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Experimental Investigation on Performance and Emission Characteristics of Methyl Ester Neem Oil with Turbocharger

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I. INTRODUCTION

1.1 GENERAL

In our project, we made the analysis in the compressed ignition engine and it is a Direct Injection engine. In this engine fuel is directly injected in to the combustion chamber. Direct injection means the fuel is directly injected into the combustion chamber. The fuel is injected under high pressure through a nozzle with either single or multiple tiny orifices. This results the fuel to issue as very fine spray making it easier to ignite and burn. In this project, the investigation process is done by using biodiesel (B20) with the turbocharger and the comparison process is done between the diesel and biodiesel. The comparison process is done both by connecting and without connecting the turbocharger.

1.2.1 NEEM OIL AS AN ALTERNATE FUEL

During the early stages of the diesel engine, strong interest was shown in the use of vegetable oils as fuel but this interest declined in the late 1950`s after the supply of petroleum products become abundant . During the early 1970`s, oil stock however caused a renewed interest in vegetable oil fuels. The interest evolved after it became apparent that the world's petroleum reserves were dwindling. Generally, there are three forms to use vegetable oils as fuel in diesel engines. They are neat or pure vegetable oils, blends of vegetable oils and diesel fuel, and

transesterified vegetable oils. In our project, we use the neem oil as the fuel to run the engine. The first and second forms have problems associated with the long term performance of diesel engines because of higher viscosity of fuel. The fuel which is made by using the neem seeds contains lower viscosity. So inorder to overcome such a problem, the neem oil is transesterified and convert in to the methyl ester neem oil.

1.3 BIO DIESEL

A Biofuel is a type of fuel whose energy is derived from biological carbon fixation. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases. First-generation or conventional biofuels are biofuels made from sugar, starch, and vegetable oil. Second generation biofuels are biofuels produced from sustainable feedstock. Many second generation biofuels are under development such as Cellulosic ethanol, Algae fuel, biohydrogen, biomethanol, Fischer-Tropschdiesel, biohydrogen diesel, mixed alcohols and wood diesel.

TABLE 1.1 Demand for Petrol, Diesel and Biodiesel

YEAR	PETROL DEMAND MT	DIESEL DEMAND MT	BIODIESEL BLENDING REQUIREMENT(20% blend) MT
2006-07	10.07	52.32	10.46
2011-12	12.85	66.91	13.38
2016-17	16.40	83.58	16.72

1.3.2 ADVANTAGES OF BIODIESEL (B20)

- Bio-diesel is eco-friendly, bio-degradable, non-toxic and essentially free of sulphur, lead and aromatics.
- It cuts down on targeted emission & hence lowers pollution in air.Itreduces carbon monoxide (CO), smoke emission, Hydrocarbon emission
- Due to its lubricating properties, engine parts function smoothly without any friction between the parts.

1.3.3 DISADVANTAGES OF BIODIESEL (B20)

- Engine knocking
- Excessive engine wear
- Carbon deposit on piston and head of the engine

1.4 TURBOCHARGER

Turbocharger is a turbine driven forced induction device that increases the internal combustion engine and power output by forcing extra air into the combustion chamber. The turbocharger is connected into the exhaust valve of the engine. This improvement over a naturally aspirated engine's power output is due to the fact that the compression can force more air and proportionately more fuel into the combustion chamber than atmospheric pressure alone.

1.4.1 TURBOCHARGER IN DIESEL ENGINE

Turbocharger is a device which is connected into the exhaust valve of the engine and the exhaust air which is coming out from the engine enters into theturbocharger. The turbocharger contains two sections in which the first section is the turbine which rotates by the flow of exhaust air coming out from the exhaust valve and the other section is the compressor which is rotated due to the rotation of the turbine and the atmospheric air enters into the compressor and the air which enters is compressed completely and send to the combustion chamber.

