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Thermal Analysis Of 4-Stroke Diesel Engine With Bio Diesel Blends

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Abstract: Alternative energy sources need to be developed in order to meet the increasing demand for fossil fuels. Furthermore, from environmental perspective, these new resources of energy must be environment friendly. Biomass, and particularly vegetable oils, fulfill these imperatives and is seen as a potential substitute for mineral diesel. Base catalyzed Tran's etherification is most acceptable process for biodiesel production. The effects of various performance, combustion and emission parameters are computed. Performance, emission and combustion characteristics of this biodiesel and its 20% blend were compared with mineral diesel in a direct injection (DI) engine. Brake specific fuel consumption for biodiesel and its blend was higher than mineral diesel but brake thermal efficiency of the biodiesel blends was found to be lower than mineral diesel. In the present investigation experimental work has been carried out to analyze the performance and emission characteristics of a four stroke single cylinder compression ignition diesel engine fueled with diesel-biodiesel blends (B15, B25, and B35). The performance parameters evaluated were brake thermal efficiency, brake specific fuel consumption, mechanical efficiency, thermal efficiency and the emissions measured were carbon monoxide (CO), hydrocarbon (HC), and oxides of nitrogen (NOX). The experimental investigation results of diesel-biodiesel blends are compared with that of standard diesel.

Keywords— 4-stroke diesel engine set up,bio diesel blends(B15,B25and b35).

1. INTRODUCTION

The vegetable oil esters named as biodiesel in 20thcentury have gained well among the non-conventional fuels over the petroleum fuel. Part of what makes biodiesel so appealing and interesting is that it can be made from numerous natural resources. Plant oil is the largest source of biodiesel such as soybean, rapeseed, canola, palm etc. The primary advantage of biodiesel over diesel is that it is non-toxic and renewable.

According to the report published by National Biodiesel Board the emission of unburned hydrocarbons is reduced by 67%, carbon mono oxide is reduced by 48% and particulate matter is reduced by 47% as compared with conventional diesel fuel. Deciduous mahua (Madhucaindica) and semi- deciduous sal (Shorearobusta) are Indian tropical trees used for production of biodiesel. The mahua kernel constitutes 70% of the seed and contains 50% oil, which can be extract-ed at levels of 34% to 37%. Sal can produce about 20% oil.

About 30-40 percent of the tribal economy in north India such as in Bihar, Madhya Pradesh and Orissa is dependent on the mahua seeds and flowers. The fresh oil is yellow in color, while commercial oil is generally yellow with disagreeable odor and taste. It is estimated that there are 64 mil-lion hectares of wasteland across India including 15 million hectares of degraded, notified forestland that could be converted to plantation to provide sal and mahua seed in a sustainable fashion as well as generating employment opportunities for a large number of people.

Biodiesel production from trees seeds in India will not only reduce the dependence on crude oil imports, but also reduce the environmental impact of transportation. Therefore an attempt is made in this research paper to study the feasibility of mahua methyl ester and its blends with diesel fuel for a compression ignition engine.

Most of the natural bio's transformed in to gas such that it can be flammable at some extent like liquid methane; these natural gases can be changed as bio- fuels mixed with diesel known as bio diesel blends.

Advantages Of Biodiesel:

Biodiesel is a fuel that has gained a lot of public attention because it is environmentally friendly and renewable and is being appreciated all over the world. Among the many advantages of using biodiesel, some are listed as follows: the use of biodiesel is not dangerous to the environment. Petro diesel-powered vehicles produce a considerable amount of emissions, and unfortunately the smoke these vehicles emit is hazardous to the environment. Biodiesel is agriculture oriented nontoxic, biodegrade able and a renewable fuel.

Disadvantages Of Biodiesel Fuels:

Although biodiesel has gained much scientific attention in recent years, it is not without some few disadvantages. One of the problems encountered when using biodiesel is the increase in nitrogen oxides emissions which can result in the formation of smog and acid rain. Similarly, biodiesel when compared to petro-diesel have a lower energy output In order to produce the same amount of energy, more bio diesel is required than petro-*diesel*. Also, the use of valuable cropland to grow biodiesel crops could result to a rise in cost of food and furthermore leads to food scarcity

***Combustion in diesel engine*:**

The basic purpose of IC Engine is to develop power by burning fuel. Therefore, good performance of an IC Engine is dependent on how quickly and completely the fuel can be burnt. This burning of hydrocarbons is called combustion, which is a chemical process (oxidation), accompanied by emission of light and heat. The process of combustion in the compression ignition engine differs widely from that of spark ignition engine. In case of diesel engine only fuel in liquid state is injected at very a high pressure, into highly heated and compressed air in the combustion chamber, the heat of the compressed air starts the combustion process and no agency like electric spark is required.

