Optimal Mixture Ratios of Biodiesel Extracted from Waste-cooking oil with Ethanol, Diesel Mixture for Diesel Engines

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Abstract— Fossil fuels are the largest source of energy in the present growing energy needs of the world. But fossil fuels are not only available in limited reserve but also pose a threat to the environment. A large number of non-renewable fuels are being used in IC engines but they are soon to be exhausted. In the recent years active research is being done to find an alternative renewable fuel. Though hydrogen, alcohols, ammonia have proved to be a promising substitute in case of S.I engines there was no substitute in the case of C.I engines until the advent of bio fuels from sources like jatropa, cotton seed etc.

In this paper, we study the best-mixture ratio of biodiesel-ethanol-diesel for diesel engines with performance evaluation of variable compression ratio engine using continuous flow process. The results show that the integrated indexes including index when the ratio of biodiesel, ethanol and diesel are 15: 15: 70. Engine power, cost-effectiveness and emission properties are rather better with different optimizing.

Index Terms— Waste cooking oil, Diesel Engine, Biodiesel, Ethanol, Best-Mixture Ratio.

I. INTRODUCTION

The sudden increase in the pollution levels due to fossil fuels throughout the world urged for the advancement in biodiesel production. Today many of the European and Asian countries are promoting active research in the field of bio diesel [1]. Since it’s advent in the 19th century biodiesel has come a long way both in terms of advancement in extracting procedures and also improvement in properties when compared to standard diesel.

Our present work discusses the optimal mixture biodiesel, ethanol and petro diesel. Biodiesel extracted from WASTE Cooking OIL by continuous flow process using microwave technique. Biodiesel from WCO proves to be advantageous when the ecological factors are considered. It has lower carbon dioxide levels, renewable and has a clearer exhaust. Hence it proves to be the best alternative for the fossil fuels.

II. OBJECTIVE

The diesel engine with biodiesel-ethanol-diesel fuel in different mixture ratio is tested in C.I. Engine [2]. In this experiment, 100% pure diesel was taken as standard for comparison of the various samples of blended mixture. Various parameters of engine performance such as BSFC, BP, BRAKE THERMAL EFFICIENCY were determined for different samples of diesel + ethanol: biodiesel (1:1).

The objective of this work is i) To produce biodiesel from waste cooking oil by continuous flow process ii) To compare fuel properties of biodiesel thus produce with standard specifications iii) Blending of biodiesel with diesel and ethanol and iv) To study the variations of fuel properties of stable blends.

III. BIODIESEL EXTRACTION BY CONTINUOUS FLOW PROCESS

Biodiesel which is a mixture of alkyl (Eg. Methyl, ethyl) ester of fatty acids is made from a wide range of vegetable oils, animal fats and used cooking oil and also from waste oil by using trans-esterification process. Moreover, biodiesel known to act as an emulsifier due to its slight polarity and long fatty acid carbon chain has potential to improve miscibility of ethanol and diesel over limited range.
A. Feed Stock

WASTE COOKING OIL having low acid value (<0.2mg of KOH/L), ethanol, sodium methoxide catalyst are mixed in a tank at a very high speed the ratio of oil : alcohol being 1:6.
B. Microwave heating

The feed stock is the fed into the reactor which consist of u shaped glass tubes in series fixed in a microwave oven [7, 8].
C. Trans – Esterification

The feedstock is heated in microwave for about 15 seconds at 60°C to complete the trans-esterification reaction. The products formed in this reaction are mixture of biodiesel, ethanol and glycerol.
D. Separation

The reaction mixture is sent into condenser for cooling
and collected in gravity separator. As the density of biodiesel and glycerol being different, different layers are formed and biodiesel is separated.

E. Distillation

The biodiesel collected from step-4 consists of alcohol impurity hence it is fed into distillation set up the mixture is continuously stirred and heated the alcohol vapors which escape are condensed and pure alcohol is collected. Hence pure biodiesel is extracted and as the process takes places continuously it is called continuous flow process.

IV. C.I ENGINE

The C.I engine operates on diesel cycle and operates at high pressures than S.I engine [3, 10]. A C.I engine operates either on a two stroke or four stroke cycle. In this study, a four stroke cycle was chosen for testing which consists of the following strokes; Suction stroke, compression stroke, expansion stroke, exhaust stroke.

F. Suction Stroke

Air enters into the cylinder during this stroke and the valves get closed during this stroke.

G. Compression Stroke

Air inducted in suction stroke gets compressed into the volume.

H. Expansion Stroke

Fuel injection starts at the end of compression stroke. Rate of injection such that during combustion the pressure is constant in spite of piston movement. After fuel is completed the products during combustion expand the valves remain closed during this stroke.

V. EXHAUST STROKE

As the piston travels from bottom dead centre to top dead centre the products of combustion escape through exhaust. The exhaust valve is opened and inlet valve is closed in this stroke.

VI. EXPERIMENTATION

The performance characteristics of biodiesel and ethanol (1:1) blended with petro diesel was studied by conducting load test on variable compression ratio diesel engine.

VII. EXPERIMENTAL SETUP

The setup has the following as shown in the figure 1; single cylinder diesel engine, tachometer, stop watch, specific gravity bottle, burette, measuring jar and miscellaneous tools.

