Abstract

Chicken fat was employed as a feedstock for producing biodiesel by transesterfication reaction with methanol and alkali catalyst. In this study biodiesel is obtained from chicken fat by transesterfication process using Calcium Oxide (CaO) as catalyst which is easily available in less cost making the entire process economical. Also the obtained fuel is tested in an engine to ascertain its performance and emission characteristics.

1. Introduction

Like two sides of a coin, on one side there is rise in the garbage that is openly dumped in our localities leading to environmental pollution and on the other side there is rapid depletion of oil reserves in the world. The contradiction is that many sources of garbage can be effectively used as a source for biodiesel.

Biodiesels are fatty acid methyl ester produced from the reaction of any oil with the alcohol in presence of a suitable catalyst at a proper temperature. The bi product of reaction in the production of biodiesel is glycerol that can also be used as an ingredient in soap and cosmetics industry. Biodiesel is bio degradable and non-toxic and low emission profiles and so is environmentally
beneficial. Thus biodiesel blends can act as an effective alternative source for reducing emission profile in modern vehicles.

A. Production Of Biodiesel

There are four ways to make biodiesel, direct use and blending, micro emulsions, thermal cracking (pyrolysis) and Transesterification. The most commonly used is transesterification of vegetable oil and animal fat [1]. The transesterification process produces glycerol as the byproduct so the process is more reliable than others. The glycerol obtained from the process is suitably dried and turns into a manufacturing industry for soap production.

B. Transesterification

Transesterification or alcoholysis is the displacement of alcohol from an ester by another in the process similar to hydrolysis except than alcohol is used instead of water. Transesterification is one of the reversible reactions as proceeds essentially by mixing the reactants. However in the presence of a catalyst (a strong acid or a base accelerate the conversion).

\[
\text{Triglyceride} + \text{Methanol} \rightarrow \text{Fatty Acid Methyl Ester (Bio Diesel)} + \text{Glycerol}
\]

Transesterification of triglycerides produce fatty acid alkyl esters and glycerol. The glycerol layer settles down at the bottom of the reaction vessel. Diglycerides and monoglycerides are the intermediates in this process. The mechanism of transesterification is shown below.

\[
\begin{align*}
\text{Triglyceride} + \text{ROH} & \rightarrow \text{Diglyceride} + \text{RCOOR} \\
\text{Diglyceride} + \text{ROH} & \rightarrow \text{Monoglyceride} + \text{RCOOR} \\
\text{Monoglyceride} + \text{ROH} & \rightarrow \text{Glycerol} + \text{RCOOR}
\end{align*}
\]

The first step involves the attack of the alkoxide to the carbonyl carbon of the triglyceride molecule, which results in the formation of a tetrahedral intermediate. The reaction of this intermediate with an alcohol produces the alkoxide ion in the second step. In the last step the rearrangement gives rise to an ester and a diglyceride [2].

C. Factors affecting the transesterification process

1. Effect of free fatty acid and moisture
2. Catalyst type and concentration
3. Molar ratio of alcohol to oil and type of alcohol
4. Effect of reaction time and temperature
5. Mixing intensity

2. Experimental Setup

A. Materials

1. Chicken bone powder
2. Distilled Water
3. Calcium Oxide Catalyst obtained by heating of sea shells
4. Methanol

B. Apparatus Required

1. Four beaker of 500ml each
ii. Two beaker of 2L each  
iii. Electronic Weighing Balance accurate to 0.01gm  
iv. Soxhlet Extractor  
v. Filter paper  
vi. One magnetic stirrer  
vii. Separating funnel  
viii. Vertical clamp stand  
ix. Ostwald viscometer  
x. Bomb calorimeter  

3. Experimental Procedure

A. Fat Extraction  

Chicken bones, adipose tissues etc… are collected from market. The bulk items sliced into pieces by using knife and forceps. Then the adequate amount of fat quantity is inserted into a filter cover and stapled. Then it is inserted into the middle chamber of soxhlet extractor which is filled with Benzene solution. During heating at 110 degree Celsius for 2 hours the fat is melted and drops down into the benzene solution forming a yellowish colored solution. This is kept open in the atmosphere leading to the vaporization of Benzene there by obtaining pure fat as residue in the container.

B. Biodiesel Production  

The reaction was performed by reacting 900gm melted chicken fat. The calcium oxide (2.5 gm) dissolved in 11gm of methanol were added and stirred well. This is then taken in a beaker and heated at 95 degree Celsius using magnetic stirrer. The speed of stirring was maintained at 600 rpm for 2 hours at 65 degree Celsius. At the end of transesterification reaction the mixture is transferred into separating funnel and there is a evidence of the separation of glycerol layer at bottom. The funnel is left undisturbed for 24 hours for the separation of biodiesel and glycerol.