2. LITERATURE REVIEW

A single cylinder, 4-stroke diesel engine of 95 mm bore, 100mm stroke producing 10 hp of power at 1500 rpm is used for conducting this test. The engine was coupled to an electrical generator and loaded by variable resistance loading bank. The air intake flow rate was measured using an orifice meter and a water manometer. Various concentrations of ester and diesel fuels that are used for conducting the test are B30 (30% ester and 70% diesel fuel), B50 (50% ester and 50% diesel fuel), B70 (70% ester and 30% diesel fuel) and B100 (100% ester and 0% diesel fuel).

S. Wagh, K. G. Nawandar(2016)a design methodology for biodiesel production from waste cooking oil is proposed. The proposed method is flexible to the biodiesel processusing various catalyst types: alkali and acid catalyst in homogenous and heterogeneous forms, and different process: enzyme process and supercritical process.

Pushpendra Kr. Singh Rathore (2013)the world today is faced with serious environmental pollution. However, these fuels are limited and depleting day by day as the consumption is increasing very rapidly. Hence, it is necessary to find out a clean alternative fuel produced from renewable sources. Biodiesel production and applications are gaining popularity in recent times due to diminishing petroleum reserves and detrimental environmental impacts. Edible and non-edible oils are trans- esterified in the presence alcohol and a suitable catalyst to prepare the esters of the corresponding alcohol, commonly called as biodiesel.

Ramakrishna Nandam (2016) Biodiesel is a non-petroleum based diesel fuel which consists of the mono alkyl esters of long chain fatty acids derived from renewable lipid sources. Biodiesel is typically produced through the reaction of a vegetable oil or animal fat with methanol in the presence of a catalyst to yield glycerin and biodiesel Biodiesel is a renewable fuel source and also biodegradable because it is part of the family of bio fuels and produced from a biological source such as vegetable oils like corn oil in It has similar physical and chemical properties with petro diesel fuel.

3. METHODOLOGY

According to the objectives of the present work mentioned in the the experimental setup need to have the following additional provisions apart from the basic functions of an engine test rig. Biodiesel has become more attractive recently because it is made from renewable resources as well as it achieved desired emission standards. Waste cooking oil (WCO) disposal is also a problem because it cannot reuse for cooking, which causes undesirable affect on human health.

Experimental Set-Up:

The present experimental set up has all the provisions that are mentioned in the above requirements. Each of the equipment's and systems in the test rig figure is modified setup and figure is block diagram of experimental setup as mentioned below;

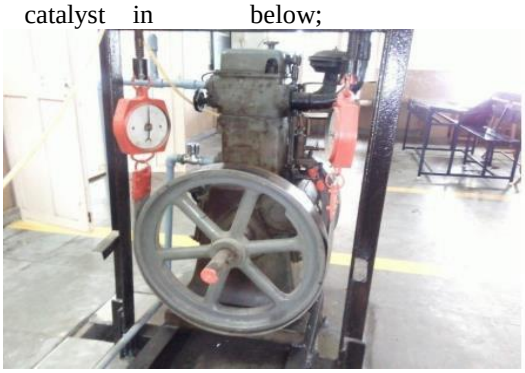

Figure: Overall engine set up

Table: Properties of waste vegetable oil Biodiesel

Properties	Pure Diesel	WCO	B15	B25	B35
Density at 150 c	0.829	0.92	0.833	0.845	0.895
Kinematic viscosity at 400 c(cst)	3.54	27.14	**3.72**	**3.79**	**4.15**
Flash point(0 c)	47	145	56	63	67
Fire point(0 c)	51	85	61	69	73
Calorific value(KJ/Kg)	42700	39750	41885	41338	41100

Performance Parameter of Engine Operation Using Biodiesel

Engine Performance Biodiesel produces about 3-5% less engine power and torque due to its lower energy compared to diesel. It is expressed in terms of kWh/liter of fuel or as Brake specific fuel consumption (BSFC) in gm/kWh.

Deposit and Clogging Deposits and clogging problems are widely reported and are generally attributed to substandard quality of biodiesel or due to its less oxidation stability and therefore engine wear is relatively more when run on biodiesel.

Pollution from engine exhaust: Biodiesel results in much less air pollution due to its higher oxygen content and absence of "aromatic compounds" and sulphur. The NOx tends to be slightly higher compared to biodiesel which can be minimized by proper engine timing.

