Comparative Analysis of the Performance and Emissions Characteristics of a C.I. Engine Fuelled With Three Different Blends of Biodiesel Derived From Waste Mustard Oil

Er. Sumit Vohra Ahuja[1],Er.Subhash[2]

[1]*M.tech (Part-Time) student, MIMIT MALOUT*

[2]*Assistant Professor*

"Department of Mechanical Engg" MIMIT Malout , (India)

ABSTRACT

Decline in fossil fuel resources along with high crude oil prices generated attention towards the development of fuel from alternate sources. Such fuel should be economically attractive and performance competent in order to replace the fossil fuel.. Throughout the world, there is an enormous amount of waste lipids generated from restaurants and food shops posing a challenge for their storage and proper disposal in the environment. Reuse of these oils not only helps in its management but also lowers the production cost of biodiesel. Biowaste cooking oils thus opened a good opportunity to study its suitability to produce biodiesel. Then, problem gets generated from viscosity of these biowaste cooking oils. Transesterification process was used to lower the viscosity of the waste oil. Biodiesel from waste mustard oil was prepared. The properties of B100 were studied. Then, Biodiesel was blended with petro diesel at three different levels i.e. B10, B15 and B20 as the direct use may cease the engine.

***Keywords*: - Biodegradable, Biodiesel, eco-friendly, renewable, mustard oil.**

I. INTRODUCTION

The large increase in number of automobiles in recent years has resulted in great demand for petroleum products. With crude oil reserves estimated to last for few decades, there has been an active search for alternate fuels. The depletion of crude oil would cause a major impact on the transportation sector**.** To meet ever increasing energy requirements, there has been growing interest in alternative fuels like biodiesel to provide a suitable diesel oil substitute for internal combustion engines. Biodiesels offer a very promising alternative to diesel oil since they are renewable and have similar properties. Biodiesel is a clean burning alternative fuel, produced from domestic, renewable resources such as plant oils, animal fats, used cooking oil and even new sources such as algae.

Biodiesel does not contain petroleum products but it can be blended at any level with petroleum diesel to create a biodiesel blend. Biodiesel blends can be used in most compression ignition (diesel) engines with little or no modification. Biodiesel may be used in any diesel automotive engines in its pure form or blended with petroleum based diesel. No modifications are required, and the result is less expensive, renewable, clean burning fuel.

II. HISTORY BEHIND BIODIESEL

The concept of biofuel firstly came into the picture in 1885 when Dr. Rudolf Diesel built the first diesel compression ignition engine with full intention of running it on vegetative source and developed the first engine to run on peanut oil. In 1912, he observed, "The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as the petroleum and coal tar products of the present time." However, due to cheap petroleum products, and probably due to economic might of the cartels, investigations of such non-conventional fuels never took off to offer any viable ideas. However, it appears the trend has changed, after the world realized that oil resources are almost on the path of exhaustion and cannot sustain the world economy for more than about half a century. In 1970, researchers have found that a simple chemical process could reduce the viscosity of vegetable oils and it could perform like diesel fuel in modern internal combustion engines. Since then the technical developments have come a long way and the plant oil today has been highly established as biofuel, equivalent to diesel.

III. ECONOMIC ASPECTS OF BIODIESEL

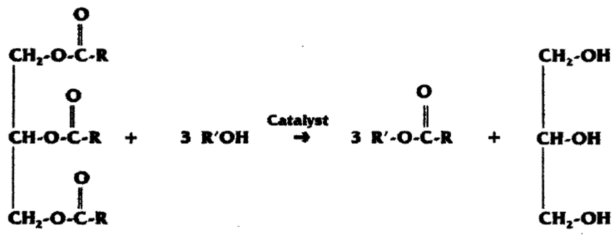
While inventing a new fuel, the economic aspect is also very important to take into account. In Brazil, there is abundance of ethanol, but petro diesel is very costly, so direct blending of ethanol into gasoline fuel is done. Government of Brazil has also legalized the direct blending up to 25% in gasoline in automobiles.

Waste mustard oil costs very less, the users of this oil put this oil in the dump after use. Waste cooking oil like mustard oil can be purchased and then biodiesel is prepared and blend of that biodiesel with petro diesel is used. This will also reduce the burden on at least government's shoulders, which in turn will reduce the tax by some part

IV. METHOD OF BIODIESEL PRODUCTION

To obtain biodiesel, vegetable oil is subjected to a chemical reaction known as ***transesterification***

In transesterification vegetable oil is treated with in the presence of a catalyst (usually a base) with an alcohol (usually methanol) to give the corresponding alkyl esters (or for methanol, the methyl esters) of the FA mixture that is found in the parent vegetable oil or animal fat.