1.4.2ADVANTAGES OF THE TURBOCHARGER

- Power output of the engine is high compared to the normal diesel engine.
- Brake thermal efficiency of the engine increases.

1.4.3DISADVANTAGES OF THE TURBOCHARGER

- Fuel consumption is high.
- Emission of the exhaust gases increases compared to the normal diesel engine.

1.5 OUTLINE OF THE THESIS

In order to achieve the objective of this study, experiment were carried out on methyl ester neem oil with turbocharger and the performance and emission characteristics for the Diesel and Biodiesel were completely mentioned in the following chapters.

Chapter 1 introduces the need of this study. Chapter 2 gives the detailed study of the literature reviews. Chapter 3 expresses the objectives and methodology of this study. Chapter 4 describes the experimental apparatus and procedure of the engine test experiment. Chapter 5 deals with the result and discussion part of the thesis. Chapter 6 highlights the conclusion and future work

II. LITERATURE REVIEW

Sundarpandian (2007) developed a theoretical model to evaluate the performance characteristics, combustion parameters and emission of vegetable oil esters like Jatropha, Mahua and Neem Oil esters.

Sharma et al (2008) studied the advancements in development and characterization of biodiesel, mainly concentrating the effect of the different parameters on production of biodiesel such as molar ratio, moisture and waterCompared to the various vegetable oils like jatropa oil, mahua oil, karanja oil, neem oil, nerium oil, the neem oil is selected as an best alternative

Hideki Fukuda et al (2001) studied that, Biodiesel (fatty acid methyl esters)

Prabhakar.S and Annamalai reported the progress regarding the best biodiesel blend. He made the test on the diesel engine with the neem oil,nerium oil, jatropa, mahua oil and made a blend of B20, B40,B60,B80, B100.

Sharaddha R Jogdhankar (2013) reported the progress regarding the biodiesel blend and had concluded that B20 is the best biodiesel blend. She made the investigation on the neem oil with the blending of B10, B20, B30

2.7 PROPERTIES OF NEEM OIL AND NOME

The following table indicates the properties of the neem oil and NOME

TABLE 2.1 Properties of Neem oil and NOME

PROPERTY	NEEM OIL	NOME
Kinematic Viscosity(cSt)at 40˚C	38	7.1
Calorific Value in kj/kg	43200	35389
Flash point(˚C)	350	98
Fire Point (˚C)	365	115
Specific Gravity	0.92	0.86
Cetane Number	38	51

VenkateswaraRao et al (2008) conducted experimental investigations of performance and emission of different blends (B10, B20, and B40) of pongamia oil methyl ester, jatropha oil methyl ester and neem oil methyl ester in comparison to diesel.

Anbumani (2010) studied the feasibility of using two edible plant oils, mustard and neem oil butyl ester on a compression ignition engine. Results have indicated that engine run at 20% blend of oils showed a closer performance to purediesel. However, mustard oil at 20% blend with diesel gave best performance as compared to neem oil blends in terms of low smoke intensity, emission of HC and NOx.

Desantes et al (2004) experimental studied the effects of injection rate shaping on the combustion process and exhaust emission of a direct-injection diesel engine.

Demirbas (2009) reported the progress and recent trends in biodiesel fuels. He concluded that the edible oils in use at that time were soybean, sunflower, rapeseed and palm and the non-edible oil used as feedstock for biodiesel production includes jatropha, karanja, mahua, polanga, neem, rubber seed, silk

2.12 SUMMARY OF LITERATURE REVIEW

From the above literature review, the following preliminary conclusions are arrived and technical facts based on these conclusions are incorporated in this research work. The important conclusions are:

- Biodiesel is an alternative fuel for diesel engines.
- Raw oils are not suitable for diesel engines.
- The applications of ester of neem oils as diesel engine fuels are suitable.
- Trans-esterification is the best way for reducing viscosities from the raw oils.
- Methyl esters of vegetable oils are preferred than the ethyl esters of vegetable oils.
- B20 is the most suitable biodiesel blend.
- The performance of the biodiesel operated engine is lower than the diesel fuel.
- The usage of the turbocharger in the engine improves the brake thermal efficiency of the engine and reduces the emission of the engine.