Cold-weather performance: Diesel engines operated in cold weather experience the problems of clogging of the filters and/or choking of the injectors. The use of flow improving additives and "winter blends" of biodiesel and kerosene has proved effective in the operating range of climate temperatures B100 tends to operate well at temperatures down to about 5°C. Additives reduce the range by about 5-8°C, while the winter blends have proved effective at temperatures as low as -20°C or below.

Blends Preparation: In the waste cooking oil bio-diesel and methanol in a molar proportion of 1:6 were reacted to produce biodiesel. Then 1% weight of KOH of the waste cooking oil was added as a catalyst in the transesterification reaction. Potassium meth oxide and water was first mixed and KOH was added as a catalyst with methanol. The reacting temperature of the transesterification process was set at 55 □C, which is below the boiling temperature of methanol at 64 □C to prevent methanol from vaporizing from the reacting mixture during transesterification process.

4. RESULTS:

Investigations On Suitability Of Waste Vegetable Oil

After going through all the experimental procedure and conducting numerous iterations as per the experimental methodology as mentioned in the chapter three, significant results are drawn and presented that are shown in this chapter. The presentations of the results are done in a classified manner of steps for the better understanding of the behavior of the engine at all the experimental conditions.

Brake Thermal Efficiency:

the variation in brake thermal efficiency(ηBth) in case of diesel, B15, B25and B35. The effect of mixture strength on BTH as the mixture strength is increasing the value of mass of fuel consumption increases and calorific value decreases.

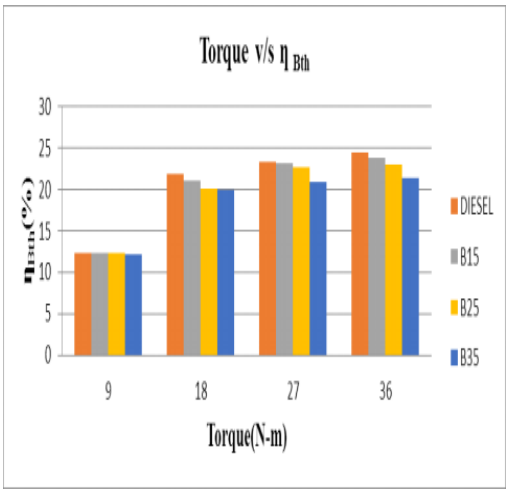

Figure: Torque versus Brake Thermal Efficiency

Mechanical Efficiency:

The variation of mechanical efficiency with Torque is shown in Figure from the plot it is observed that there is slight variation of the mechanical efficiency for all the blends of waste vegetable oil compared to the diesel fuel. At full load condition, the mechanical efficiencies are obtained 84.48%, 83%, 74.2%, 69%for fuels of diesel, B15, B25, B35, respectively. Among the three blends of waste vegetable oil the maximum Mechanical efficiency is 83% which is obtained for B15.

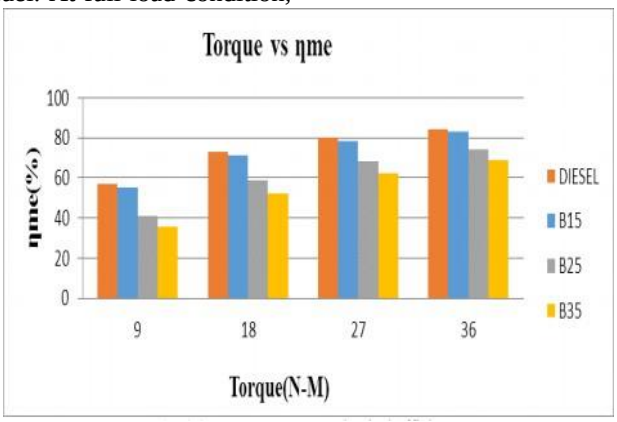

Figure: Torque versus Mechanical efficiency

Thermal Efficiency:

The variation of thermal efficiency with Torque is shown in from the plot it is observed that there is slight variation of the thermal efficiency for all the blends of waste vegetable oil compared to the diesel fuel. At full load condition, the thermal efficiencies are obtained 24.31%, 23.47%, 22.79%, and 21.26%for fuels of diesel, B15, B25, B35, respectively.

