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Performance Analysis of Biodiesel Derived from Waste Cooking Oil on Four Stroke CI Engine

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Abstract- **The fast development of human population and there comport zones by utilizing a more automobile vehicle, industrial equipment driven by fossil fuel and also agriculture equipment Leeds demand of energy sources. Therefore researcher are made an interest on alternative fuel such as biodiesel, biomass etc., as an alternative fuel. Biodiesel is environmentally friendly clean and non-toxic in nature is became a more advantages to use as substitute in CI engine and also it is one of kind of major renewable energy resources. Biodiesel can extract by transesterification process of vegetable oil and animal fats. According to point of economical view the cost of vegetable oil is more because of that only it not became a popular. However the use of edible oil as feed stock is increases the food issues and further increases the cost of oil. Therefore we were focused to use a used fired cooking is a feed stock of biodiesel extraction process this minimize the cost of production also help in environmental issue and also help in reduce the effect of human health as cancer, skin allergies etc. The main intension of this project is biofuel produced from fired cooking oil and find the properties of extracted biodiesel and compered with the ASTM standards. And made experiment to find a performance of engine like BP, IP, BTH, ITH, n_{bth}, n_{ith}etc., are find and compared with diesel for different blend such asB20,B30 and B40. This project shows good performance to use waste fired cooking oil can be successful unitized in CI engine as biodiesel.**

Keywords: Bio Diesel, Four stroke CI Engines, Alternative fuels, Waste cooling oil.

1. INTRODUCTION

Now a days biodiesel will became a more popular in the use of CI engine as substitute of diesel. It can be derived from the many varieties of oil such as vegetable oil, fish oil, dairy products cum and animal fats etc. and the biodiesel derived from the this feed stock may meets ASTM standard of biodiesel and it can be efficiently use in CI engine with or without any engine modification also it would reduce the sulphur content and escalate cetane number which assist the with increasing lubricity of low sulphur diesel and it have a higher cetane number it boots the ignition quality and also combined in the petroleum diesel. And it can be consider as environmental friendly and clean alternative fuel because they don't have a sulphur content in fuel and also it build with 10% oxygen it help in combustion of fuel to burn completely.

Biodiesel derived from vegetable oil having high enchantment because of environmental merits means it produce a less pollution and also it is one of the kind of renewable sources. Now a days cost of production of biodiesel production from the vegetable oil had a more than petroleum production because of that only still biodiesel not became a more popular. However the uncertainty of petroleum product and continuous increasing in price tag of the petroleum product result it may leads to increase the interest in production of biofuel and using a biofuel and they became more popular. There are two types of vegetable seeds they are edible and nonedible. According to survey more than 340 types of oil based vegetable seed sare there among that on sunflower seeds, soybean seeds, rape seeds, peanut, cotton seeds oil became high potential, more popular and also have great conversion efficiency. Biodiesel derived from these oils is effectively use in CI engine and the properties of converted fuel meets ASTM standards of biodiesel.

The cost of biodiesel production from the edible oil may leads increases the price tag because it is eatable things and demand of this type of oil also increase even though if you rise the interest in production of fuel form this type oil it may increases the food issues because the production means yielding of this type of seeds become lesser than demand result it further increases the price tag. So it avoid by selecting biodiesel feedstock as a waste fired sunflower cooking it is also kind of edible oil but this oil used for one time in food frying so it is not affect the food consumption issues also reduces the cost of production of biodiesel.so now days researcher made an interest on this type fuel. Financially possible Research also demonstrates we can produce biodiesel form used cooking oil, dairy scum, animal fats, fish oil etc. almost all of which are useless and we can convert them into useful biodiesel that can be used as gasoline. Waste Cooking oil for carrying out this research was gathered from five star hotels, local hotel, chips corners shop, cafeteria, catering services and food industries located near our surroundings. It is basically used sunflower oil. Sunflower oil is edible oil used for cooking in majority. Each month huge liters of oil are disposed which in turn causes contaminants of land and drinking water. Hence we may use this waste or abused cooking oil to create biodiesel. The expense of waste cooking oil is approximately Rs.25 per liters and after transesterification the price is just about Rs.50 per liter. The produce or yield from waste cooking oil WCO is approximately 90%. This implies form 20 liters of waste cooking oil (WCO) the biodiesel produced was 18 liters.

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2. LITERATURE SURVEY

TapaswyMuppaneniet al 2015 [1] shows biofuel became a high promising substitutable alternative fuel and he successfully produce a biodiesel from ethanolysis with hexane as co-solvent. From this ethanolysis process minimize the taut process parameter with quality of biodiesel yield obtained. And he conducted an experiment to find the process variable on effect of biodiesel yield such as reaction temperature, molar ratio means ethanol to oil ratio and reaction time and he found a result concluded as a for 88% of biodiesel yield the optimum condition of variable was reaction time is 20miniute, molar ratio is 40:01 at reaction temperature is 300^0c. And he made a comparison of biodiesel obtained from used cooking oil with ASTM standard and successfully meets the ASTM standard values.