III. EXPERIMENTAL INVESTIGATION

An experimental set up was made with necessary instrumentation to evaluate the performance, emission characteristics of the neem oil with the turbocharger in diesel engine at different operating conditions. In this chapter, the apparatus those were used in the experiments and the procedures followed in this study are described.

3.1 DESCRIPTION OF THE ENGINE

A Simpsons engine is widely used engine in agriculture, pump sets, farm machinery and medium scale commercial purpose. The engine can withstand high pressure encountered during test because of its rugged construction. Further the necessary modification on the cylinder head and piston crown can be easily carried out in this type of engine

Fig 3.1 Photographic view of Experimental set up

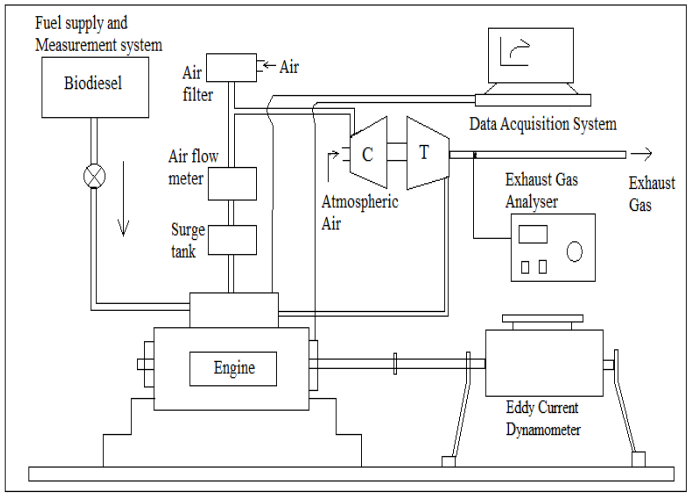

Fig 3.2 Schematic diagram of Experimental set up

3.2 INSTRUMENTS USED

The various instruments used in the experimental setup are described in this section

- Electrical dynamometer
- Load and speed measurements
- Fuel consumption measurement device
- Temperature measurement
- Exhaust gas emission measurements device
- Measurement of smoke opacity
- Pressure measurement
- Charge amplifier
- Crank angle measurement
- Signal conditioner
- Data acquisition system

3.3 BIODIESEL PRODUCTION

In this study biodiesel are produced from neem through transesterification method.

3.3.1 TRANSESTERIFICATION METHOD

To reduce the viscosity of the vegetables oil, trans-esterification method is adopted for the preparation of biodiesel. The procedure involved in this method is shown in Figure 4.14.

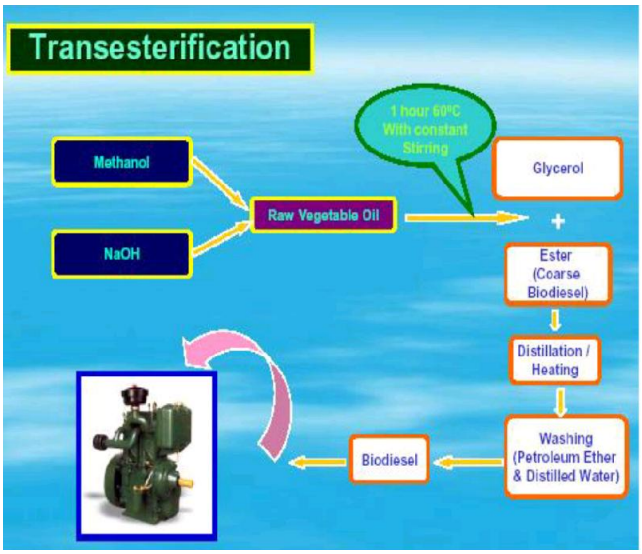

Fig 3.14 Photographic view of Trans-esterification process

The step by step procedure involved in this method is as follows:

1. 1000 ml of vegetable oil (Neem oil) is taken in a three way flask.
2. 12 grams of Sodium hydroxide (NaOH) pellets is mixed with 200 ml of methanol (CH3OH) is taken in a beaker.
3. The NaOH is stirred with the alcohol until it is properly dissolved.
4. The solution obtained is mixed with Neem oil in three way flask and it is stirred properly.
5. The methoxide solution with Neem oil is heated to 60°C to 65°C and it is continuously stirred at constant rate for 1 hour by stirrer.
6. The solution is poured down to the separating beaker and is allowed to settle for 8 hours.
7. The glycerin settled at the bottom and the methyl ester formed at the top (coarse biodiesel).
8. Methyl ester is separated from the glycerin.
9. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol.
10. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. .

3.6 EXPERIMENTAL PROCEDURES

Before starting the engine experiments, the fuel tank, engine oil level, coolant and other proper conditions of the test engine were checked and the testengine was started. The test engine was permitted to run until the stable condition is achieved. Then the engine load was increased gradually to maximum recommended load. At the same time, the dynamometer, allanalyzers and meters for measurements were switched on and the proper preparations and settings for measurements were carried out as the recommended methods by the makers‟ instruction manuals. When the engine reached the stable condition and when the initial setup is made for all measuring instruments, the experiment was started. The type of experiment is a steady state engine test. The applications of loads were at five levels and they were 0%, 25%, 50%, 75% and 100% loads respectively. The engine speeds at all load levels were adjusted for constant engine speed and fixed at 1800 rpm, in each load levels, the measurements of fuel consumption, intake air temperature, exhaust gas temperature, engine coolant temperature, combustion pressure, crank angle, hydrocarbon (HC) emission, carbon monoxide (CO) emission, nitrogen oxides (NOX) emission, carbon di-oxide emission (CO) and smoke emission were carried out and recorded the data.to the engine and the reading is taken. After completing the first process. Second process is to add the biodiesel(B20) is added to the fuel tank and the same procedure is followed as the readimg taken for the diesel fuel. Both the fuel reading are taken with the turbocharger and it is compared.

After the engine experiments were finished, the experimental data calculation and the analysis were done

IV. RESULT AND DISCUSSION

4.1 COMPARISON OF PERFORMANCE AND EMISSION CHARACTERISTICS OF BIODIESEL(B20) – DIESEL BLEND WITH STANDARD ENGINE SPECIFICATION

First the diesel and biodiesel blend were tested at standard engine specification, with a standard injection pressure of 200 bar and with a standard compression ratio of 18.5:1. The important results of the experimental work are presented in the following sections.The comparisons of performance and emission characteristics of diesel, biodiesel, diesel turbo, biodiesel turbo is represented in the form of graph.

4.1.1 Brake Thermal Efficiency (BTE)

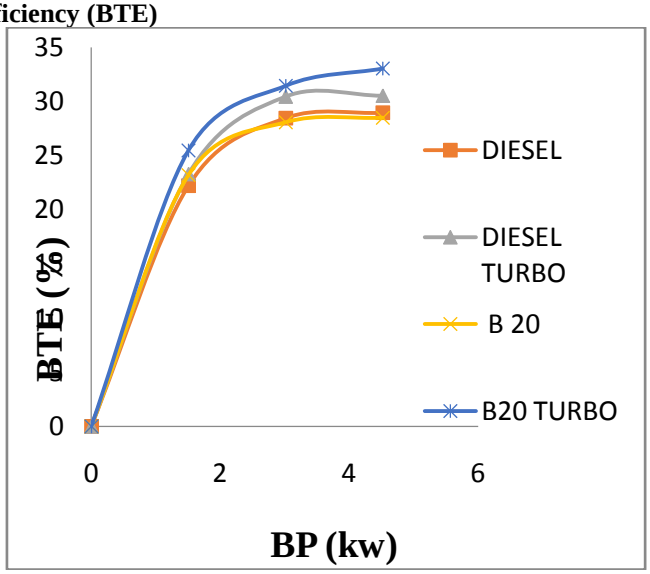

Fig 4.1 Comparison of brake thermal efficiency with brake power for Diesel, Diesel Turbo,B20,B20Turbo