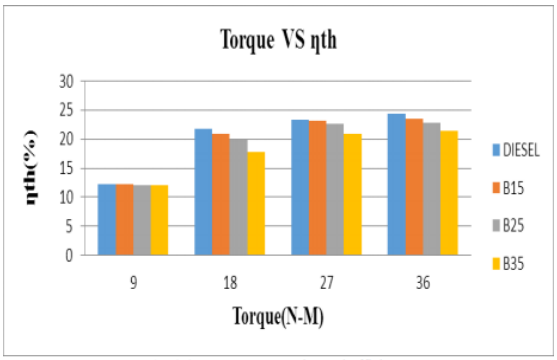

Figure: Torque versus Thermal efficiency

Brake Specific Fuel Consumption:

Brake Specific fuel consumption is another important parameter that determines the performance of any engine. It is the specific quantity of fuel used to generate a unit of power. the BSFC reduces with increase in load up to 75% and then 100% load small increments in all cases at various Blends of vegetable and Diesel. brake specific fuel consumption of engine against Torques

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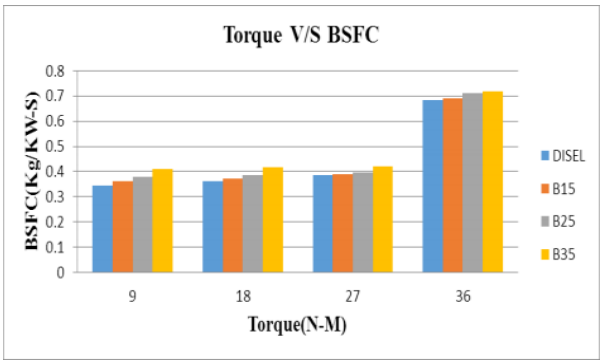

Figure: Torque versus Brake Specific Fuel Consumption:

Thermal Comparative Analysis:

The performance and emission features of compression ignition engines depends on the inner Nozzle flow and spray performance. Inner nozzle flow and spray performance in an engine, controls the air fuel mixing, which is necessary for the process of combustion. Because of differences in the physical properties of biodiesel and petro-diesel, the inner nozzle flow and spray structure are expected to be significantly altered and, consequently the performance and emission features of the diesel engine that because of lower vapor pressure of biodiesel, it was observed to cavitate less than petro-diesel. A reduction in injection velocity and loss of flow efficiency was also observed because biodiesel viscosity is higher.

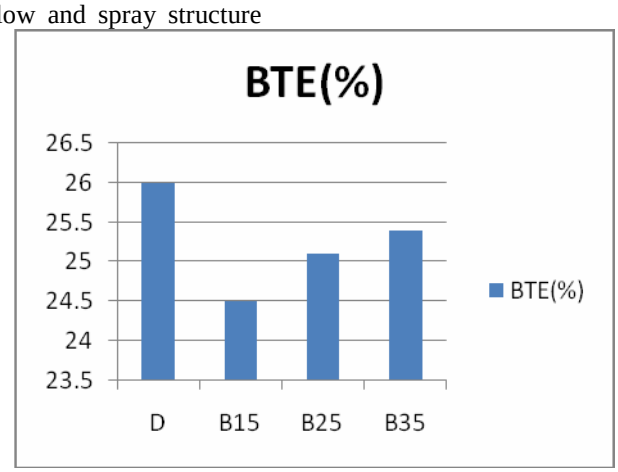

Figure: Comparison of BTE for diesel and biodiesel- diesel blends at full load

Waste/Used Cooking Oil:

The feedstock coming from waste vegetable oils or commonly known as waste cooking oils is one of the alternative sources among other higher grade or refine oils. Waste cooking oil is easy to collect from other industries such as domestic usage and restaurant and also cheaper than other oils (refine oils). Hence, by using these oils as the raw material, we can reduce the cost in biodiesel production. The advantages of using waste cooking oils to produce biodiesel are the low cost and prevention of environment pollution.

5. CONCLUSIONS

Waste vegetable oil biodiesel and its blends were characterized by measuring its density, viscosity and calorific value. Performance, emission and combustion characteristics of this biodiesel and its blends were measured in a constant speed direct injection engine. Brake specific fuel consumption for biodiesel and its blends was higher than mineral diesel but brake thermal efficiency of all the biodiesel blends was lower than mineral diesel. Brake specific CO2, CO and Hydrocarbon emissions for biodiesel fuelled engine operation were lower than mineral diesel but NO emissions were higher for biodiesel blends. The conclusions derived from present experimental investigations to evaluate performance and emission characteristics on four stroke single cylinder engine with diesel- waste cooking oil blends are summarized as follows.

- The BTE of waste cooking oil is decreases as compared with Diesel at full load condition.
- The Brake specific fuel consumption is increased with the blends when compared to diesel.
- CO and HC emissions are decreased significantly with the blends when compared with diesel.
- Comparatively a slighter increment in NOx emission was found while working with all blend at all loads.
- From the above analysis the blend B15 shows the better performance and emissions compared to other blend (B15, B25, and B35) and diesel. So the B15 blend can be used as an alternative fuel in DI diesel engine.

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