Investigations on the Performance of an IDI Diesel Engine Using Azadirachta Indica and Calophyllum Inophyllum Linn Bio Diesel Blends and Ethanol

G.R.K Sastry
Associate Professor, Dept. of Mechanical Engineering, NIT Agartala
grksastry1@rediffmail.com

Abstract. The present investigation has been carried out to study the performance and emission of an IDI engine using Neem (Azadirachta indica) and Undi (Calophyllum Inophyllum Linn) as bio diesel and ethanol as an additive. Total 6 numbers of blends being used in the experiment. The bio diesel used in this experiment is blended by 10% of bio diesel 10% ethanol and 80% diesel, 15% bio diesel 5% ethanol and 80% diesel and 20% bio diesel 80% diesel. Both for neem and undi these blends are used. The present experiment was carried out at constant rpm of 1500.

Keywords: IDI, bsfc, BThE, CO, HC, NO, Azadirachta indica methyl ester, Calophyllum Inophyllum Linn methyl ester

Nomenclature:

| Code  | Description                                      |
|-------|--------------------------------------------------|
| BL T 1 | 10% Undi biodiesel, 10% Ethanol, 80% Diesel.        |
| BL N 1 | 10% Neem biodiesel, 10% Ethanol, 80% Diesel.        |
| BL T 2 | 15% Undi biodiesel, 5% Ethanol, 80% Diesel.         |
| BL N 2 | 15% Neem biodiesel, 5% Ethanol, 80% Diesel.         |
| BL T 3 | 20% Undi biodiesel, 80% Diesel.                    |
| BL N 3 | 20% Neem biodiesel, 80% Diesel.                    |
| PD    | Pure Diesel                                      |
| D100  | 100% pure Diesel fuel                            |
| bTDC  | before Top Dead Centre                            |
| kW    | kilowatt                                         |
| UME   | Undi Methyl Ester                                |
| BTHE  | Brake Thermal Efficiency                         |

1. Introduction
Fossil fuel such as petrol, diesel plays a very significant part in the arenas of industrial growth, transportation, agriculture etc. Owing to their accessibility, combustion possessions and great heating cost. Yet, their works of these fuels are quickly reducing due to amplified fuel ingesting. Rendering to the approximation of the International Energy Agency, by 2030 global energy ingesting will be augmented about 53% [1-3]. The United States Energy Information Administration (EIA) has predicted that the world's watery energy ingesting will rise from 86.1 million tubs/ day to 110.6 million tubs/day by 2035[4,5]. The discharges material produced by the scorching of petroleum-derived fuels must a thoughtful result on both the environment as well as anthropological fitness [9].

2. Methods & materials
2.1 Experimental Set-up
2.1.1 Performance Setup

The tentative study has been approved out in a current single cylinder, 4- stroke, air cooled Indirect
Diesel Injection diesel engine as shown in figure (1 & 2). The engine is mounted on a sturdy base frame (1300 X 1450 mm) while the dimension of Panel is 1550 X 580 mm. The engine was arrangement straight fixed to an eddy current dynamometer by a control structure by means of a lite link and a stub shaft meet. There are provisions on the engine to provide a different load on an engine from 0 to 6 kg. Six temperature devices were used to amount the temperature of setup at different point important being at the drain manifold before cooling in the calorimeter. The arrangement has been interfaced to a processor over an NI Labview® founded central DAQ stage coordinated with a crank angle encoder onto an operator border founded device Soft post dispensation software. The injection timing has been optimized and set at 230bTDC (static) has shown in Fig. 3 The engine speed has been kept at 1500 rpm static with varying loads (0%, 25%, 50%, 75% and 100%). The cooling water temperature, average ambient temperature, and relative humidity throughout experimentation were recorded at 190C, 280C and 54%, respectively.