For this blend, Brake thermal efficiency increases with increase in brake power. The maximum brake thermal efficiency is observed at three fourth of load for diesel and biodiesel. The maximum brake thermal efficiency for neat diesel at three fourth of load was 26.48 %. B20 (20% of methyl ester neem oil with 80% of diesel) blend at three fourth of load. It can be seen that the Brake thermal efficiency characteristics for diesel is highest and lesser in the case of biodiesel blends.

4.1.2 Hydrocarbon emission (HC)

The figure 6.2 shows the comparison of Hydrocarbon emission with brake power for diesel and biodiesel(B20) blend.

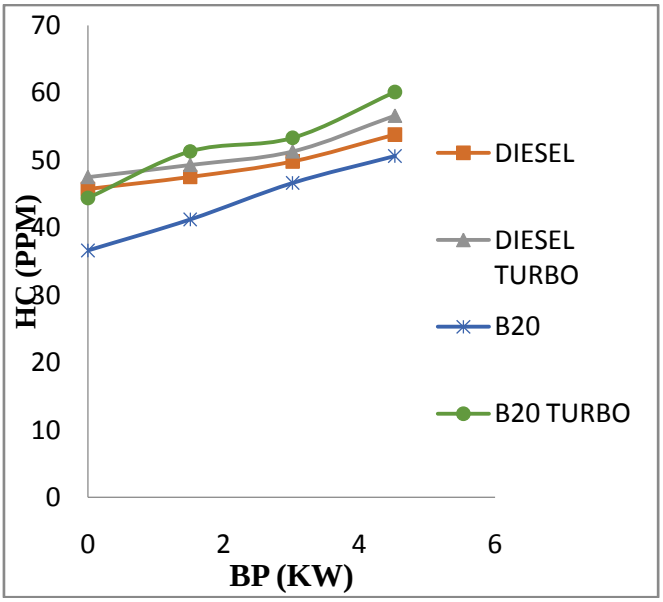

Fig 4.2 Comparison of Hydrocarbon emission with brake power for Diesel, Diesel Turbo, B20, B20Turbo

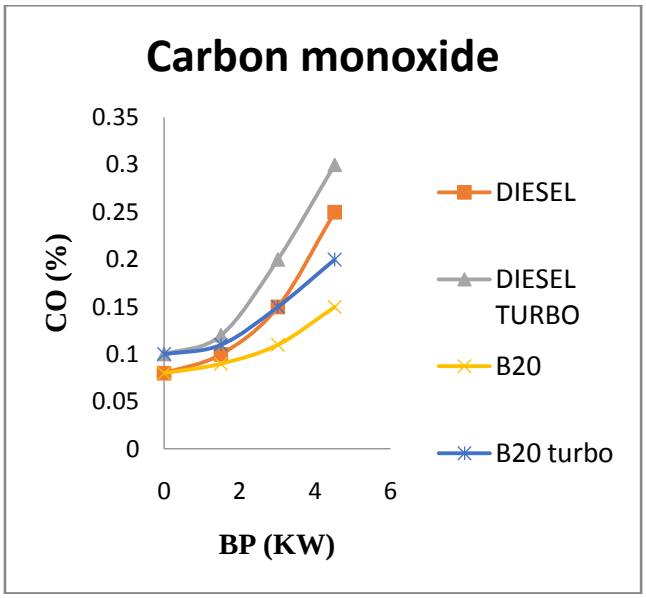

Fig 4.3 Comparison of Carbon monoxide emission with brake power forDiesel, Diesel Turbo, B20, B20Turbo

For this blend, The CO emission for diesel at maximum load was 0.25%, where as it was decreased by 0.5% for B20 blend at maximum load respectively. It can be seen that the Carbon monoxide emission characteristics for diesel is highest and least in the case biodiesel(B20) blend.

