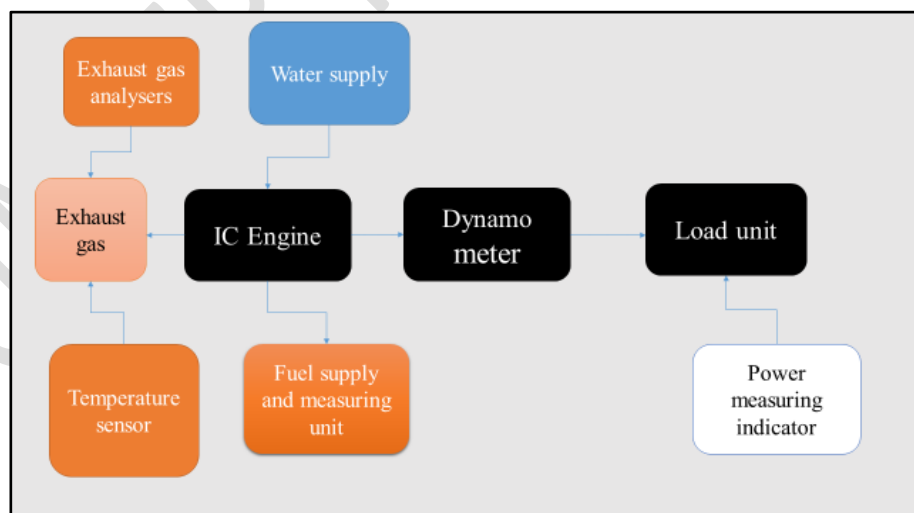


Chart 2. Schematic diagram of experimental set up

2.4 Exhaust gas analyzers

Three types of exhaust gas analyser is used for measuring concentration of different exhaust gas components.

- 1) Gas board analyser
- 2) NO_x gas analyser
- 3) ECO GAS 100 gas analyser



Pic 1. Gas board analyser



Pic 2. NO_x gas analyser



Pic 3. ECO GAS 100 gas analyser

2.5 Engine power performance

a) Power developed by engine

$$\text{Power in kW} = (V \times I) / 1000$$

where,

V = Voltage (Volt)

I = Current (Ampere)

b) Break specific fuel consumption (BSFC)

Total Fuel Consumption TFC

$$\text{TFC} = (v \times \tau \times 3600) / t$$

Where,

TFC = Total fuel consumption, g/h

v = Volume of fuel, ml

τ = Specific gravity of the fuel,

t = Time taken to consume specific volume of fuel, sec

c) Brake specific energy consumption (BSEC)

Break specific fuel consumption = Total fuel consumption / Power output,

$$\text{BSFC} = (\text{TFC} / P) (\text{kg/kWh})$$

d) Brake thermal efficiency (BTE)

$$\eta_{bt}(\%) = \frac{\text{Energy equivalent of brake power (Kw)}}{\text{Energy supplied by fuel (Kw)}} \times 100$$

Dharmadhikari (2012)

3. RESULTS AND DISSCUSION

This is the analysis and representation of the experimental data collected during the course investigation.

The short duration engine performance test was conducted using diesel (100%) fuel for comparison with blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of di-tert butyl peroxide (DTBP) (0.5, 1.0, 1.5, 2.0 and 2.5%) at various engine load conditions (0, 20, 40, 60, 80 and 100 %).

3.1 Performance of CI engine with different loads, different blends of biodiesel with diesel fuel and different proportions of DTBP additive.

i. Brake specific fuel consumption

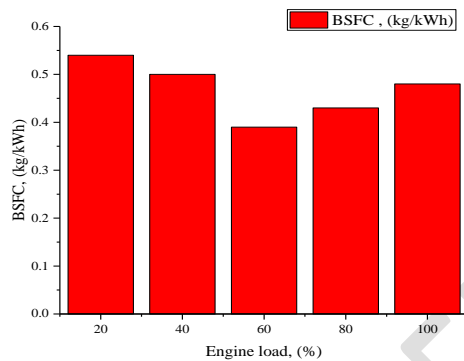


Fig.1 Variation in brake specific fuel consumption of engine with different engine loads using 100 % diesel

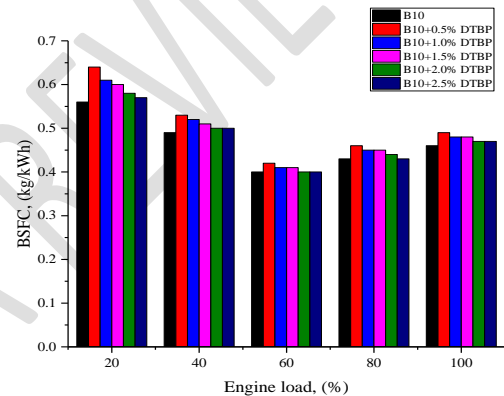


Fig.2 Variation in brake specific fuel consumption of engine with different engine loads using B10 with different proportion of DTBP

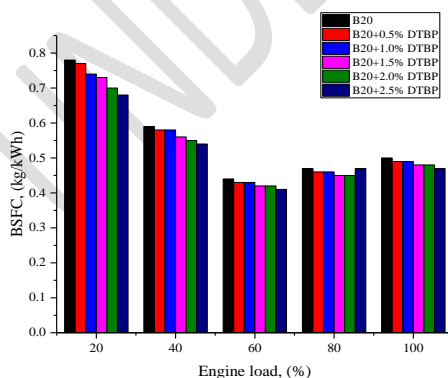


Fig.3 Variation in brake specific fuel consumption of engine with different engine loads using B20 with different proportion of DTBP

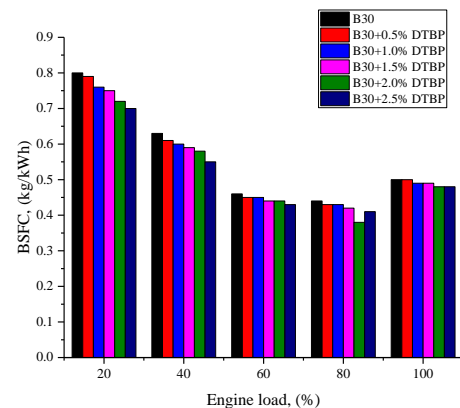


Fig.4 Variation in brake specific fuel consumption of engine with different engine loads using B30 with different proportion of DTBP

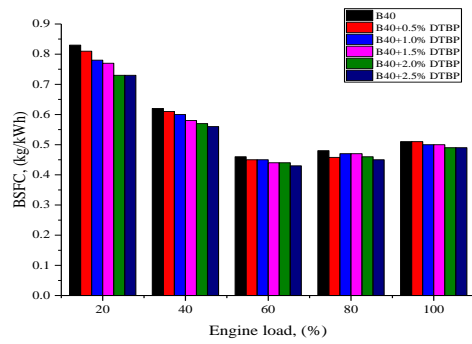


Fig.5 Variation in brake specific fuel consumption of engine with different engine loads using B40 with different proportion of DTBP

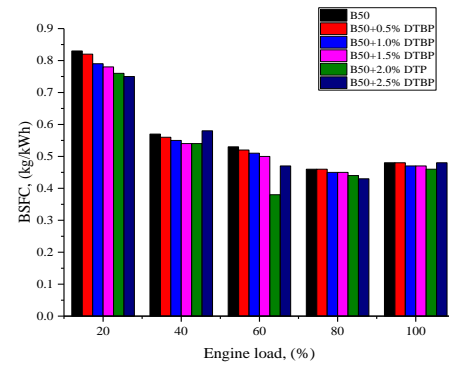


Fig.6 Variation in brake specific fuel consumption of engine with different engine loads using B50 with different proportion of DTBP

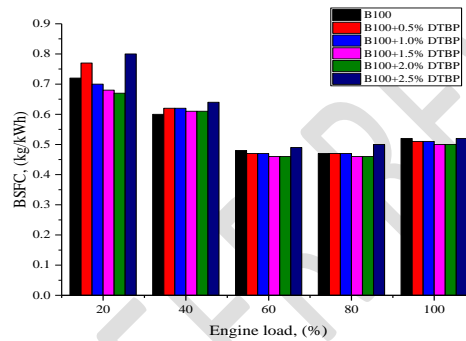


Fig.7 Variation in brake specific fuel consumption of engine with different engine loads using B100 with different proportion of DTBP

Brake specific fuel consumption designated as BSFC is the quantity of fuel consumed per kilowatt per hour in an engine. Brake specific fuel consumption of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Brake specific fuel consumption of the CI engine.