Mihir J. Pate, Tushar M. Pate, Gaurav R. Rathod et, al, 2015 [2] prepared biofuel from waste cooking oil and tested different blends B10, B20 and B30 on single cylinder diesel engine and he found their optimal blend to be B20 as it showed the least BSFC and highest Mechanical Efficiency.

B. K. Abdalla et al 2013[3]in this paper gives a clear idea about concept of biodiesel production from fired cooking oil. The aim of use this oil because it reduce the cost the price of the production of biodiesel because it is obtained chiefly from local hotels, catering services, cafeteria etc, .he gives the result as biodiesel yield is 92% and it is depends on the quality of the collected raw oil, kinematic viscosity is 5.5091 $mm^2 s^{-1}$ at 40^0c, flash point 174^0c and cetane number is 4820.

Suresh Kumar P et al 2012 [4]this works shows that fired cooking oil can effectively use as a feed stock as biodiesel production and he conduct a performance on diesel engine. He obtain a result such as if the engine is operated at full load and if increases the pressure of fuel injection it leads to improves the brake thermal efficiency for a biodiesel and for diesel at fully load it vice versa like while increases in the pressure fuel injection it reduces the brake thermal efficiency and also carbon monoxide emission also continuously increases.

Conclusion from Literature

From literature survey we conclude that waste fired cooking oil is very good potential for the production of biodiesel as aspect of economical point of view, because sunflower oil is edible oil the cost of edible oil and forming of edible oil seeds and requirement of land to forming leads to increases the cost of production biodiesel this will eliminates by using a used fired cooking oil as feed stock it minimize the cost of production and also minimize the effect of pollution of land as well as water because used cooking fired oil will disposed improperly this will lead to extra treatment to purification of municipal waste so to avoid this problem we can use as a feed stock to production of biodiesel.

From literature survey, it shows biodiesel from the waste cooking fired oil is almost similar properties of ASTM standards of biodiesel. And it will full fill the substituent fuel in diesel engine. From the literature survey it is clear shows that biodiesel such as derived from waste cooking is almost similar properties and examining their suitability as an alternate fuel in single cylinder 4-stroke diesel engines.

3. METHODOLOGY

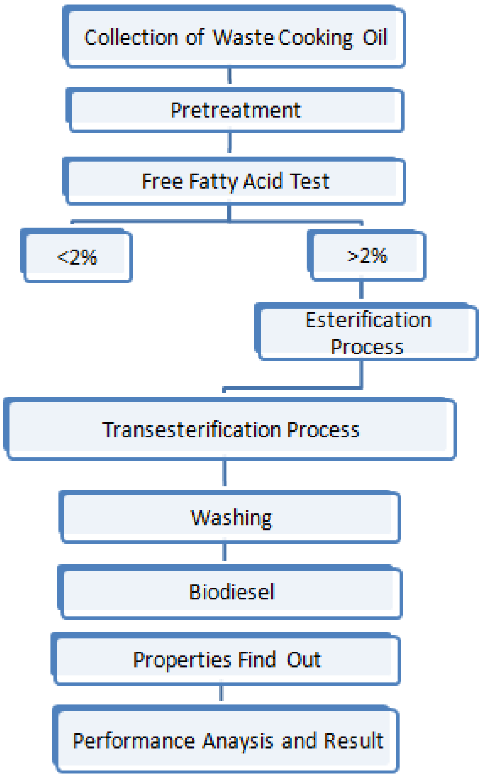

Fig 1 Flow chart of methodology

The project was carried out in three phases as shown below.
1. In the first phase we gathered the faired waste cooking oil from the local restaurants, cafeterias, catering service etc., and make pretreatment to collected waste cooking oil.

2. In the second phase we performed acid esterification followed by transesterification and obtained the bio oil, after which we prepared the blends B20, B30, and B40.

3. In the third phase we conducted the performance tests for the blends and compared the resultant values to those of regular diesel at different compression ratios.

Steps in converting waste cooking oil into Biodiesel

1. Pretreatment

The collected waste cooking essential oil were permitted to stand for minimal of two to three days so that pollutants would relax in bottom then it was allowed to filter to eliminate residues in oil and also solid particles.

Next step is heating the filtered waste cooking essential oil at 100^0C with a constant continuous Stirring for a minimum of quarter-hour

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2.Free fatty acid test

It is important parameter to biodiesel yield and this test decides the usages of this oils feed stock in biodiesel production if it is present more FFA it is consider as a bad oil. We use a titration process to find a free fatty acid. In this titration process the given waste cooking oil is mix with isopropanol after that it is mixed with the mixture of water and NaOH or KOH solution drop by drop continuously up to it became converted in pink color.

