Performance and Emission Analysis in DI Diesel Engine Using Biodiesel with Bio Additive

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Abstract - *The energy demand is increasing due to ever-increasing number of vehicles employing internal combustion engines. The world today is facing twin crisis of fossil fuel deflection and environmental degradation. Fossil fuels are limited resources & hence, search for renewable fuels is becoming more and more prominent issue of ensuring energy security and environmental protection. In this present work is carried out performance and emission characteristics of diesel and biodiesel (Mahua) with bio additives (kriya) various ratio are analyzed. The biodiesel (Mahua) with bio additives (kriya) B20 +1ml is having the better characteristics in terms of performance and emission. The results with B20 +1ml kriya shows, the smoke and NOx emission is reduced.*

Key Words: **Biodiesel, Bio additive, Diesel engine, Emission.**

1. Introduction

The advent of the use of biological systems for the fulfilment of human needs perhaps started way back in 6000 B.C. when Sumerians and Babylonians fermented a kind of beer. Though it started with fermentation, the biological processes kept undergoing many changes over the centuries. Old biotechnology is fermentation, antibiotic production and baking. New technology is brewing, and comprises techniques related with cell culture, fusion, bio- processing, genetic engineering, production of bio fuels etc. Terrestrial fuels like coal and petroleum are in the service of human kind since time immemorial. These fuels, generated from plants and animals, have been stored under earth some million years before these were put to use by the present human race. With an asymptotic rise in the use of the fuels (with developing thermal power stations and increase in number of transporting vehicles) the terrestrial coal pits and petroleum vessels are going to be emptied within a short period. Alternative energy sources are under harvest, which include solar, wind, geothermal and many more. For the need of future race a great devastation is required to bury the biosphere under earth for continuous harvesting of fuel from lithosphere. In the proteomic and genomic era, where biotechnology has become the mother of many inventions, a technology has emerged to harvest energy from plant materials, without waiting for a long period for the transformation of fresh plant to fossil fuel. This energy is in the form of a liquid fuel and is termed as bio- fuels.

Biodiesel has many environmentally beneficial properties. The main benefit of biodiesel is that it can be described as 'carbon neutral'. This means that the fuel produces no net output of carbon in the form of carbon dioxide (CO_2). This effect occurs because when the oil crop grows it absorbs the same amount of CO_2 as is released when the fuel is combusted. In fact this is not completely accurate as CO2 is released during the production of the fertilizer required to fertilize the fields in which the oil crops are grown. Fertilizer production is not the only source of pollution associated with the production of biodiesel, other sources include the esterification process, the solvent extraction of the oil, refining, drying and transporting. Biodiesel is rapidly biodegradable and completely non-toxic, meaning spillages represent far less of a risk than fossil diesel spillages. Biodiesel has a higher flash point than fossil diesel and so is safer in the event of a crash. Bio diesel is an oxygenated fuel which can be used as a replacement of diesel or using blends of biodiesel.

1.1 Trans esterification

Transesterification is most commonly used and important method to reduce the viscosity of vegetable oils. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called esterification. This esterified vegetable oil is called bio-diesel. Bio-diesel properties are similar to diesel fuel. It is renewable, non-toxic, bio-degradable and environment friendly transportation fuel. After esterification of the vegetable oil its density, viscosity, cetane number, calorific value, atomization and vaporization rate, molecular weight, and fuel spray penetration distance are improved more. So these improved properties give good performance in CI engine.

Physical and chemical properties are more improved in esterified vegetable oil because esterified vegetable oil contains more cetane number than diesel fuel. These parameters induce good combustion characteristics in vegetable oil esters. So unburnt hydrocarbon level is decreased in the exhaust. It results in lower generation of hydrocarbon and carbon monoxide in the exhaust than diesel fuel. The vegetable oil esters contain more oxygen and lower calorific value than diesel. So, it enhances the combustion process and generates lower nitric oxide formation in the exhaust than diesel fuel.

2. Experimental Setup

The experiments diesel with bio-diesel mixture was carried out in DI diesel engine. The specification of engine is listed in table 1. The test engine is a single cylinder, direct injection, water cooled Compression Ignition engine. The experimental setup is shown in figure 1. Diesel engine was directly coupled to an eddy current dynamometer. The engine was always run at its rated speed. The governor of the engine was used to control the engine speed. The dynamometer was interfaced to a control panel. Experimental tests have been carried out to evaluate the performance, emission and combustion characteristics of a diesel engine when fuelled Mahua oil with bio additives and its blends of B20+1ml, B20+2ml , B20+3ml , B20+4ml and B20+5ml of biodiesel with ordinary diesel fuel separately at different load. The emission like HC, CO, and NOx, were measured in the exhaust gas analyser and smoke density was measured in the smoke meter.