Triacylglycerols Alcohol Alkyl Ester Glycerol

(Vegetable oil) (Biodiesel)

R is a mixture of various fatty acids chain. Alcohol is generally methanol (methyl alcohol) as it is cheap, but now a days, Ethanol (Ethyl Alcohol) and iso-propanol may yield a biodiesel fuel with better fuel properties. Ethanol is costlier, so methanol is used. Often the resulting products are also called fatty acid methyl esters (FAME) instead of biodiesel. Catalyst is generally base like NaOH, KOH.

Biodiesel can be produced from a great variety of feedstocks. These feedstocks include most common vegetable oils (e.g., soybean, cottonseed, palm, peanut, rapeseed/canola, sunflower, safflower, coconut) and animal fats (usually tallow) as well as waste oils (e.g., used frying oils). The choice of feedstock depends largely on geography. Depending on the origin and quality of the feedstock, changes to the production process may be necessary.

V.LITERATURE REVIEW

First step is to prepare biodiesel. Biodiesel was prepared by *transesterification.* In this work, Biodiesel was derived from waste mustard oil which underwent single stage transesterification process. Waste mustard oil can be purchased or collected easily from any restaurant, sweet shops, and pakorawalas in our nation. Literature is divided into following two main categories:

1. Production and characterization of biodiesel.
2. Performance and emission characteristics of C.I. engine fuelled with biodiesel blends.

VI. STANDARD PROCESS ADOPTED

- A known quantity of waste mustard oil was taken. .It is almost black in colour.
- ii) Neutralizing the free fatty acids using potassium methoxide (known quantity of methanol) is used because of its low cost and its physical and chemical advantages (polar and shortest chain alcohol) with known amount of alkali KOH as a catalyst.
- Creating an alcohol ester under desired temperature with suitable speed. Stir for agitating the mixture.
- Within a process period of 1 hr, biodiesel is formed as shown in along with the glycerine with clear phase separation.

- Then the biodiesel can be collected in a vessel as shown in plate 3.2. It is *light black (Coffee)* coloured liquid. The change in colour is due to elimination of glycerine from the oil during the separation process that has taken place at the end of transesterification process.

VII. METHODOLOGY

Due to the continuous use of fossil fuels and rise in the number of automobiles on the planet, biodiesel has emerged as a good option as an alternative fuel. Biodiesel from *waste mustard oil* is to be prepared. Biodiesel used as such without engine modifications will lead to ceasing of the engine operation. Therefore, it was then blended with petrodiesel at three different levels i.e. B10, B15 and B20. These three blends were fuelled in a compression ignition (C.I.) engine. The performance characteristics like brake power (B.P.), indicated power (I.P.), brake specific fuel consumption (BSFC), indicated specific fuel consumption (ISFC) and the emission characteristics like nitrogen oxide(NOx) formation, carbon monoxide(CO) & unburnt hydrocarbons (HC) in the smoke were measured. These performance and emission characteristics were then compared with that of petro diesel.

VIII. METHODOLOGY TO BE ADOPTED

The work performed can be divided into following steps:-

1. Production of biodiesel.
2. Estimating the properties of the biodiesel produced.
3. Blending of biodiesel with petro diesel.
4. Performance and Emission characteristics.
5. Comparison of performance and emission characteristics of biodiesel with that of petro diesel

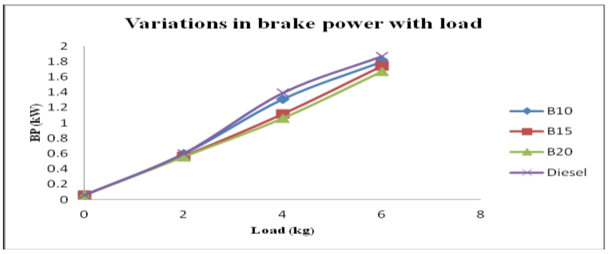
IX.RESULTS AND DISCUSSION

Performance Results

Worldwide, biodiesel is largely produced by methyl transesterification of oils. The concept of methyl transesterification is gaining attention as ethanol is derived from renewable biomass sources. The fuel consumption test and rating test of a 3.5 kW constant speed CI engine was conducted to evaluate the performance of the engine on diesel and waste mustard biodiesel with diesel.