The variation in brake specific fuel consumption at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP(0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 1 to Fig. 7. The maximum and minimum in brake specific fuel consumption was observed 0.84 kg/kWh with B₅A₁L₁ and 0.37 kg/kWh with B₃A₅L₅ treatment combination respectively.

ii. Brake specific energy consumption

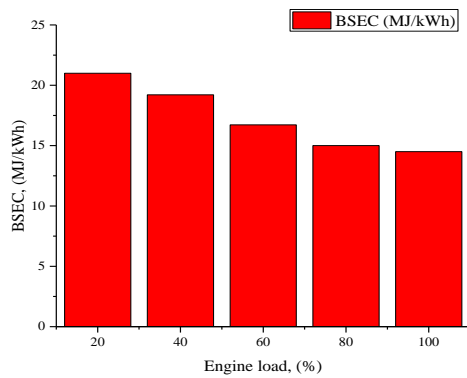


Fig. 8 Variation in brake specific energy consumption of engine with different engine loads using 100 % diesel

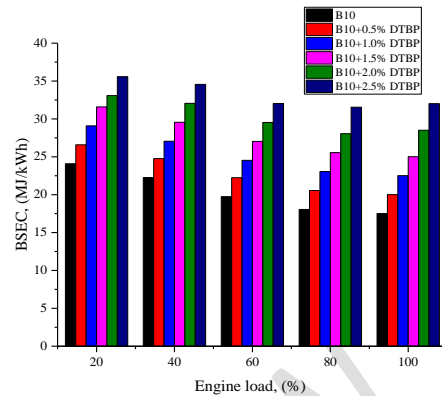


Fig. 9 Variation in brake specific energy consumption of engine with different engine loads using B10 with different proportion of DTBP

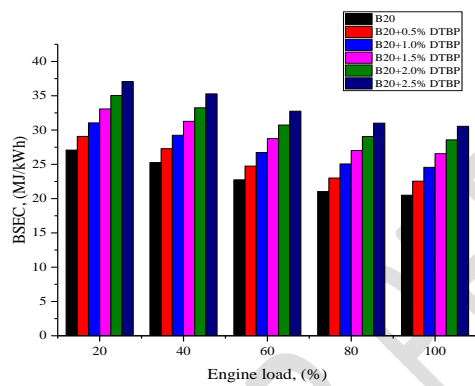


Fig. 10 Variation in brake specific energy consumption of engine with different engine loads using B20 with different proportion of DTBP

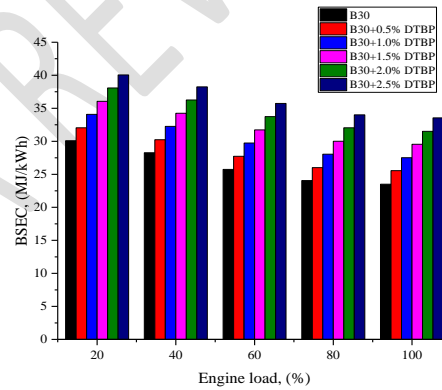


Fig. 11 Variation in brake specific energy consumption of engine with different engine loads using B30 with different proportion of DTBP

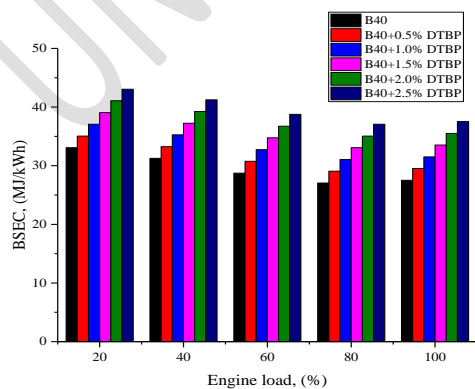


Fig. 12 Variation in brake specific energy consumption of engine with different engine loads using B40 with different proportion of DTBP

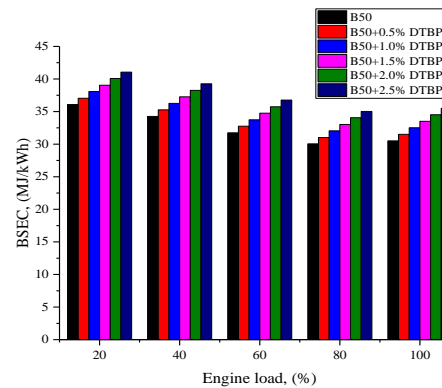


Fig. 13 Variation in brake specific energy consumption of engine with different engine loads using B50 with different proportion of DTBP

loads using B40 with different proportion of
DTBP

DTBP

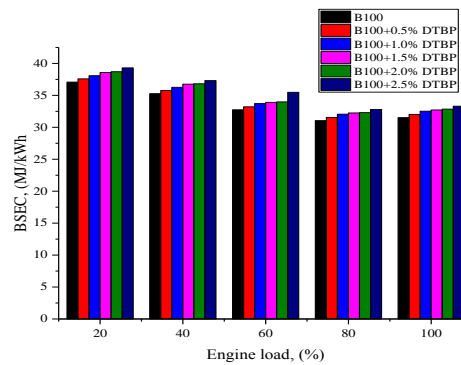


Fig. 14 Variation in brake specific energy consumption of engine with different engine loads using B100 with different proportion of DTBP

Brake specific energy consumption designated as BSFC is the quantity of energy consumed per kilowatt per hour in an engine. Brake specific energy consumption of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Brake specific fuel consumption of the CI engine.

The variation in brake specific energy consumption at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 8 to Fig. 14. The maximum and minimum in brake specific fuel consumption was observed 42.15MJ/kWh with B₄A₆L₂ and 17.51MJ/kWh with B₁A₁L₆ treatment combination respectively.

iii. Brake power

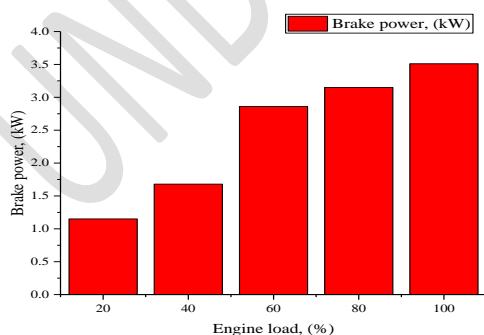


Fig. 15 Variation in brake power (kW) of engine with different engine loads using 100 % diesel

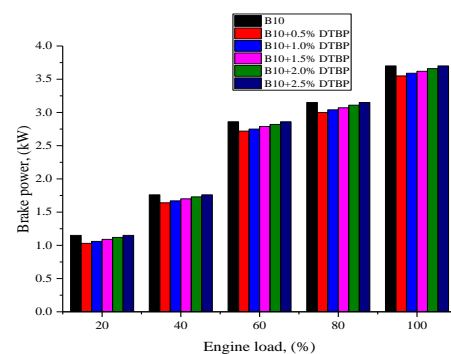


Fig. 16 Variation in brake power (kW) of engine with different engine loads using B10 with different proportion of DTBP

