Research Papers

An Experimental Investigation of Thermal Behavior of Engine Fueled with Diesel and Bio-Diesel Blends B20N and B80N

M.Prabhahar
Research scholar,
St.Peters University, Avadi.

Dr.S.Sendilvelan
Principal,
PERI Institute of Technology,
Chennai.

R.Murali Manohar
Research scholar,
St.Peters University, Avadi

Abstract

In the present experimental research work, used vegetable oil methyl ester (UVOME) is derived through transesterification of used vegetable oil using methanol in the presence of sodium hydroxide (NaOH) catalyst. Experimental investigations have been carried out to examine the combustion characteristics in a direct injection transportation diesel engine running with diesel, biodiesel (UVOME), and its blends with diesel such as B20N and B80N.A careful analysis of the crank angle at which heat release occurs was carried out. The result has shown that biodiesel blends has higher heat release and exhaust gas temperature than diesel.

Keywords-- Bio-Diesel, Diesel, exhausts emission, Used Vegetable oil methyl esters.

1. INTRODUCTION

The demand of fossil fuel increases day to day in the near future, the need to find a renewable energy sources becomes more and more important all over the world. Bio-diesel is produced from vegetable oils has characteristics similar to petroleum-derived diesel oil and has received considerable attention and used as a substitute fuel for diesel engines [5]. The performance of both vegetable oils and their esters were promising alternatives as fuel for diesel engine when the vegetable oil fuels and their methyl esters on a direct injected, four stroke, and single cylinder diesel engine [16]. To reduce the cost of biodiesel production, to use waste oil as feedstock, such as waste cooking oil, non-edible oils, and so on [2]. The technologies for converting waste oil to bio-diesel are well established, which include alkali [8], acid [3], or no catalytic reaction in supercritical methanol. The various blends of rubber seed oil and diesel were evaluated and compared with diesel. The engine performance and emission tests and compared with that of diesel [15]. Due to the presence of considerable free fatty acids in such feedstock, the alkali-catalyzed process is not recommended because a large amount of soap byproduct is formed during reaction, which creates a serious problem of product separation and ultimately low, the yield substantially [3] decreases. Bio-diesel can be produced from non-edible oils [12]. The bio-diesel yield is maximum of 85.6 – 97.1 %, when used vegetable oil to methanol molar ratio 1:9, reaction temperature 60°C, and reaction time 4 hours. The effects of several crucial variables in a packed column reactor were also studied, such as reaction temperature from 40°C to 80°C, molar ratio of oil/methanol from 1:3 to 1:15, and reaction time from 2 to 6 h. [11]. The combustion and emission characteristics of diesel engine fuelled with used veg. oil methyl ester and its diesel blends. Used veg. oil methyl ester (UVOME) was derived through the transesterification process. Tests were conducted on a, single cylinder, direct injection, air cooled stationary diesel engine to evaluate the UVOME and its diesel blends as alternate fuels. The emission of nitrogen oxides (NOX) from vegetable oil and its blends were lower than that of pure diesel fuel. The results from the experiments proved that vegetable oil and its blends were potentially good substitute fuels for diesel engine. [10].The environmental degradation all over the world has led the researchers to work towards the development of Low Emission Vehicle (LEV) and Ultra Low Emission Vehicle (ULEV). Automobile vehicles emit substantial quantities of hydrocarbons (HC), carbon monoxide (CO) and particulate matter. [6, 7, 8]. Biodiesel is an attractive diesel fuel, because of its renewable character, potential for greenhouse gas emission reduction [1] [14]. Exhaust emission profile of biodiesel fuels improved. CO and CO2 emissions decreased. However, NOx emissions increased [9] [13]. This paper investigates the performance of combustion of Diesel and used veg. oil methyl esters blends with diesel in varying proportions such as B20 (NaOH), and B80 (NaOH).

2. EXPERIMENTAL PROCEDURE

The used vegetable oil methyl ester (UVOME) is prepared through transesterification of used vegetable oil using methanol in the presence of two different catalyst such as sodium hydroxide (NaOH) and Potassium hydroxide (KOH). These biodiesel blends are tested in a single cylinder with bore diameter of 87.5mm, stroke length of 10mm, Cubic capacity of 0.661 liters, Compression ratio of 17.5:1, Peak pressure of 77.5 kg/cm2 , Speed of 1500 rpm, four stroke, and naturally aspirated, direct injection and water- cooled kirloskar computerized diesel engine test setup. The engine was directly coupled to an eddy current dynamometer. The engine and dynamometer were interfaced to a control panel, which was connected to a computer. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator. Fig 1 shows the experimental engine setup. Experiments were conducted when the engine was fueled with diesel and UVO methyl ester blends with diesel. The proportions of 20:80 and 80:20 (by volume Bio-diesel: Diesel), which are generally called as B20, and B80 respectively. The experiment covered a range of loads such as 0%,25%,50%,75% and 100%. The following fuels are tested such as Diesel, B20K, B80K, B20N and B80N (where K and N are the catalyst KOH and NaOH respectively) by using the tested engine and observe the thermal and exhaust emission characteristics.