4.1.4Nitrogen oxide emission (NOX)

The figure 6.4 shows the comparison of Oxides of nitrogen emission with brake power for diesel and biodiesel(B20) blend.

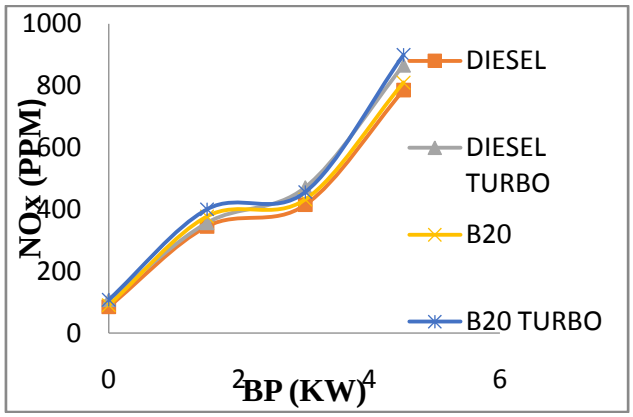

Fig 6.4 Comparison of Oxides of nitrogen emission with brake power for Diesel, Diesel Turbo, B20, B20Turbo

For this blend, Oxides of nitrogen emission increases with increase in brake power. The NOX emission for diesel at maximum load was 740 PPM, where as it is more by 3.4% for B20 blend at maximum load. It can be seen that the Oxides of nitrogen emission characteristics for diesel is least and highest inthe case of all biodiesel(B20) blend. As stated, the presence of oxygen in the biodiesel has led to complete combustion of biodiesel better than diesel.

4.1.6 Exhaust gas temperature (EGT)

The Figure 6.6 show the comparison of Exhaust gas temperature with brake power for diesel and biodiesel(B20) blend.

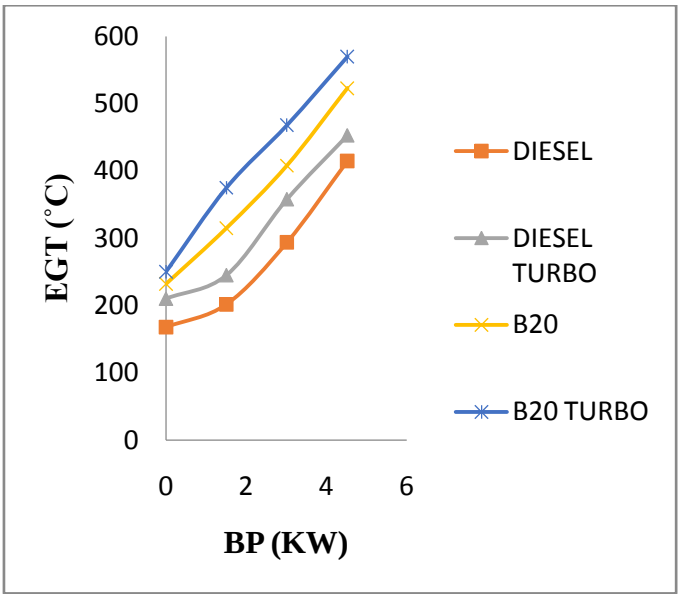

Fig 4.6 Comparison of Exhaust gas temperature with brake power for Diesel, Diesel Turbo, B20, B20Turbo

4.1.7 Cylinder pressure and Crank Angle

Figure 6.7 shows the Comparison of Cylinder pressure with Crank angle for diesel B20 at standard engine specification.