Table 1. Technical specifications of Engine.

| Specification of Engine | Make/model | Kirloskar/Varsha |
|-------------------------|------------|-----------------|
| Type                    | Type       | Horizontal four stroke/single cylinder diesel engine |
| Combustion type         | Cool Combustion Chamber Type |
| Swept volume            | 0.381 litres |
| Fuel                    | Diesel     |
| Speed                   | 1700-1800 rpm |
| HP                      | 4 hp       |
| Max load                | 4 kg       |
| Starting                | Crank      |
| Lubrication             | Forced     |
| Bore Size               | 74mm (0.074m) |
| Stroke Length           | 74mm (0.074m) |
| Compression Ratio       | 20:1       |

2.1.2 Emissions Analyzer

The gutter gas analyzer AVL Digas 444 will be castoff for consume gas analyzer. The emissions such as Carbon mono-oxide (CO), Carbon-di-oxide (CO2), and Oxygen (O2) were measured by volume (%) whereas unburnt hydrocarbon (HC), Nitrogen oxide (NO) are measured as n-hexane equivalent ppm (parts per million). Together they constitute the emission characteristic for the combustion process. The measuring pipe of the analyzer is directly applied on the exhaust manifold of the engine after the calorimeter. Above table 2 represent the Measurement range of AVL Digas 444 exhaust gas analyser.

Table 2 Measurement range of AVL 444

| Measurement parameter | Measurement range |
|-----------------------|-------------------|
| Oxygen (O2)           | 0-22 Vol %        |
| Carbon mono-oxide (CO)| 0-10 Vol %        |
| Nitric oxide (NO)     | 0-5000 ppm        |
| Carbon dioxide (CO2)  | 0-20 Vol %        |
| Hydro Carbon (HC)     | 0-20000 ppm       |

2.1.3 Test Fuels

Aimed at the experimentations, six fuel kinds remained used. Ethanol was blended with biodiesel throughout the experiment. Biodiesel–ethanol blends were prepared with 5% & 10% of ethanol concentrations by volume basis. (e.g. B10E10 contains 10% biodiesel and 10% ethanol & 80% diesel
Table 3. Properties of ethanol

| Name of the fuel sample → | Ethanol |
|---------------------------|---------|
| ↓ Characteristics         |         |
| Flash point, open cup, °C | 9       |
| Specific gravity, 20/20°C | 0.45    |
| Viscosity at 20°C (Centipoises) | 1.87 |
| Auto ignition temperature, °C | 425    |
| Surface tension at 20°C, ((dynes/cm) | 19.4 |
| Heat of combustion, kJ/kg  | 28959   |

Table 4. The properties of diesel, with under and neem biodiesel

| S.N o | Name of the fuel sample → | Diesel | B 100 (Undi) | B 100 (Neem) |
|-------|---------------------------|--------|--------------|--------------|
|       | ↓ Characteristics         |        |              |              |
| 1     | Kinematic viscosity(C.S)  | 3.15   | 10.15        | 11.41        |
| 2     | Density(g/cm³)            | 0.83   | 0.896        | 0.897        |
| 3     | Flash point(°C)           | 60     | 141          | 145          |
| 4     | Fire point(°C)            | 63     | 172          | 178          |
| 5     | Lower calorific value(KJ/kg) | 42500 | 37250        | 41430        |

2.2 Experimental Procedure

The biodiesel used were Neem and Undi. Basic fuel properties for diesel, biodiesel and ethanol were shown in chapter 2. Once the test fuels were prepared in the engine, various engine parameters were tested at 0 kg load, 2 kg load, 4 kg load and 6 kg (full load). The tests were performed at four loads for each fuel type. The BSFC, bte, dissipates air heat, and engine secretions were logged. The deplete secretions such as CO, HC, and NOx remained stately by a gas analyzer (AVL).
3. Results

3.1 Performance analysis

3.1.1 BTHE vs. Load

BTHE designates the aptitude of the ignition method to receive the investigational fuel, also offers similar means of assessing how efficient the energy in the fuel is transformed to automatic production. The variation of brake thermal efficiency at different load conditions when the engine was operated with diesel, diesel-Neem, and diesel-Undi with ethanol is shown in Figure 4. Thermal efficiency is the true pointer of efficiency with which the natural energy contribution in the method of fuel of rehabilitated into valuable work. It is pragmatic that the BTHE rises with the load for all fuel [3]. It can be attributed to the presence of ethanol as a viscosity improver and also to the presence of oxygen which acts as combustion efficiency improves as the high hotness is found as of great oxygen content.