Table 1 Specifications of the Test Engine

Type	Vertical, Water cooled, Four stroke
Number of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection pressure	220 kgf/cm^2

2.1 Experimental procedure

Details of the engine are given in Table.6.1. Fuel flow rate is obtained on the gravimetric basis and the airflow rate is obtained on the volumetric basis. NOx emission is obtained using an AVL di-gas analyser working on electro chemical principle. AVL 444 smoke meter is used to measure the smoke capacity, in terms of Hartridge smoke unit (HSU). All the measurements were obtained and recorded by a data acquisition system. A burette is used to measure the fuel consumption for a specified time interval. During this interval of time, the fuel consumption is measured, with the help of the stopwatch.

The engine was allowed to run with sole fuel at a constant speed at 1500 rpm for nearly 5 minutes to attain the steady state condition at the lowest possible load the following observations were made twice for averaging /concordance. The test at various load ranges were conducted on the engine at a constant speed at 1500 rpm to obtain parameters such as fuel consumption, brake thermal efficiency, smoke density, NOx, and hydrocarbon.

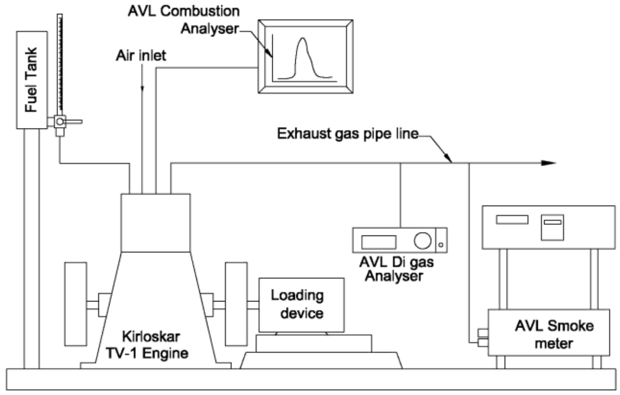

Figure 1 Experimental setup

3. Result and Discussion

The variation of specific fuel consumption with increasing brake power is shown in figure 2. The data shows the specific fuel consumption for diesel was less compared to various blends of bio diesel with bio additives. Also it was evident from the graph that the difference in fuel consumption between diesel and B20 + 1ml blend was very negligible.

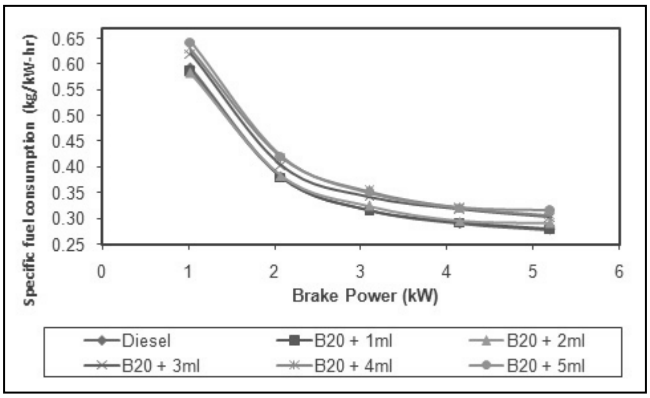

Figure 2 Brake Power Vs Specific fuel consumption

The variation of brake thermal efficiency with respect to brake power is shown in figure 3. It is seen that brake thermal efficiency increases with increase in break power for diesel and biodiesel with bio additives blends. The brake thermal efficiency of diesel was superior for diesel compared to biodiesel with bio additives blends. Also from the data, it is noted that the brake thermal efficiency of B20 +1ml blend was nearer to that of diesel compared to other biodiesel blends. This variation in brake thermal efficiency for biodiesel with bio additives blends was due to higher viscosity and lower volatility, which leads to poor mixture formation. This results in decrease of brake thermal efficiency for biodiesel with bio additives blends.