3 Esterification

Esterification can be done only if free fatty acid percentage is more than two percentages if it is not there is no need to made esterification directly we go to transesterification process. Esterification is the process is used to minimization of free fatty acid in the given oil.

4 Transesterification

Transesterificationis the process followed by esterification. Transesterification is the process as the name indicates transformingof ester to one form to another form. Transesterification is the process is used to reduce the viscosity of the give oil by using some alcohol such as methanol or ethanol with addition KOH or NaOH solution as a catalystout of this methanol and ethanol, methanol became a more attractive alcohol because they have most advantage over ethanol and also it could be easily react with KOH of NaOH solution because of it chemical advantages we can yield a maximum percentage of biodiesel by thetransesterification process.

3 EXPERIMENTAL SET UP AND EXTRACTION PROCESS

Bio-diesel extraction process from waste cooking oil

Fig 2 Reactor with Condenser and Acid Catalyzed Esterification

Fig.3 Base Catalyzed Transesterification and Water Washing Process

Diesel engine

VCR Diesel Engine

VCR (Varying compression ratio) is a technology is to be used to modify the compression ratio of IC engine while the engine is within procedure. The compression ratio of the engine can be altered by altering the cylinder head. The cylinder-head can be altered by using a hydraulic system or mechanical arrangement which is linked to the crank shaft and responds in line with the weight and acceleration required.

Engine setup

Table 1 V.C.R Diesel Engine specifications

No. of cylinders	1
No. of strokes	4
Fuel	H.S. diesel
Rated power	3.5 kW @ 1500 RPM
Cylinder diameter	87.5mm
Stroke length	110mm
Connecting rod length	234mm
Compression ratio vary	12 to 18:1
Orifice diameter	20mm
Dynamometer arm length	185mm

Fig.4 Front view of VCR 4-stroke diesel engine

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Fig.5 Side view of VCR 4-stroke diesel engine

4. RESULTS AND DISCUSSIONS

Performance Test Results

The performance test was first conducted on pure diesel at loads, 2kg, 4kg, 6kg, 8kg and 10kg loads. After obtaining the required results for the performance test onthe computer in the form of Excel we started conducting the performance test for the blends B20, B30 and B40 Variable compression ratios namely 16:1, 17:1 and 18:1 were used for the performance test. The following results were found for the different fuels on thecomputer for the performance test.

Mechanical Efficiency

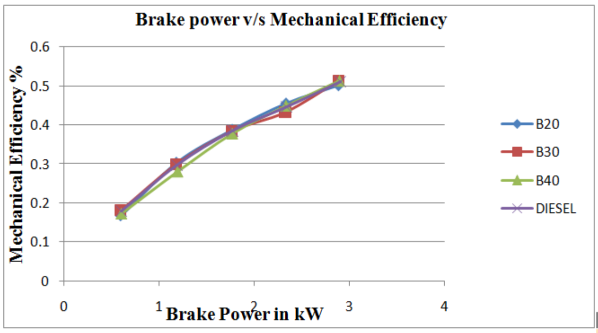

Fig 6 Mechanical Efficiency v/s Brake power

In the above fig 6 Brake power is plotted along x-axis and Mechanical efficiency is plotted along y-axis. And we made comparisons of different blend with diesel from the graph The mechanical efficiency of diesel and all blends of biodiesel is found to be nearly same. This indicates that all blends of biodiesel are efficient in transforming input energy to output movement.

Brake Specific Fuel consumption (BSFC)

In the below fig 5.6, Brake power is plotted along x-axis and BSFC is plotted along y-axis. From figure, it is clear that blend B40 has minimum fuel consumption as compared to all blends. Due to less fuel consumption, B40 blend have more brake thermal efficiency of the engine than all other blends. Due to low compression ratio there is more fuel consumption.