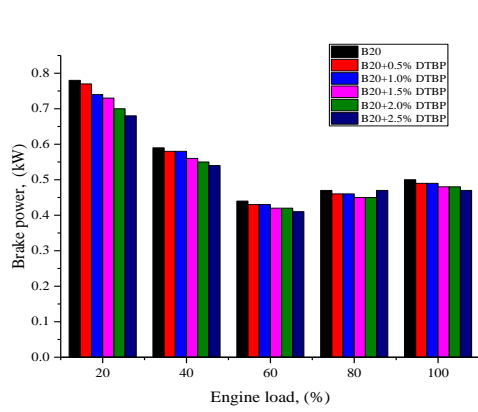


Fig. 17 Variation in brake power (kW) of engine with different engine loads using B20 with different proportion of DTBP

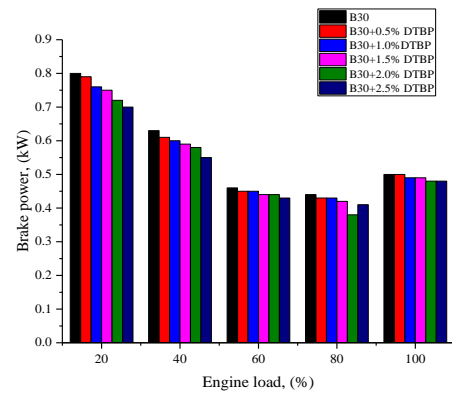


Fig. 18 Variation in brake power (kW) of engine with different engine loads using B30 with different proportion of DTBP

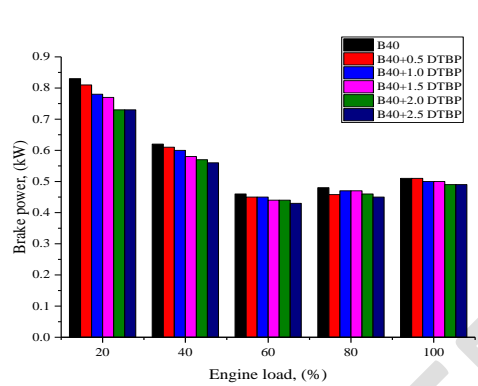


Fig. 19 Variation in brake power (kW) of engine with different engine loads using B40 with different proportion of DTBP

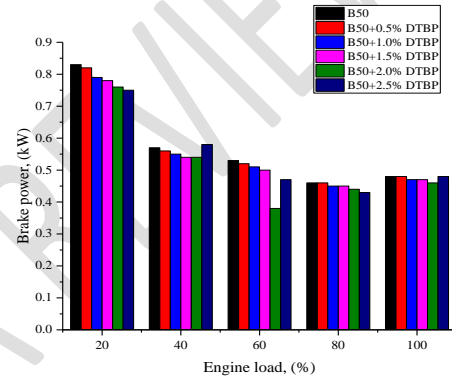


Fig. 20 Variation in brake power (kW) of engine with different engine loads using B50 with different proportion of DTBP

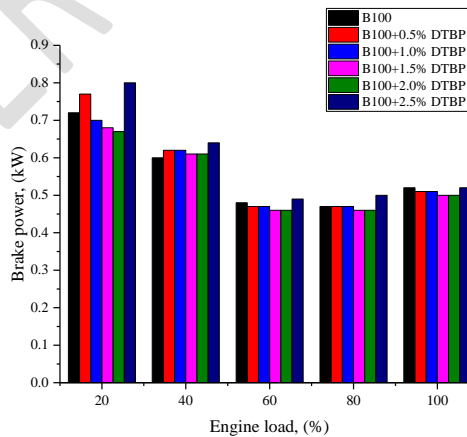


Fig. 21 Variation in brake power (kW) of engine with different engine loads using B100 with different proportion of DTBP

Brake power (kW) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Brake power of the CI engine.

The variation in brake power at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 15 to Fig. 21. The maximum and minimum in brake power (kW) was observed 3.97kW with B₆A₅L₆ and 0.85kW with B₄A₁L₂ treatment combination respectively.

iv. Brake thermal efficiency

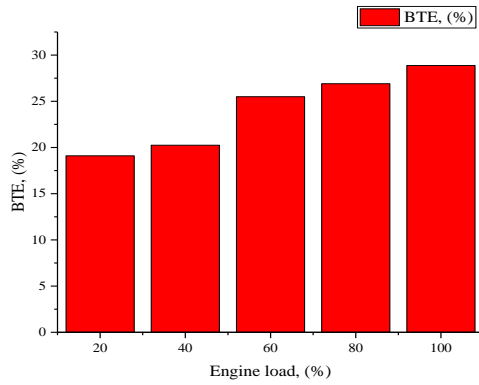


Fig. 22 Variation in brake thermal efficiency (%) of engine with different engine loads using 100 % diesel

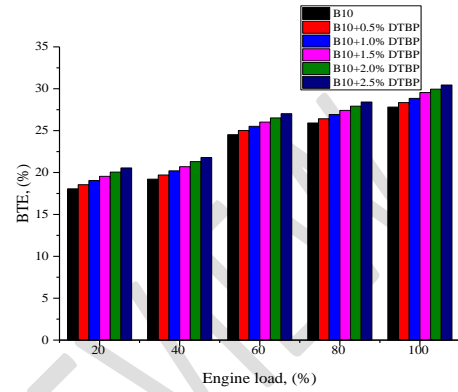


Fig. 23 Variation in brake thermal efficiency (%) of engine with different engine loads using B10 with different proportion of DTBP

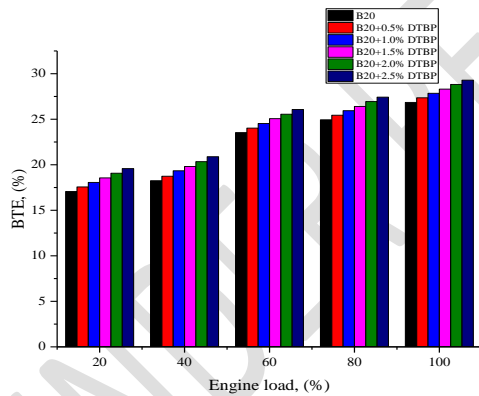


Fig. 24 Variation in brake thermal efficiency (%) of engine with different engine loads using B20 with different proportion of DTBP

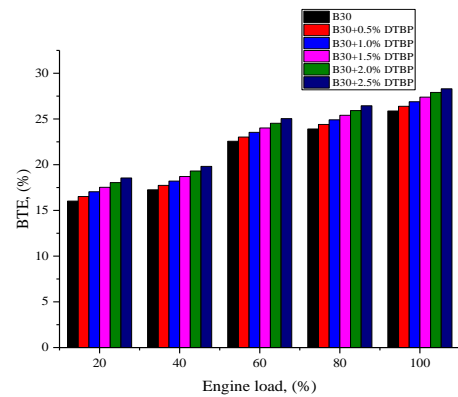


Fig. 25 Variation in brake thermal efficiency (%) of engine with different engine loads using B30 with different proportion of DTBP

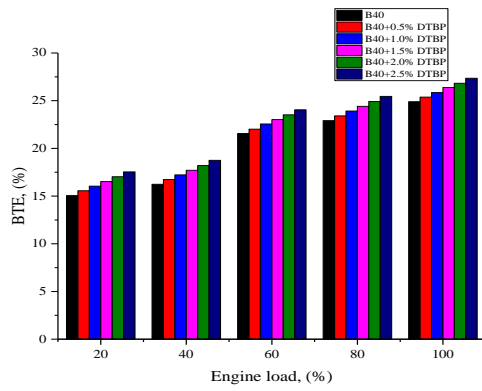


Fig. 26 Variation in brake thermal efficiency (%) of engine with different engine loads using B40 with different proportion of DTBP