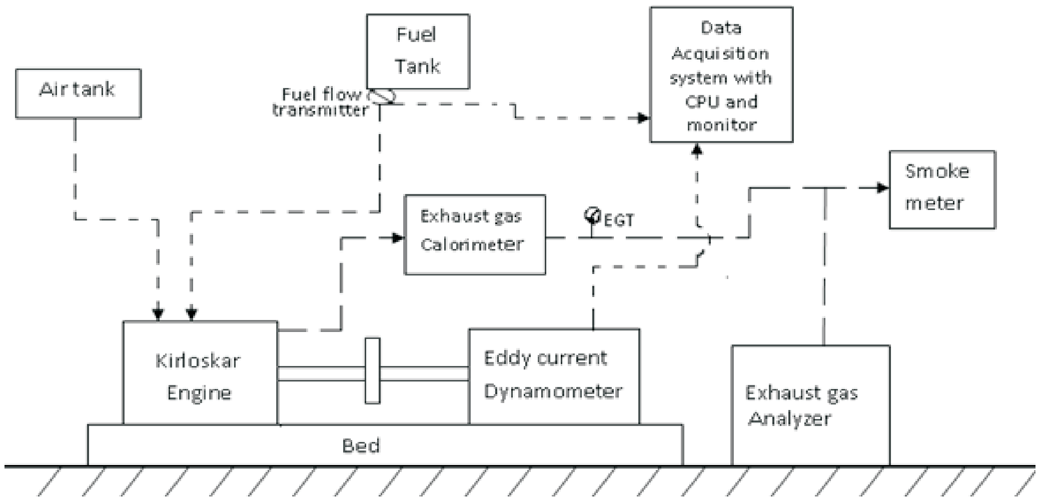

Fig 1.Experimental Engine Setup

3. RESULTS AND DISCUSSION

3.1. Exhaust gas temperature

Fig 2 shows the variation of exhaust gas temperature with load for various test fuels. It is observed that the exhaust gas temperature increases with load because more fuel is burnt at higher loads to meet the power requirement. It is also observed that the exhaust temperatures of used veg. oil methyl ester blends are higher than that of diesel. This may be due to the oxygen content of the methyl ester, which improves combustion and thus may increase the exhaust gas temperature.

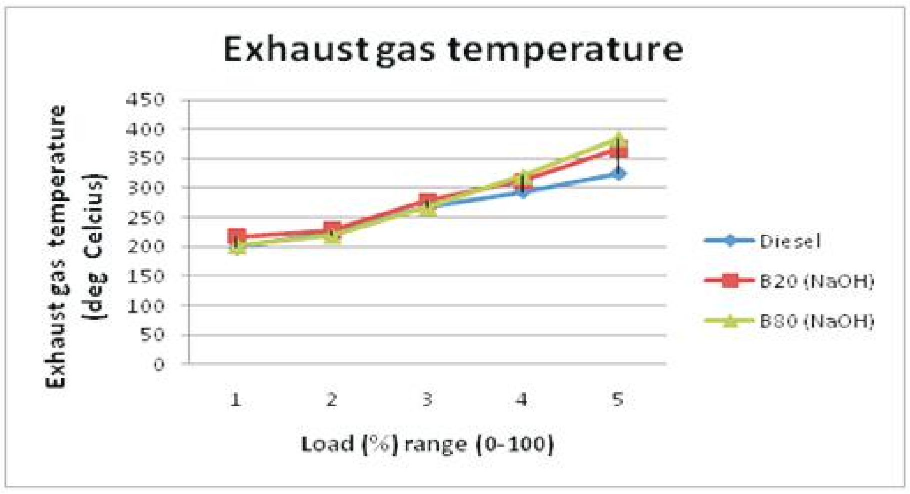

Fig 2.Comparision of Exhaust gas temperature for Diesel,B20 and B80 in varying load conditions (0%,25%,50%,75% and 100%)