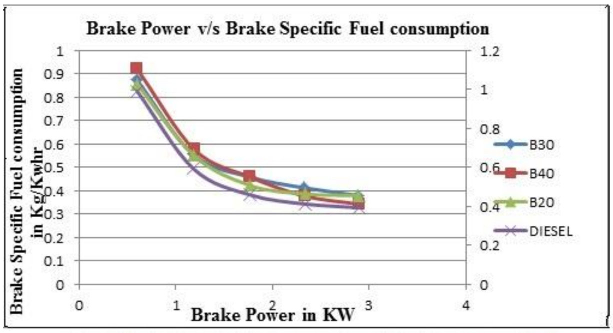

Fig 7 BSFC Vs BP

Brake Thermal Efficiency

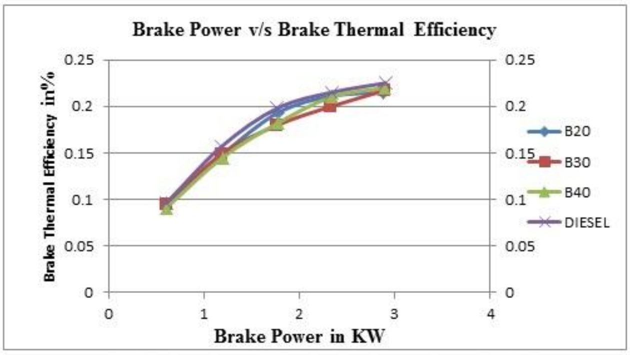

Fig 8 BTE Vs BP

In the above figure 8, Brake power is plotted along x-axis and Brake thermal efficiency is plotted along y-axis. And we made comparisons of different blend with diesel from graph, increase in brake power leads increases brake thermal efficiency of the engine. Blend B40 has BTE closest to Diesel. This indicates that the efficiency produced by blend B40 is more than all other blends.

Indicated Thermal Efficiency

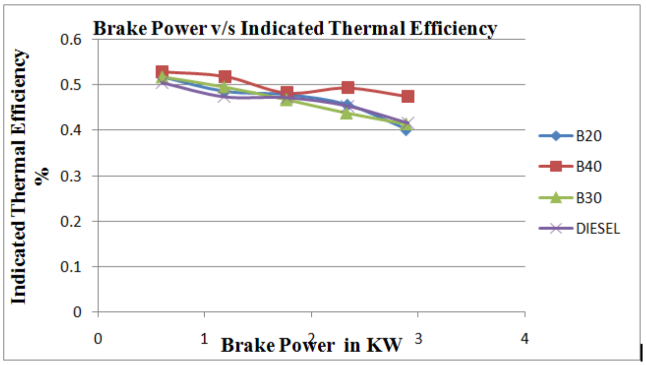

Fig 9 ITE Vs BP

In the above figure 9, Brake power is plotted along x-axis and indicated thermal efficiency is plotted along y-axis. And we made comparisons of different blend with diesel. From graph, indicated thermal efficiency of the engine decreases with increase in brake power. Blend B30 has ITE closest to Diesel. This indicates that the efficiency produced by blend B30 is more than all other blends.

Indicated Power

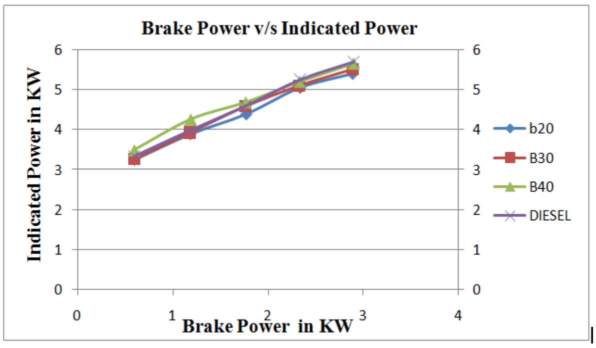

Fig 10 IP Vs BP

In the above figure 10, Brake power is plotted along x-axis and indicated power is plotted along y-axis. And we made comparisons of different blend with diesel. From graph, it is clear shows trend of indicated power, with increase in brake power indicated power also increases. Blend B40 has IP closest to Diesel. This indicates that the efficiency produced by blend B40 is more than all other blends.

CONCLUSION

In this study the Performance analysis of biodiesel derived from waste cooking oil was evaluated in a computerized 4 stroke single CI engine at 200 bar. The test was carried out at 200 bars for all the blends i.e. B20, B30and B40.

1. After the transesterification process it can be concluded that waste vegetable oil can be used as a biodiesel as it satisfies all the properties like density, viscosity, fire point, flashpoint, calorific value, which are nearer to the values of diesel.
2. By substituting NaOH as catalyst in transesterification reaction in place of KOH yield was found to increase from 84% to 92%.
3. In the blending of biodiesel B40 show good characteristics for compression ratio 16:1
4. For higher compression ratios B30 blend shows good characteristics.
5. At compression ratio 16:1 B40 blend showed the highest brake thermal efficiency 25.19% closer than the rest to diesel's brake thermal efficiency of 25.52%
6. At compression ratio 16:1 all blends showed mechanical efficiency slightly higher than that of diesel.
7. At compression ratio 16:1 B40 showed the least BSFC of 0.3356 Kg/KWhr lower than that of diesel which showed BSFC of 0.3775 Kg/KWhr.
8. At compression ratios above 16:1 B30 blend showed the maximum Brake thermal efficiency of all blends close to that of diesel.
9. At compression ratios above 16:1 B30 blend showed the least value for BSFC lower than that of diesel.

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