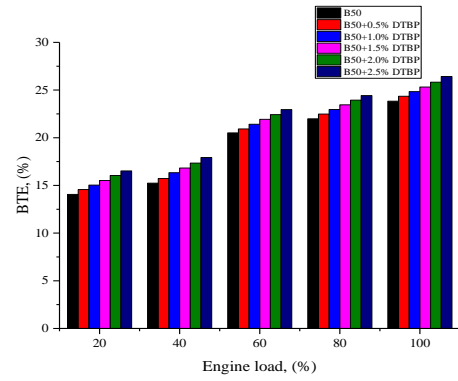


Fig. 27 Variation in brake thermal efficiency (%) of engine with different engine loads using B50 with different proportion of DTBP

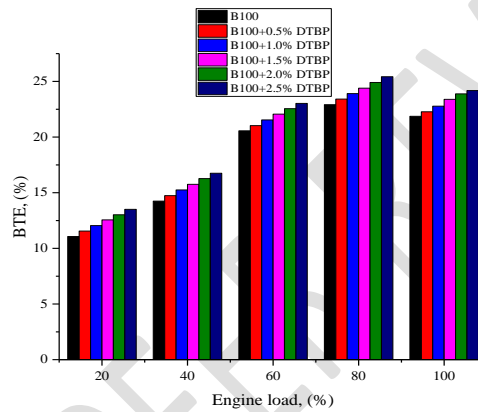


Fig. 28 Variation in brake thermal efficiency (%) of engine with different engine loads using B100 with different proportion of DTBP

Brake thermal efficiency (%) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Brake thermal efficiency (%) of the CI engine.

The variation in brake power at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 22 to Fig. 28. The maximum and minimum in brake thermal efficiency (%) was observed 30.55 % with $B_{10}A_6L_6$ and 10.97 % with $B_{26}A_1L_2$ treatment combination respectively.

3.2 Emission characteristics CI engine with different loads, different blends of biodiesel with diesel fuel and different proportions of DTBP additive.

a) Carbon dioxide (CO₂)

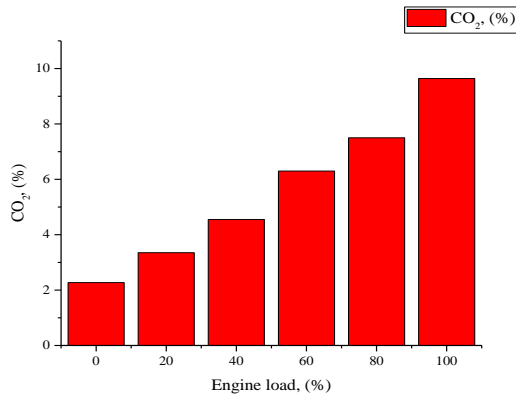


Fig. 29 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using 100 % diesel

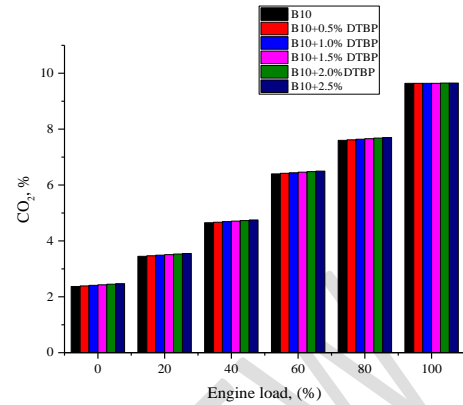


Fig. 30 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using B10 with different proportion of DTBP

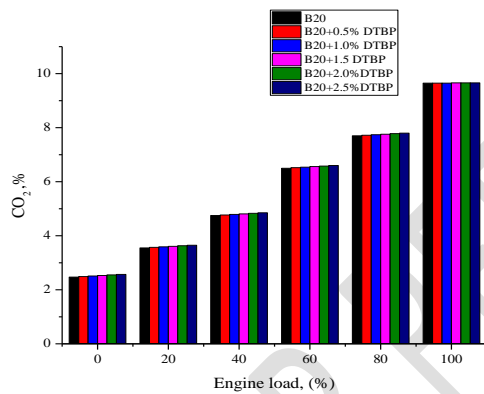


Fig. 31 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using B20 with different proportion of DTBP

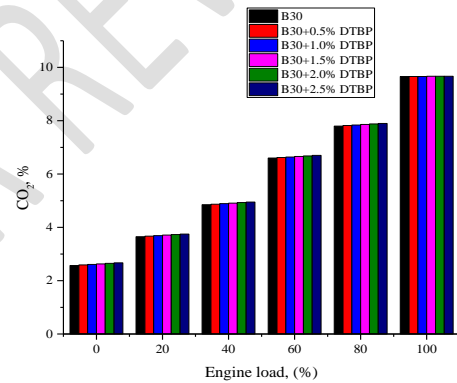


Fig. 32 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using B30 with different proportion of DTBP

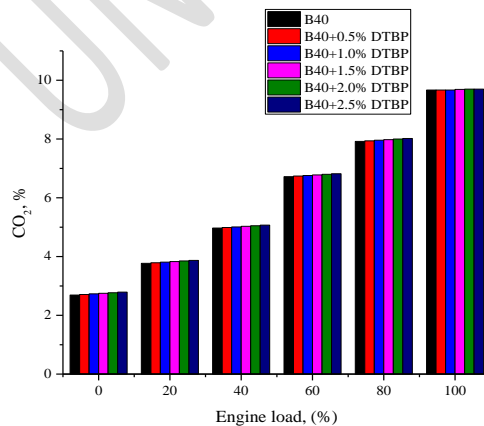


Fig. 33 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using B40

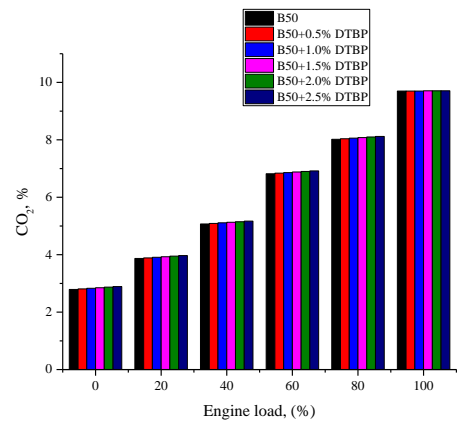


Fig. 34 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads

with different proportion of DTBP

using B50 with different proportion of
DTBP

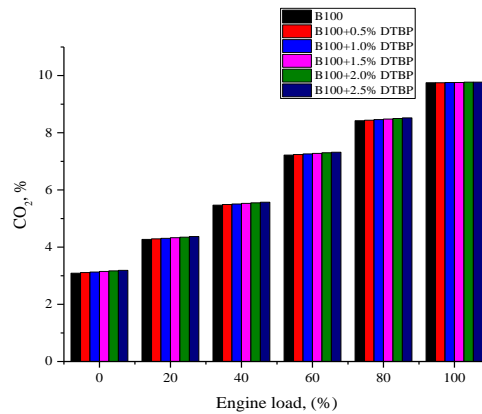


Fig. 35 Variation in carbon dioxide (CO₂) (%) of engine with different engine loads using B100 with different proportion of DTBP

Carbon dioxide (CO₂) (%) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Carbon dioxide (CO₂) (%) of the CI engine.