3.2.Heat release

Fig 3 shows the heat release (QA) at crank angle for Diesel in varying load conditions (0%,25%,50%,75% and 100%).Fig 4 shows the heat release (QA) at crank angle for B20N in varying load conditions (0%,25%,50%,75% and 100%). Fig 5 shows the heat release (QA) at crank angle for B80N in varying load conditions (0%,25%,50%,75% and 100%). By analyzing the heat release (QA) and crank angle, determine in which crank angle, the maximum heat release is occured .All test fuels exhibited similar combustion stages as diesel.The heat release of engines using diesel fuel and bio-diesel blends have been investigated. The results illustrate that the combustion happens in advance and the ignition delay period is shortened. It is observed that,compared to all fuels such as B80N and B20N, the maximum heat release of 124.262 KJ/m3degree occurs at which crank angle of (-5)degree, when the engine is fueled with Diesel in the load condition of 50%. Biodiesel blends showed an earlier start of combustion and lower heat release during premixed combustion phase at all engine load-speed combinations. Fig 6 shows the heat release (IA) at crank angle for Diesel in varying load conditions (0%,25%,50%,75% and 100%). Fig 7 shows the heat release (IA) at crank angle for B20N in varying load conditions (0%,25%,50%,75% and 100%). Fig 8 shows the heat release (IA) at crank angle for B80N in varying load conditions (0%,25%,50%,75% and 100%). It is observed that,compared to all fuels such as diesel and B20N, the maximum heat release occurs at which, when the engine is fueled with B80N in the load condition of 100%. Compared to Diesel the oxygen content is more in Bio-diesel blends, hence the heat release in B20N and B80N are higher.

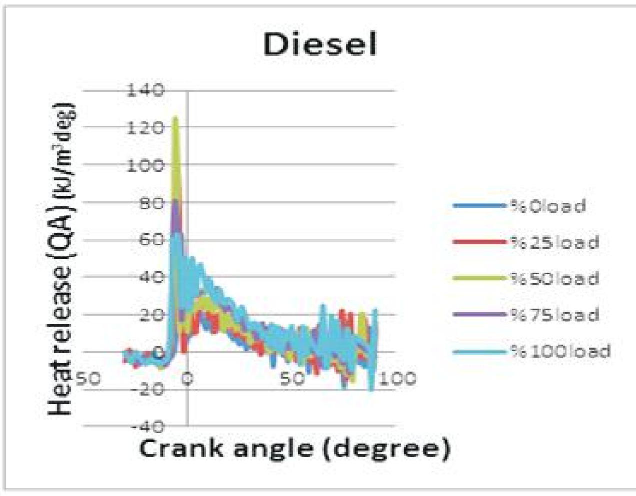

Fig 3. Heat release (QA) at crank angle for Diesel in varying load conditions (0%,25%,50%,75% and 100%)

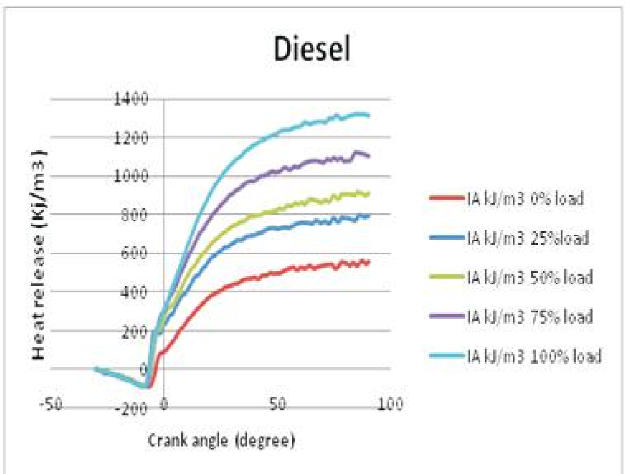

Fig 6. Heat release (IA) at crank angle for Diesel in varying load conditions (0%,25%,50%,75% and 100%)

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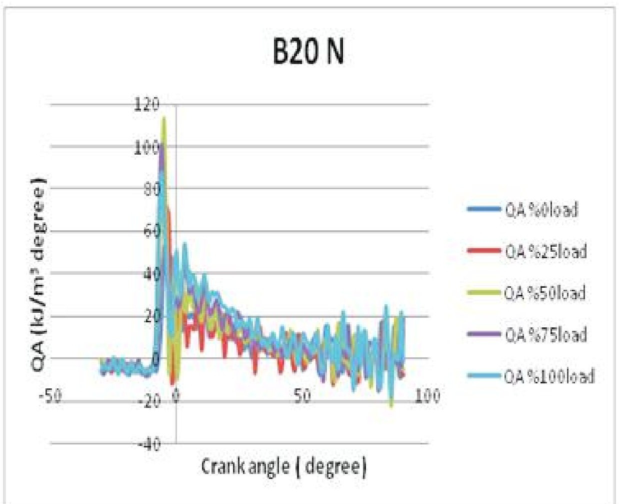