3.1.2 bsfc vs. Load

Bsfc is the ratio amid mass fuel consumption and brake power. Figure 5 shows the comparison of bsfc of various blends at varying load. As clear from the figure that bsfc shows a persistent trend of reduction with the load for all fuel, which may be due to the higher percentage increase in brake power through load as associated to an upsurge in the fuel ingesting [2-4]. These effects have a major influence on combustion, for the same volume due to the greater density of the experimental fuel more fuel by mass was injected into the combustion chamber compared with the amount of diesel injected.

3.2 Emission Analysis

3.2.1 CO vs. Load

Differences of CO emissions as a purpose of mixture relations and engine loads are shown in Figure 6 for all fuels, CO emanations reduction as the load upsurges as predictable since there is additional whole ignition as the load upsurges [7]. Ethanol-biodiesel mixed oils have smaller entire cetane number and upsurge detonation postponement, which clues to imperfect ignition in the chamber and outcomes in advancement in CO emissions in the drain as related to solitary biodiesel fuels owing to partial in-cylinder ignition [6]. If combustion is completed, CO is converted to CO₂ if combustion is incomplete due to the shortage of air and the CO is formed.

3.2.2 NO vs. Load

Nitric Oxide results from the reaction of nitrogen and oxygen at relatively high temperatures. NO is a major component in the NOx emission. The NO shaped is cumulative as the load upsurges [9-14]. The NO emissions of the mixtures were originated to lessen with cumulative mixture fraction of ethanol with biodiesel. Meanwhile (Figure 7), ethanol has great oxygen gratified and great heat of
disappearance [8]. It is easy to burn the fuel-air combination and it harvests smaller ignition period. Through the addition of ethanol, hotness announcement reductions in the phase of dispersal measured combustion, thus important to inferior NO emissions [15].

4. Conclusions

1. At full loads, the BTHE was highest for diesel. Among the blends, BL U 5 shows the highest BTHE which is 3.03% less than diesel and BL N 3.

2. At full load (6 kg) BL U 5 shows the lowest bsfc compared to the other blends but bsfc was higher for every blend compared to diesel. BL N 3 shows the highest bsfc (10.56%), & BL U 5 shows the lowest by1.88% among the entire blend. But diesel shows overall lowest bsfc. Between bio diesel of Undi & Neem, at full load Undi shows lower bsfc then At full loads, the BThE was highest for diesel. Among the blends, BL U 5 shows the highest BThE which is 3.03% less than diesel and BL neem.

3. At full load, the BL U 4 CO emission was the lowest. At full load, the CO emissions were lower by 42% for BL N 1 & BL U 6. Blend N 2 & Blend N 3 shows 28% lower CO, 14% for Blend U 5. Blend U 4 shows the lowest CO emission by 55% then diesel.

4. At full load, diesel gives the lowest NO. Among the blends, the BL N 2 shows the lowest the emission of NO which is 6.47%. The BL U 6 gives the highest of NO emission (36.47%). The NO increases by 16.47% for BL N 1, 29.41% for BL N 3, 21.76% for BL U 4 and 7.64% for BL U 5 respectively.

5. Cylinder pressure increases with increase in injection pressure, in case of blended fuels.

6. CO emissions and smoke thickness can be reduced knowingly, by mixed fuels with ethanol as the stabilizer. Additional they are originating to reduction with the upsurge in inoculation pressure.

7. NO emissions were reduced slightly by using mixed fuels with ethanol as the stabilizer. However, they are found to increase with injection pressure.

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