The variation in Carbon dioxide (CO₂) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 29 to Fig. 35. The maximum and minimum in Carbon dioxide (CO₂) (%) was observed 9.8 % with B₆A₆L₆ and 2.2 % with B₅A₆L₃ treatment combination respectively.

b) Carbon monoxide (CO)

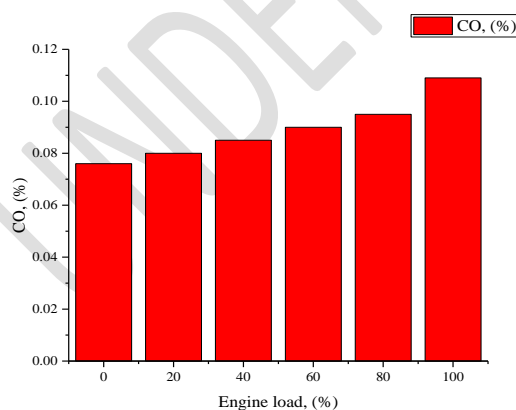


Fig. 36 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using 100 % diesel

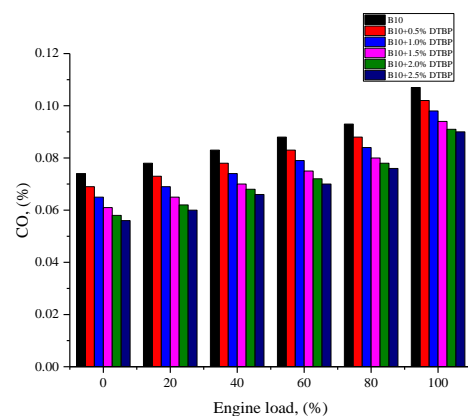


Fig. 37 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B10 with different proportion of DTBP

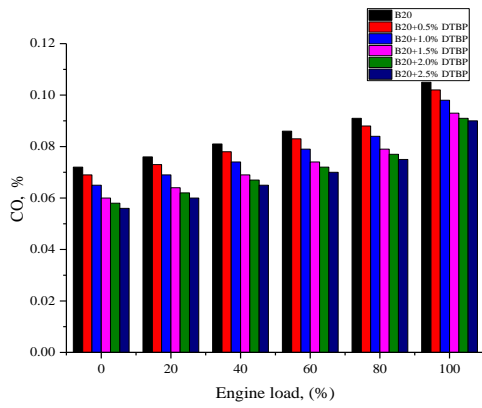


Fig. 38 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B20 with different proportion of DTBP

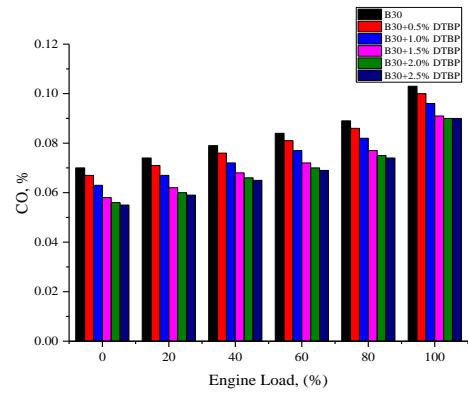


Fig. 39 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B30 with different proportion of DTBP

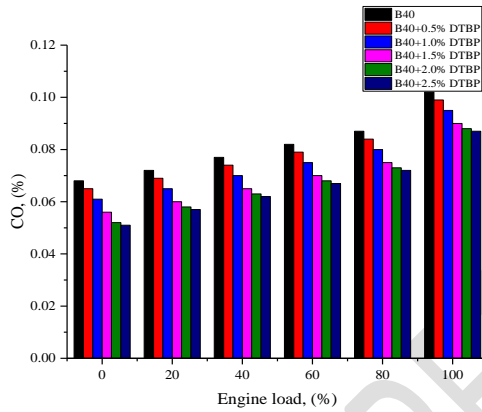


Fig. 40 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B40 with different proportion of DTBP

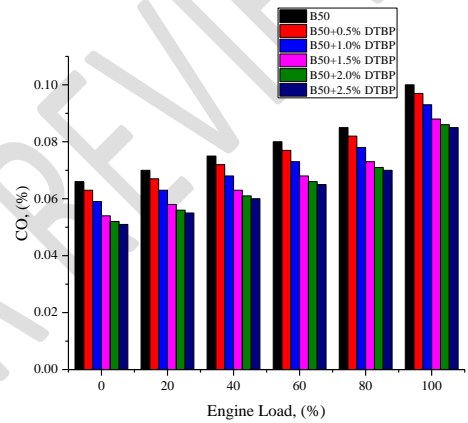


Fig. 41 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B50 with different proportion of DTBP

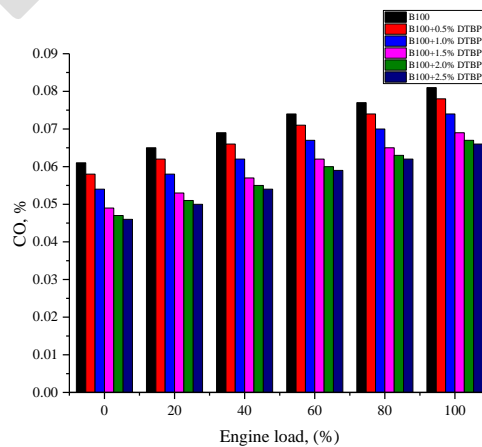


Fig. 42 Variation in carbon monoxide (CO) (%) emission of engine with different engine loads using B100 with different proportion of DTBP

Carbon monoxide (CO) (%) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Carbon dioxide (CO₂) (%) of the CI engine.

The variation in carbon monoxide (CO) (%) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 36 to Fig. 42. The maximum and minimum in carbon monoxide (CO) (%) was observed 0.107 % with B₁A₁L₆ and 0.046 % with B₆A₆L₁ treatment combination respectively. Carbon monoxide (CO) emission permissible limit is 0.0687 %.

c) Nitrogen oxides (NO_x)

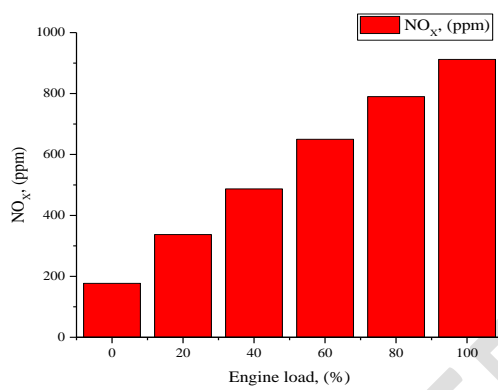


Fig. 43 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using 100 % diesel.

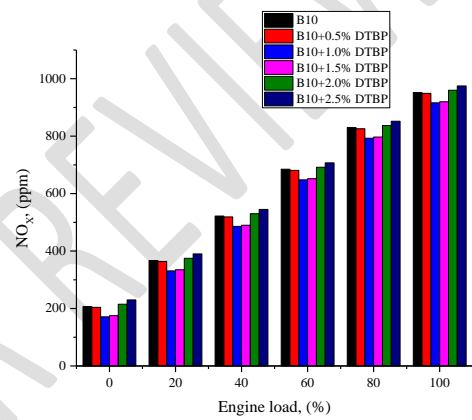


Fig. 44 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B10 with different proportion of DTBP

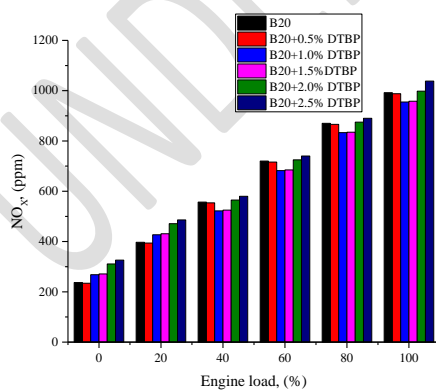


Fig. 45 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B20 with different proportion of DTBP