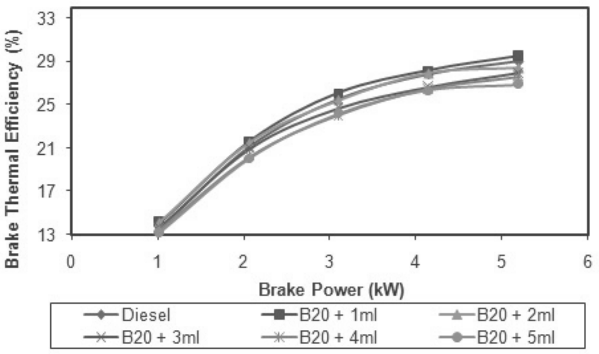

Figure 3 Brake Power Vs Brake Thermal Efficiency

From the test data shown in the figure 4, it is observed that smoke density of diesel was higher compared to biodiesel with bio additives blends. It was evident from the graph that, among the biodiesel with bio additives blends the smoke density of B20 + 1ml blend is lower. Higher thermal efficiency means, better and complete combustion and lesser amount unburnt hydrocarbon in the engine exhaust thus improving smoke density values.

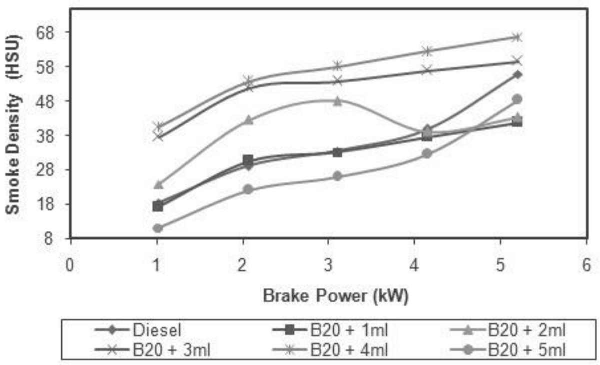

Figure 4 Brake Power Vs Smoke Density

Figure 5 shows the variation in the NOx emission of diesel and biodiesel with bio additives with respect to brake power. The figure clearly illustrates the NOx emission was higher for biodiesel with bio additives blends compared to diesel. This variation in NOx emission depends on combustion temperature inside the cylinder.

Figure 6 shows the rate of hydrocarbon emission for diesel and various blends of biodiesel with bio additives. The data clearly depicts, the emission rate of hydrocarbon is higher for diesel compared to blends of biodiesel with bio additives. During full load condition, an exception arises, where emission rate is higher for B20+1ml, B20+2ml blends of biodiesel with bio additives. The reduction of emission in biodiesel with bio additives was because of presence of oxygen in the fuel. The oxygen presence promotes complete combustion, thus the reduction in HC emission.

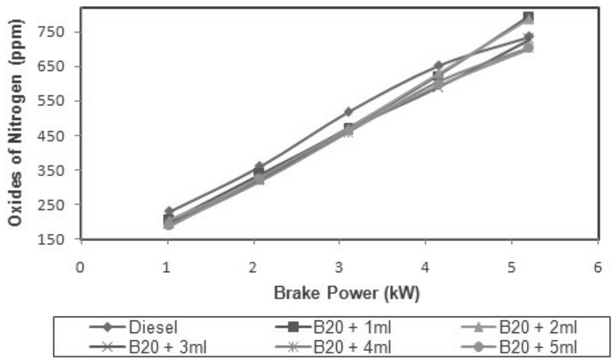

Figure 5 Brake Power Vs Oxides of Nitrogen

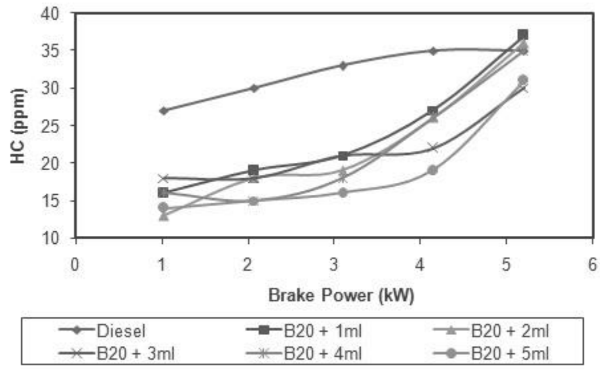

Figure 6 Brake Power Vs HC

4. Conclusions

- Brake thermal efficiency with B20+1ml was found to be comparable with diesel at all loads.
- NOx emission for B20+1ml was found to be comparatively higher than the diesel.
- HC emission levels were more for diesel with B20+1ml. This reduction in HC emissions was due to the availability of molecular oxygen and increase in HC emissions is due to bad flame diffusion in combustion.
- Some density for B20+1ml was found to be lower than diesel.
- CO emission B20+1ml the CO emission nearly closer to diesel.

- B20+1ml was found to be environmental friendly as far as carbon monoxide and unburned hydrocarbons were considered.

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