Fig 4. Heat release (QA) at crank angle for B20 in varying load conditions (0%,25%,50%,75% and 100%)

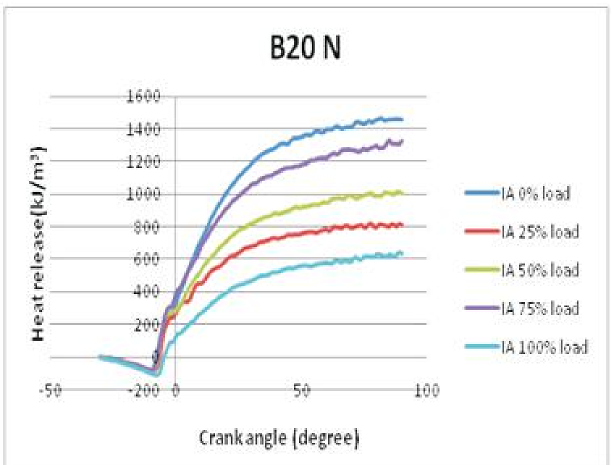

Fig 7. Heat release (IA) at crank angle for B20N in varying load conditions (0%,25%,50%,75% and 100%)

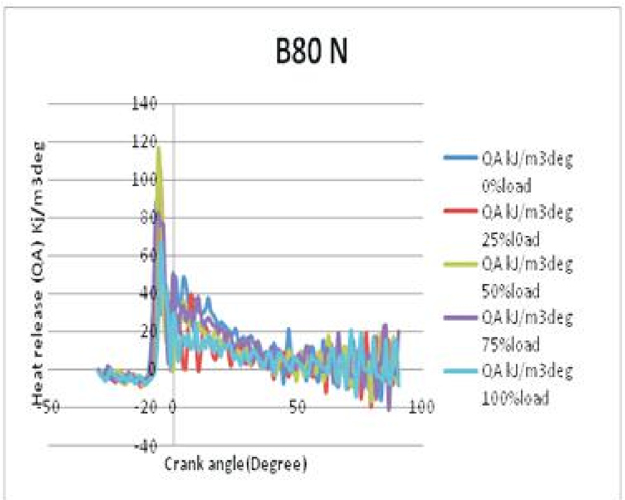

Fig 5. Heat release (QA) at crank angle for B20 in varying load conditions (0%,25%,50%,75% and 100%)

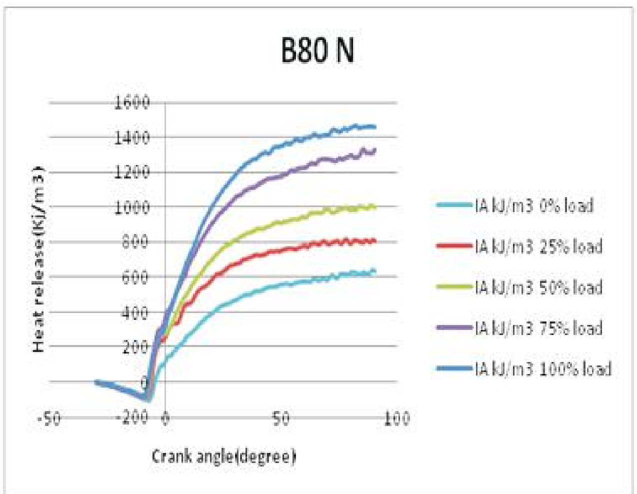

Fig 8. Heat release (IA) at crank angle for B80N in varying load conditions (0%,25%,50%,75% and 100%)

IV. CONCLUSIONS

This work clearly shows that the performance tests were carried on a single cylinder, four stroke engine and the experiments were conducted when the engine was fuelled with diesel, B20N and B80N. Results show engine performance such as exhaust gas temperature and heat release. It is observed that the exhaust gas temperature increases with load and the exhaust temperature of Bio-diesel blends are higher than that of diesel. Compared to Diesel and B20N, the heat release (IA) gradually increases in B80N, and also the heat release in B20N is greater than diesel.

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