In this experiment, 100% pure diesel was taken as standard for comparison of the various samples of blended mixture. Various parameters of engine performance such as BSFC, BP, and BRAKE THERMAL EFFICIENCY were determined for different samples of diesel + ethanol: biodiesel (1:1).

VIII. PROCEDURE

The fuel tank is filled with the blended sample and lubricating oil lever is checked. the valve is opened so that fuel flows to the engine. The circulation of coolant is ensured. the test is started only after the engine is run for sufficient time so it attains suitable temperature for proper functioning for high viscosity fuel.

1. In the First Step, The engine is started using self start.

2. In the Second Step, the engine is made to run for some time this ensures consumption of residual fuels and precise values.

3. In the third Step, load is applied and corresponding values of voltage, current, speed time taken for consumption of 20cc of fuel, manometer gradient are recorded.

4. In this Fourth Step is repeated for different loads.

5. The Fifth Step, engine is now turn off and the loads are lowered. When this is done a spring loaded solenoid fuel supply valve is pulled to shut fuel supply and turn off the engine.

6. The values are tabulated in the Sixth Step.

IX. CALCULATIONS

1. BRAKE POWER=V*I KW

J. Mass flow rate =

\[(\text{Volume of fluid} \times \text{sp. Gravity of fuel}) \times 60\]
Time take for consumption of 20cc of fuel

K. Brake Thermal efficiency = BP*60 CV*mf
L. Specific fuel Consumption = mf*60 Kg/KW-Hr
BP
M. Volumetric efficiency = actual volume (Va)
Swept volume (Vs)

\[ V_a = C_d A \left( \frac{2g}{h} \right)^{1/2} \text{ m}^3/\text{sec} \]

\[ V_s = 3.14 \cdot D^2 \cdot \text{L} \cdot \text{N} \text{ m}^3/\text{sec} \]

H = h2 - h1

\[ 0.1 \cdot 1.16 \]

A/F = \[ \frac{m_a}{m_f} \]

\[ m_f = \text{mass of fuel consumed} \]

Brake diameter D=85mm
Stroke Length L=110mm
Orifice diameter = 20mm

\[ C_d = 0.64, \text{ Compression ratio}=20.03 \]

X. EXPERIMENTAL RESULTS AND DISCUSSIONS

The biodiesel extracted was tested in VCR Engine using different compositions, blended with the petro diesel. The blends tested are compared with pure petro diesel values. The tested samples are 90% petro diesel and 10% Biodiesel, 85% petro diesel and 15% Biodiesel, 80% petro diesel and 20% Biodiesel, 75% petro diesel and 25% Biodiesel, 70% petro diesel and 30% Biodiesel. The performances of these blends are given in Table 1 to Table 6.

Also the tested values in VCR Engine with different blends are shown in figures as follow: Fig.2. Brake power Vs Specific fuel consumption, Fig.3. Brake thermal efficiency Vs brake power, Fig.4. Brake Power Vs Volumetric efficiency, Fig.5. Brake Power Vs HSU, Fig.6. Brake Power vs K.
Fig.6: Brake Power Vs K

From the obtained values it can be concluded that the blend containing a Mixture of 30% biodiesel and ethanol (1:1) and 70% diesel gives the best performance of an engine. It was observed that the engine runs smoothly with the use of biodiesel as compared to pure petro diesel. Since bio-diesel is produced from Waste Cooking Oil, the cost of production decreases there-by less dependence on foreign countries for fuel. It can be used in all types of diesel engines without any modifications.

The various properties tested with pure Petro-diesel and pure Biodiesel are mentioned in table 7.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Properties</th>
<th>Petro diesel</th>
<th>Bio (diesel from Non-edible oil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Viscosity at 40°C (cSt)</td>
<td>3.04</td>
<td>4.20</td>
</tr>
<tr>
<td>2</td>
<td>Density @25°C (g/ml)</td>
<td>0.80</td>
<td>0.87</td>
</tr>
<tr>
<td>3</td>
<td>Flash point (°C)</td>
<td>70</td>
<td>147</td>
</tr>
<tr>
<td>4</td>
<td>Carbon residue (%)</td>
<td>0.1</td>
<td>0.41</td>
</tr>
<tr>
<td>5</td>
<td>Ash content (%)</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>6</td>
<td>Cetane number</td>
<td>40</td>
<td>51</td>
</tr>
<tr>
<td>7</td>
<td>Cold in Stages</td>
<td>60.07</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 7: Comparison of biodiesel properties with petro diesel

The various advantages of using the complete project are:

a. It is sustainable and non-toxic.

b. Studies show that it gives longer engine life.

c. It is carbon neutral hence the emission has lower pollutants.

d. Smoother and quieter running of engine.

e. Development of the biodiesel industries would strengthen the domestic, and particularly rural agricultural economies in agriculture based countries like India.

XI. CONCLUSIONS.

A Mixture of 30% biodiesel and ethanol (1:1) and 70% diesel gives the best performance of an engine. The engine runs smoothly with the use of biodiesel. Since bio diesel is produced from WCO the cost of production decreases thereby less dependence on foreign countries for fuel. It can be used in all types of diesel engines without any modifications.

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