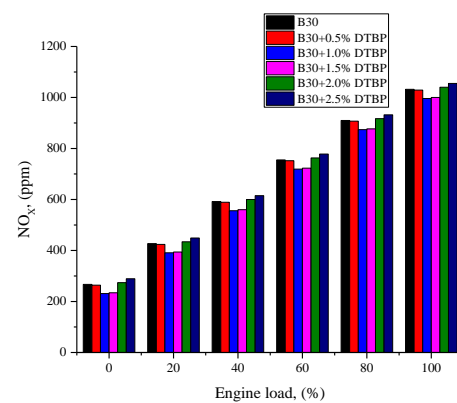


Fig. 46 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B30 with different proportion of DTBP

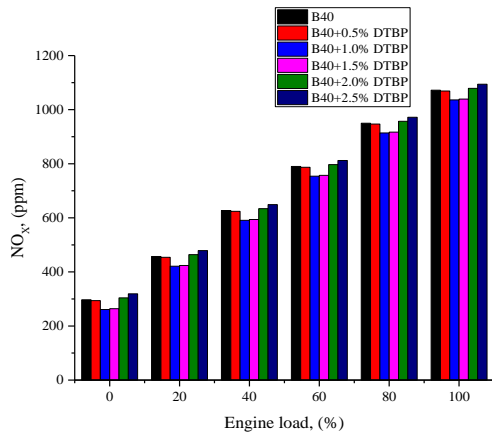


Fig. 47 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B40 with different proportion of DTBP

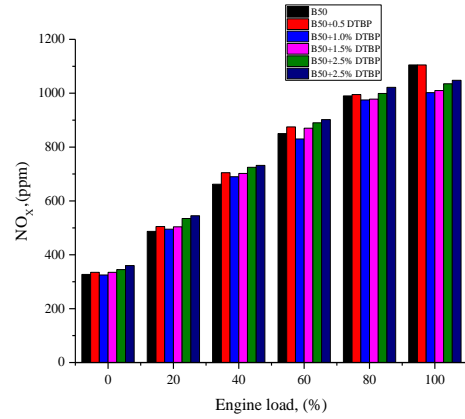


Fig. 48 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B50 with different proportion of DTBP

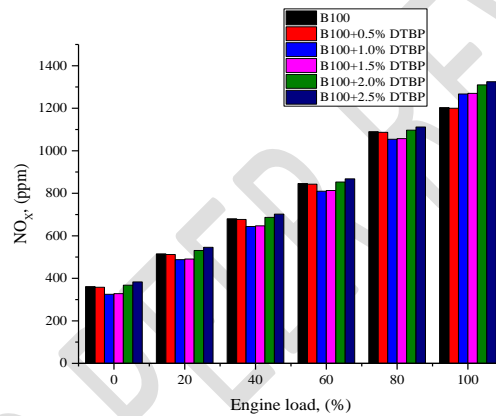


Fig. 49 Variation in nitrogen oxides (NO_x) (ppm) emission of engine with different engine loads using B100 with different proportion of DTBP

Nitrogen oxides (NO_x) (ppm) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the nitrogen oxides (NO_x) (ppm) of the CI engine.

The variation in nitrogen oxides (NO_x) (ppm) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 43 to Fig. 49. The maximum and minimum in nitrogen oxides (NO_x) (ppm) was observed 1325 ppm with B₆A₆L₆ and 171 ppm with B₁A₃L₁ treatment combination respectively. Nitrogen oxides (NO_x) permissible limit is 1011 ppm.

d) Hydrocarbons (HC)

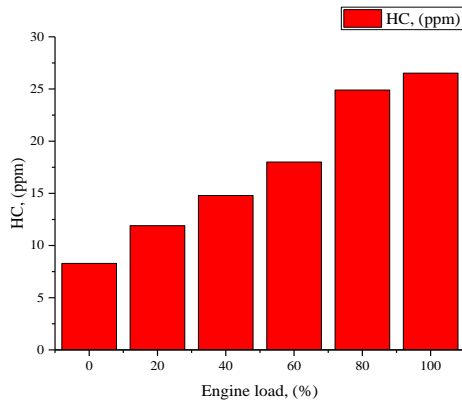


Fig. 50 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads using 100% diesel

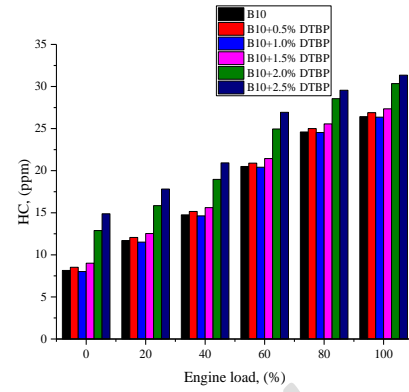


Fig. 51 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads using B10 with different proportion of DTBP

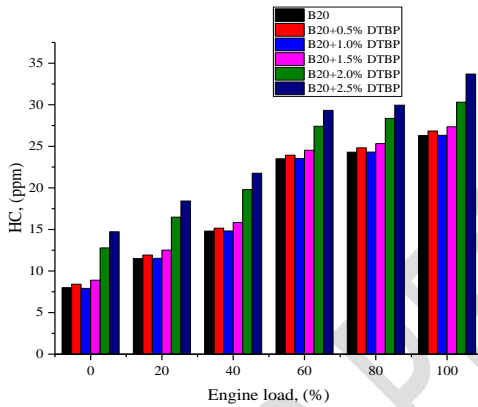


Fig. 52 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads using B20 with different proportion of DTBP

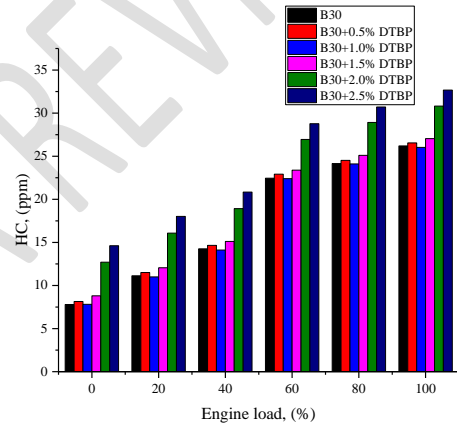


Fig. 53 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads using B30 with different proportion of DTBP

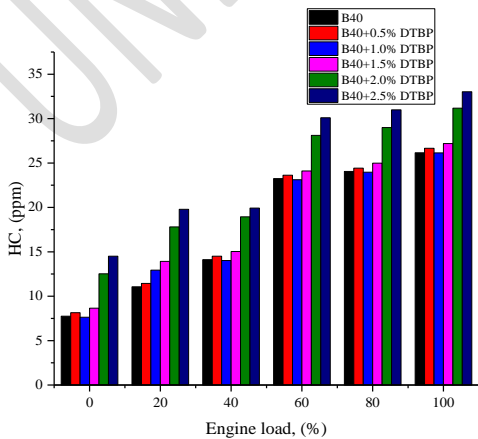


Fig. 54 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads

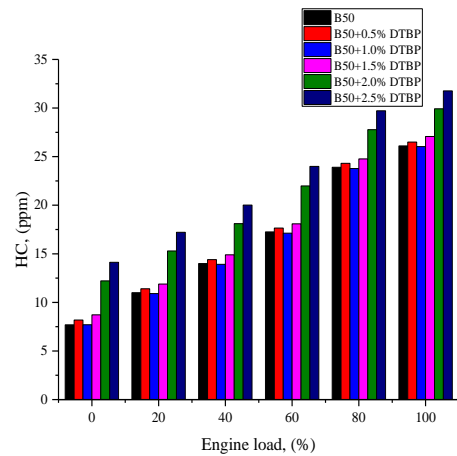


Fig. 55. Variation in hydrocarbons (HC) (ppm) emission of engine with different

using B40 with different proportion of DTBP

engine loads using B50 with different
proportion of DTBP

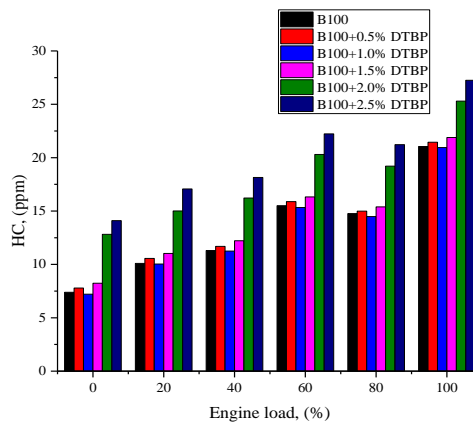


Fig. 56 Variation in hydrocarbons (HC) (ppm) emission of engine with different engine loads using B100 with different proportion of DTBP

Hydrocarbons (HC) (ppm) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the hydrocarbons (HC) (ppm) of the CI engine.