Brake Power

Change in B.P. of blends B10, B15, B20 and diesel with respect to change in load is shown in the fig.

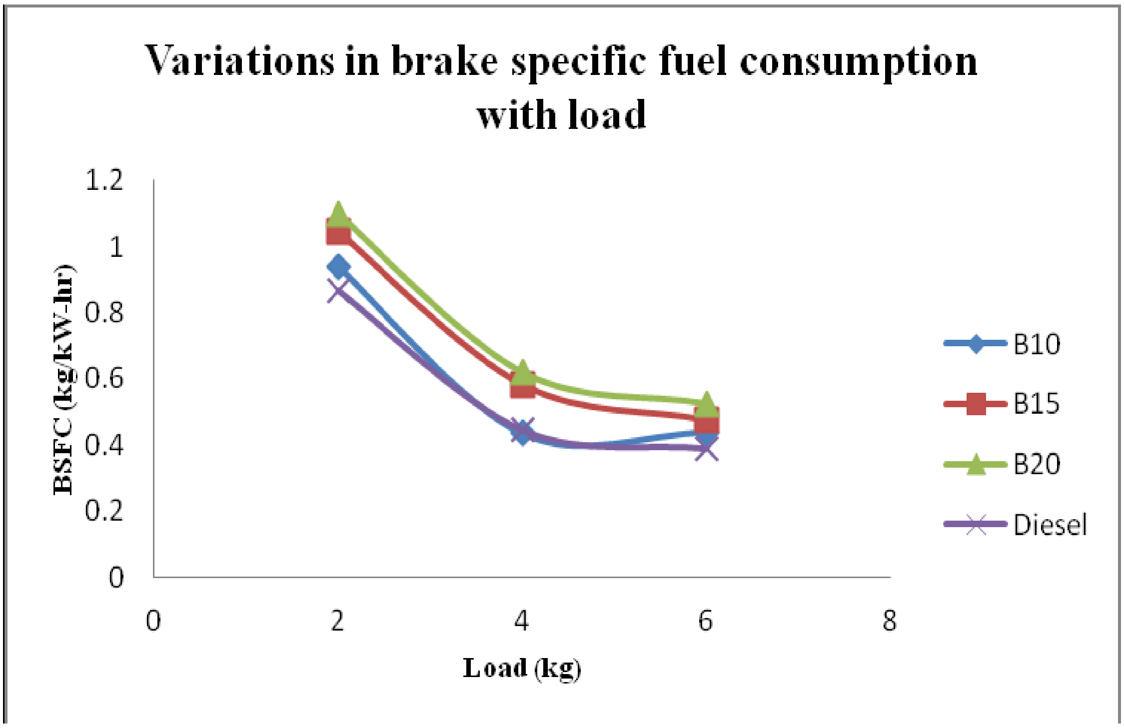


Variations in brake power with change in load

Brake power of the engine increases with increase in the load on the engine. At no load conditions,the brake power of diesel, B10, B15 and B20 is almost same. As the load increases, B.P. of the engine starts to be less for biodiesel blends as compared to diesel.The decrease in B.P. is due to the higher viscosity and density and lower heating value of biodiesel than diesel. As the quantity of the biodiesel increses in the blend, B.P. of the engine decreases due to decrease in the heating value of the fuel. Diesel is having the highest heating value amongst D, B10, B15 and B20. So, maximum brake power is obtained in fuelling diesel in comparison to B10, B15 and B20 respectively. At full load conditions, the brake power produced by B10 is 3.74%,B15 is 6.9% and B20 is 10.1% less than diesel.