For purifying the biodiesel i.e. remaining catalyst and glycerin washing operation is performed by mixing hot water (70 degree Celsius). Then the biodiesel is dehydrated using a rotary evaporator. Thus biodiesel obtained is a clear yellowish transparent layer on the upper part called the pure biodiesel and the lower segregated lower layer is called glycerol which is red in color then it turns into the process of soap manufacturing.

Thus the great advantage of the process is there is a zero waste process. Biodiesel produced is clean safe and high reliable fuel. The produced biodiesel blended with our conventional diesel to access the emission profile in our modern automobile.

C. Standard Fuel Test  

The determination of sample properties of poultry fat Biodiesel and pure diesel using standard fuel test. Different test are performed on sample such as density, flash point, fire point, kinematic viscosity. So the fuel test gives a clear idea about calorific value, flash point, fire point, cloud point. The fuel testing requires the calibrated instrument like Redwood viscometer, Bomb calorimeter, Fire and flash point tester and cloud and pour point measuring apparatus the biodiesel produced is tested for fuel properties and then compared with the conventional diesel.

From the analysis we can conclude that the calorific value is similar to the diesel. The flash and fire point are tested on flash and fire point tester. The viscosity tested on Redwood viscometer.
Figure 3.1: Biodiesel Production Flow Chart

Table 3.1: Biodiesel Extraction Results

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Amount of raw material taken</td>
<td>900 gm</td>
</tr>
<tr>
<td>02</td>
<td>Volume of fat obtained</td>
<td>366 ml</td>
</tr>
<tr>
<td>03</td>
<td>Volume of methanol added</td>
<td>108 ml</td>
</tr>
<tr>
<td>04</td>
<td>Volume of CaO catalyst added</td>
<td>2.91 gm</td>
</tr>
<tr>
<td>05</td>
<td>Volume of Biodiesel produced</td>
<td>333 ml</td>
</tr>
<tr>
<td>06</td>
<td>Volume of glycerol obtained</td>
<td>141 ml</td>
</tr>
</tbody>
</table>

Table 3.2: Properties Of The Biodiesel Obtained

<table>
<thead>
<tr>
<th>SL no.</th>
<th>Properties</th>
<th>Units</th>
<th>Test Method</th>
<th>B100 (Poultry Fat)</th>
<th>Similar diesel values for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density</td>
<td>Gm/cc</td>
<td>ASTM D1448</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>2</td>
<td>Net Calorific Value</td>
<td>MJ/Kg</td>
<td>ASTM D6751</td>
<td>41.2</td>
<td>43.4</td>
</tr>
<tr>
<td>3</td>
<td>Kinematic Viscosity</td>
<td>Centi Strokes</td>
<td>ASTM D445</td>
<td>5.6</td>
<td>2.6</td>
</tr>
<tr>
<td>4</td>
<td>Flash Point</td>
<td>Degree Celsius</td>
<td>ASTM D93</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td>5</td>
<td>Cloud Point</td>
<td>Degree Celsius</td>
<td>ASTM D2500</td>
<td>4</td>
<td>8.9</td>
</tr>
<tr>
<td>6</td>
<td>Pour Point</td>
<td>Degree Celsius</td>
<td>ASTM D2500</td>
<td>-9</td>
<td>-10</td>
</tr>
</tbody>
</table>
D. Emission Testing
The produced biodiesel was tested using a single cylinder Kirloskar Diesel engine. The fuel enters to the engine through fuel filter. The fuel filter filters the particle and there is a combustion at the end of the working stroke of engine produces particular work done and exhaust emission at the outlet manifold.

![Flow Chart](image)

Figure 3.2: Emission Analysis Flow Chart

4. Emission Analysis Results
The emission analysis of Diesel (D), Chicken fat Biodiesel (CFBD) and the Chicken blend Biodiesel (CHBD) using the Kirloskar diesel engine is summarized as follows

![Graph](image)

Figure 4.1: NO₂ Emission Vs Engine Load
The above figure shows that the emission of Chicken blend Diesel is less compared to Diesel and Chicken blend.

**Figure 4.2: CO2 Emission Vs Engine Load**

The above figure shows that the emission of Chicken blend Diesel is less compared to conventional Diesel. So it can be implemented as an alternative energy source.

**Figure 4.3: HC Emission Vs Engine Load**

The above figure shows that the Hydrocarbon emission is least in Chicken blend diesel compared to other two.
4. Conclusion

From the experimental study, we can conclude that:

- Use of calcium oxide reduce the cost of production
- The biodiesel blends can used as an alternative energy source in the present scenario
- The fuel that reduces the less CO₂ to atmosphere is biodiesel; however a fuel that releases the highest CO₂ emission is diesel fuel at high engine speed. The main advantage of CO₂ emission in the case of use of biodiesel, can be regarded as carbon credit as it is biofuel from photosynthesis
- It is efficient, safe and clear fuel

5. References