The variation in hydrocarbons (HC) (ppm) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 50 to Fig. 56. The maximum and minimum in hydrocarbons (HC) (ppm) was observed 33.69 ppm with B₂A₆L₆ and 7.21 ppm with B₆A₃L₁ treatment combination respectively. Hydrocarbons (HC) permissible limit is 480 ppm.

e) Exhaust gas temperature

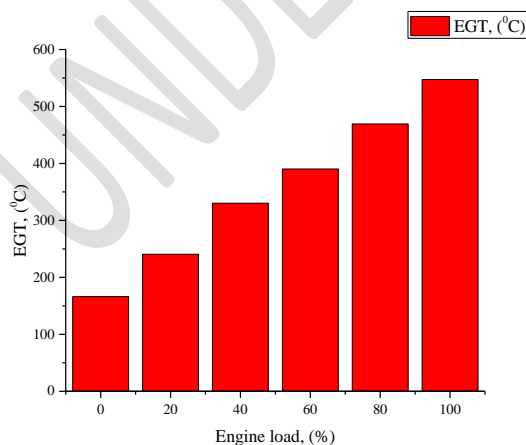


Fig. 57 Variation in exhaust gas temperature (°C) of engine with different engine loads using 100 % diesel.

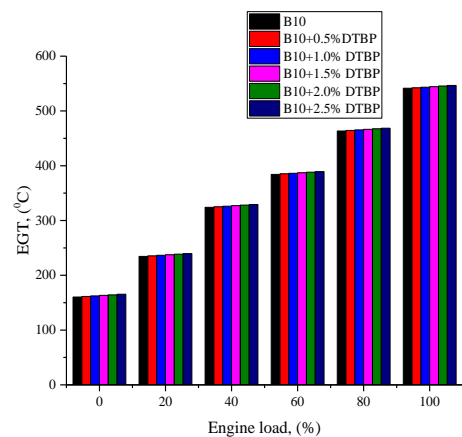


Fig. 58 Variation in exhaust gas temperature (°C) of engine with different engine loads using B10 with different proportion of DTBP

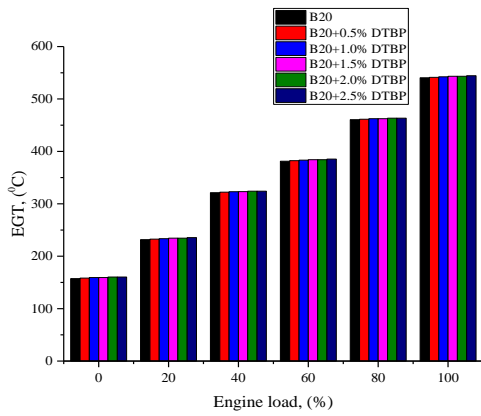


Fig. 59 Variation in exhaust gas temperature (°C) of engine with different engine loads using B20 with different proportion of DTBP

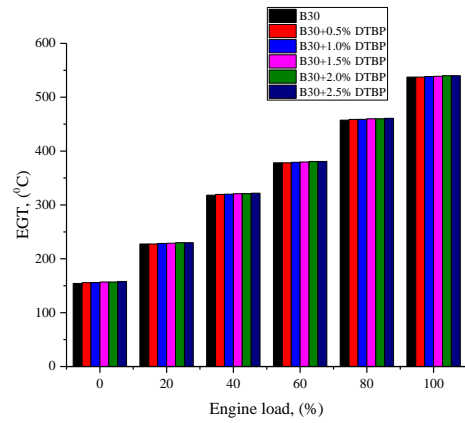


Fig. 60 Variation in exhaust gas temperature (°C) of engine with different engine loads using B30 with different proportion of DTBP

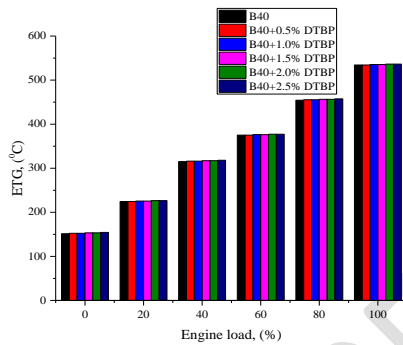


Fig. 61 Variation in exhaust gas temperature (°C) of engine with different engine loads using B40 with different proportion of DTBP

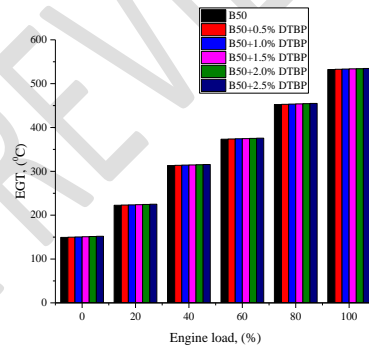


Fig. 62 Variation in exhaust gas temperature (°C) of engine with different engine loads using B50 with different proportion of DTBP

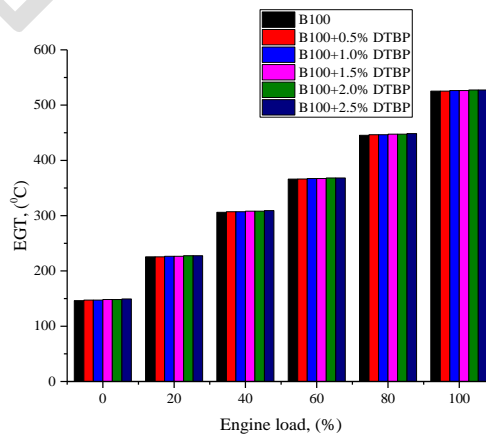


Fig. 63 Variation in exhaust gas temperature (°C) of engine with different engine loads using B100 with different proportion of DTBP

Exhaust gas temperature ($^{\circ}\text{C}$) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the exhaust gas temperature ($^{\circ}\text{C}$) of the CI engine.