Brake specific fuel consumption

Change in BSFC of blends B10, B15, B20 and diesel with respect to change in load is shown in the fig



Variation in brake specific fuel consumption with change in load

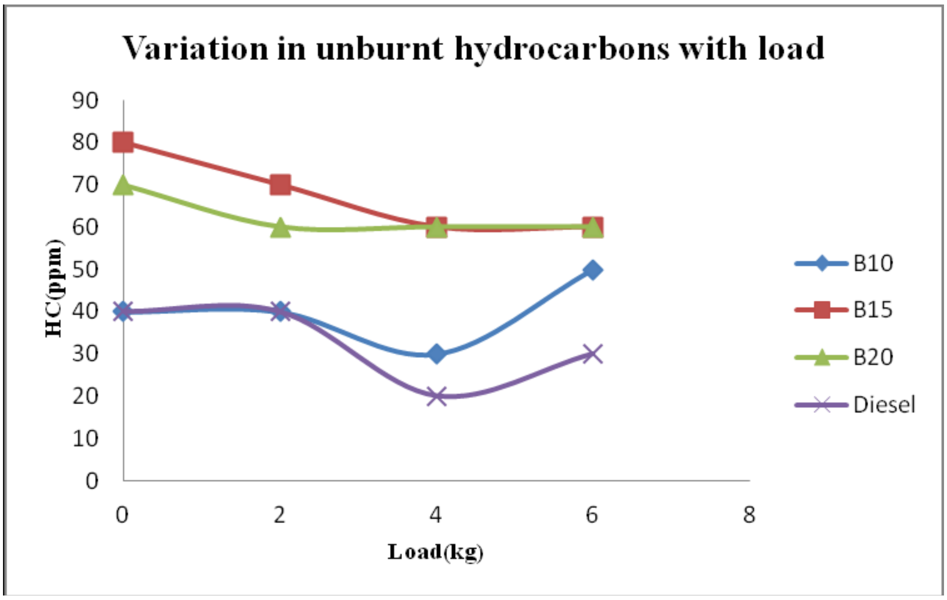
At 2 kg load conditions, BSFC of diesel is least. BSFC of B10, B15 and B20 is more than that of diesel respectively. After that the brake specific fuel consumption decreases continuously with increase in load. But BSFC in case of waste mustard biodiesel remains more than in case of diesel. It is due to lower energy content of waste mustard biodiesel. At part load conditions BSFC of B10 and diesel is almost same whereas BSFC of B15 is 23.4%, B20 is 28.05% more than that of diesel. At full load conditions, BSFC of B10 is 10.9%, B15 is 18.23%, B20 is 25.5% more than that of diesel.

Emission Results

The emissions of carbon monoxide, unburned hydrocarbons and nitrogen oxide were examined and the results are shown below. Carbon monoxide and unburned hydrocarbons are the products of incomplete combustion whereas oxides of nitrogen are produced at very high temperatures.

HC Emissions

Fig. shows the variation in the quantity of unburnt hydrocarbons with change in load at 18 compression ratio.



Change in quantity of unburnt hydrocarbons with load variation

X. CONCLUSION

The overall studies based on the production, engine performance and exhaust emission of waste mustard biodiesel were carried out. The following conclusions can be drawn:

- The kinematic viscosity of diesel, waste mustard oil biodiesel were found as 2.049, 3.575 centistokes at 400C. The results indicated that the waste mustard biodiesel had the kinematic viscosity 74.4 percent more than that of diesel.
- The calorific value of diesel, waste mustard biodiesel were found as 42, 39.54 MJ/kg respectively. The calorific value of waste mustard biodiesel is decreased by 5.85% than that of diesel.

- The waste mustard biodiesel was found to have higher flash and fire point than those of diesel.
- The results thus indicate that pour point and cloud point of waste mustard biodiesel is higher than that of diesel.
- The waste mustard biodiesel were found to have carbon residue content lower than that of diesel which is better for engine performance and it also prevents carbon deposition inside the combustion chamber. The carbon residue content of waste mustard biodiesel was obtained to be 0.0138 %.
- Waste mustard biodiesel are non-toxic, biodegradable, environment-friendly, renewable fuels and do not add to global warming.
- At full load conditions, the brake power produced by B10 is 3.74%,B15 is 6.9% and B20 is 10.1% less than diesel.
- At part load conditions BSFC of B10 and diesel is almost same whereas BSFC of B15 is 23.4%, B20 is 28.05% more than that of diesel. At full load conditions, BSFC of B10 is 10.9%, B15 is 18.23%, and B20 is 25.5% more than that of diesel.
- At full load conditions, brake thermal efficiency of B10, B15 and B20 is almost same but is less than diesel.
- B10 emits almost same amount of CO and NOx but more unburnt hydrocarbons than that by diesel.
- Use of 10% blends of waste mustard biodiesel as partial diesel substitutes can go a long way in conservation measure, reducing uncertainty of fuel availability and making more self-reliant.

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