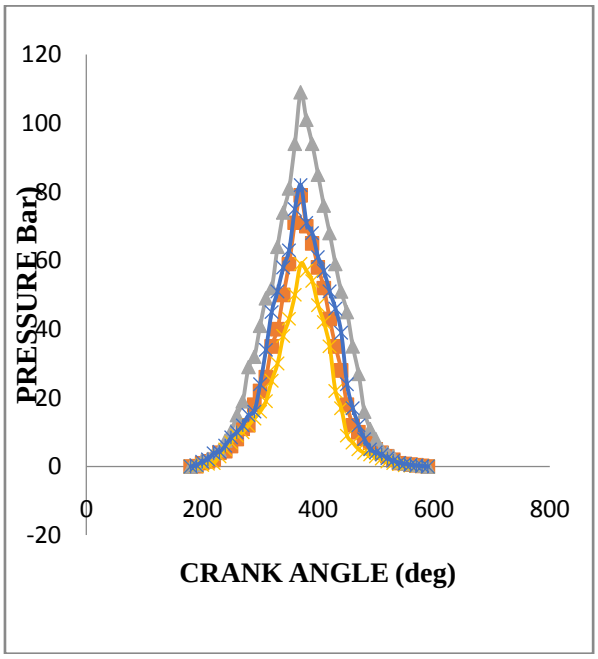

Fig 4.7 Comparison of Cylinder pressure with Crank angle for Diesel, Diesel Turbo, B20, B20Turbo

4.1.8 Heat Release Rate

The Figure 6.8 shows the Comparison of Heat release rate with Crank angle for diesel, B20 at standard engine specification.

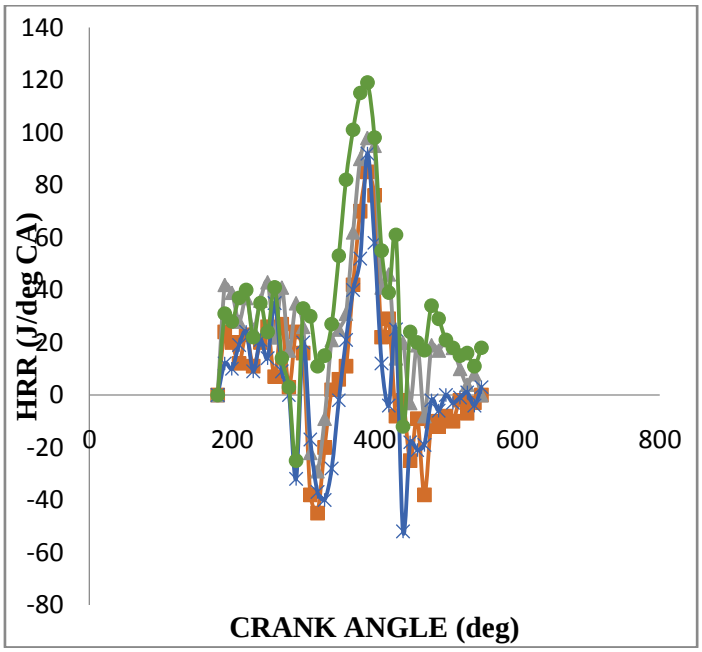

Fig 4.8 Comparison of Heat release rate with Crank angle for diesel, diesel Turbo, B20, B20 Turbo

V. CONCLUSIONS

From the present investigations the following conclusions are drawn,

• The B20 biodiesel blend reduces the hydrocarbon, carbon monoxide, carbon dioxideemission compared to the diesel.

• As the NOME(biodiesel) gives less efficiency compared to the diesel, but the turbocharger which is added improves the brake thermal efficiency and it is high in B20 compared to the diesel

• Hence 20% methyl ester neem oil and 80% of diesel blend with a standard compression ratio of 18.5:1 gives slightly better performance and reduced emission when compared to diesel fuel.

• Hence, the turbocharger which is added to the engine improves the brake thermal efficiency by using the biodiesel compared to the diesel but there is high heat release rate compared to the diesel.

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