The variation in exhaust gas temperature ($^{\circ}\text{C}$) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 57 to Fig. 63. The maximum and minimum in exhaust gas temperature ($^{\circ}\text{C}$) was observed 546.53°C with $\text{B}_1\text{A}_6\text{L}_6$ and 146.32°C with $\text{B}_6\text{A}_6\text{L}_6$ treatment combination respectively.

f) Sound level

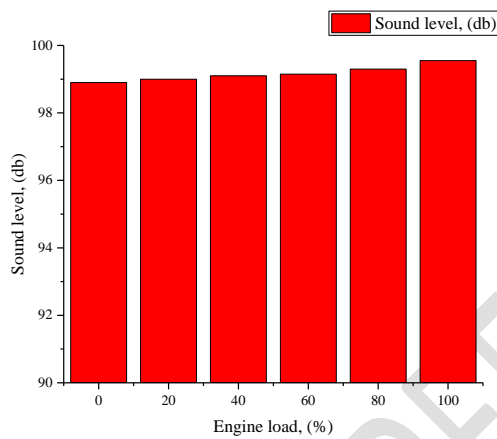


Fig. 64 Variation in sound level (db) of engine with different engine loads using 100 % diesel

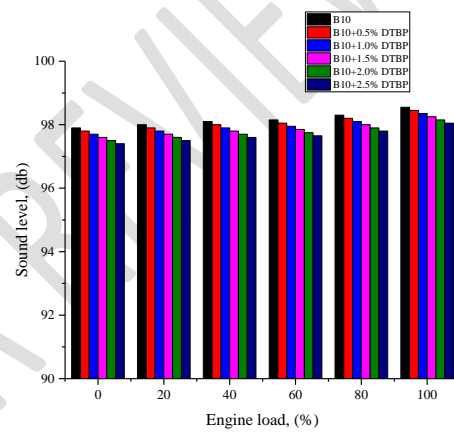


Fig. 65 Variation in sound level (db) of engine with different engine loads using B10 with different proportion of DTBP

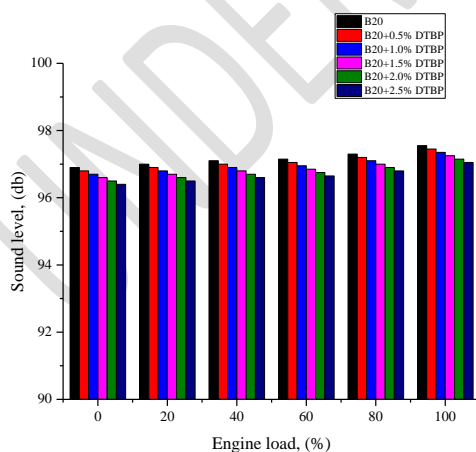


Fig. 66 Variation in sound level (db) of engine with different engine loads using B20 with different proportion of DTBP

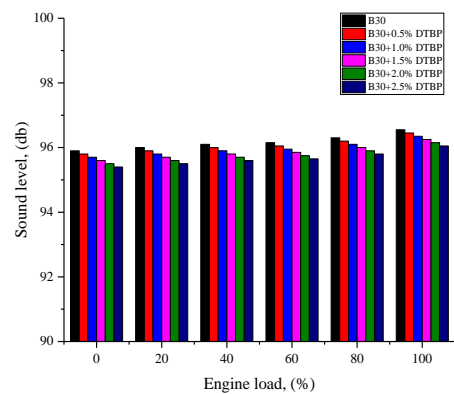


Fig. 67 Variation in Sound level (db) of engine with different engine loads using B30 with different proportion of DTBP

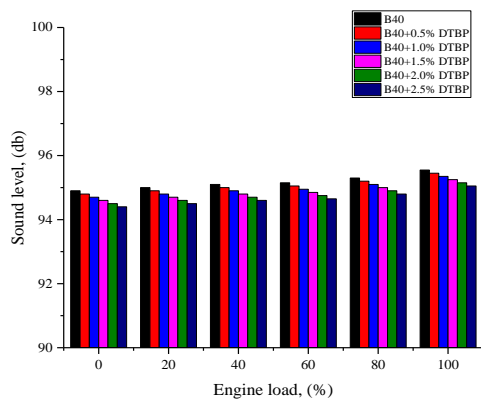


Fig. 68 Variation in sound level (db) of engine with different engine loads using B40 with different proportion of DTBP

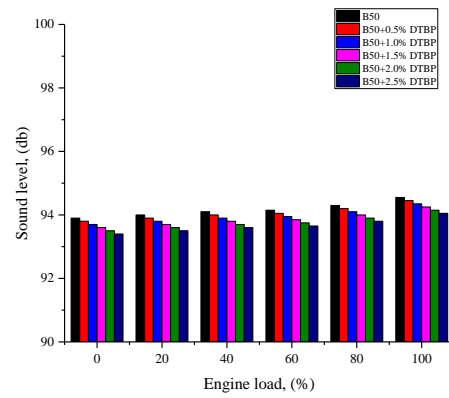


Fig. 69 Variation in sound level (db) of engine with different engine loads using B50 with different proportion of DTBP

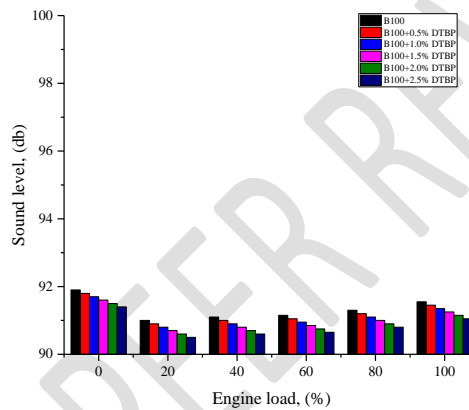


Fig. 70 Variation in sound level (db) of engine with different engine loads using B100 with different proportion of DTBP

Sound level (db) of CI engine was measured with different combination of blends with diesel and different load conditions. It was also showed that all the independent parameters significantly affect the Sound level (db) of the CI engine.

The variation in sound level (db) at diesel fuel (100%), blends of biodiesel with diesel (10, 20, 30, 40, 50 and 100%) with different proportion of DTBP (0.5, 1.0, 1.5, 2.0 and 2.5%) at various load conditions (0, 20, 40, 60, 80 and 100 %) is shown in Fig. 64 to Fig. 70. The maximum and minimum in sound level (db) was observed 90.49 (db) with B₆A₆L₂ and 98.55 (db) with B₁A₁L₆ treatment combination respectively.

4. CONCLUSIONS

The overall summary of the study carried out based on the conducted experimentation. The salient findings of the study are listed below.

1. The maximum and minimum break specific fuel consumption was found as 0.84kg/kWh and 0.37kg/kWh with B₅A₁L₁ and B₃A₅L₅ treatment combination, respectively.
2. The maximum and minimum break specific energy consumption was found as 42.15 MJ/kWh and 17.51 MJ/kWh with B₄A₆L₂ and B₁A₁L₆ treatment combination, respectively.
3. The maximum and minimum break power was found as 3.97 kW and 0.85 kW with B₆A₅L₆ and B₄A₁L₂ treatment combination, respectively.
4. The maximum and minimum brake thermal efficiency was found as 30.55 % and 10.97 % with B₁A₆L₆ and B₆A₁L₂ treatment combination, respectively.
5. The maximum and minimum carbon dioxide (CO₂) was found as 9.82 % and 2.2 % with B₆A₆L₆ and B₅A₆L₃ treatment combination, respectively.
6. The maximum and minimum carbon dioxide (CO₂) was found as 0.107 % and 0.046 % with B₁A₁L₆ and B₆A₆L₁ treatment combination, respectively.
7. The maximum and minimum nitrogen oxides (NO_x) was found as 1325 ppm and 177 ppm with B₆A₆L₆ and B₁A₃L₁ treatment combination, respectively.
8. The maximum and minimum hydrocarbons (HC) was found as 33.69 ppm and 7.21 ppm with B₂A₆L₆ and B₆A₃L₁ treatment combination, respectively.
9. The maximum and minimum exhaust gas temperature was found as 546.53 °C and 146.32 °C with B₁A₆L₆ and B₆A₆L₆ treatment combination, respectively.
10. The maximum and minimum sound level was found as 90.49 (db.) and 98.55 (db.) with B₆A₆L₂ and B₁A₁L₆ treatment combination, respectively.
11. Percentage of fuel cost saving per hour using biodiesel blends in CI Engine at full load condition with all the blends of biodiesel and diesel were 1.78, 3.61, 5.47, 7.38, 9.34 and 20.44 percentage, respectively.
12. Percentage of fuel cost saving per hour using 50 % biodiesel + 50 % diesel + 1.5 % DTBP blends in CI Engine at full load condition was 0.23 % at best treatments (B₅A₃L₆).

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