Production of Biodiesel from used Cooking Oil

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Abstract— Growing concern regarding necessity of energy resources and the environmental impact and demand of fuel sources has increased interest in the research of alternative sources of energy. To meet this criteria Biodiesels will play a vital role as alternative to diesel oil since they are renewable and have similar properties. This paper aimed to give a clear idea and view on producing Biodiesel from used cooking oil. These days, many used cooking oils from restaurants were re-used by street sellers to fry their food. Those waste oils commonly just throw away. Whereas waste oils which have not any treatment first, will pollute the environment. One of the ways to treat the waste oil is by converting to biodiesel. This paper aimed to study the kinetic reaction of second-used cooking oil into biodiesel and find the optimum condition of its process. This process is going to be done by Transesterification reaction. The feedstock is going to be collected from the street sellers in Salem, Namakkal, Erode. Methanol was used as a reactant and KOH was used as a base catalyst. It is found that Biodiesel obtained from used cooking oil has similar properties and efficiency.

Key words: Biodiesel ,Used cooking oil , Transesterification ,Yield of FAME, Performance of fuel in engine

I. INTRODUCTION

Due to the increase in scarcity of petroleum resources all over the world, we are driven to search for some alternative fuels to meet the demand of fuels among the various alternative fuels like LPG, bio diesel, hydrogen, ethanol, battery etc., biodiesel finds a remarkable and significant position.

Nowadays many research experts says that the amount of petroleum products in the world can be exhausted within 40 to 60 years. So there is increase in research regarding effective substitute for petroleum (¹)

As a report says that India produces only 30 to 40% of total petroleum requirements for its consumption and remaining 70% is imported from other countries, which costs about Rs.10,00000 million per year. It is sure that mixing of 5%of Biodiesel with present diesel can save Rs.40,000 million per year (²).

Biodiesel came into effect in 1990’s due to global warming, greenhouse gas emission from vehicles and its benefits over normal diesel such as non sulfur emissions, low toxicity, biodegradable and ecofriendly.

Biodiesel is obtained from renewable sources like fresh or used vegetable oils, animal fats etc...It is superior to diesel fuels in terms of Cetane number, flashpoint, lubricity, exhaust emissions. It can be blended with conventional diesel in some proportions can be used to run any existing conventional CI engine and does not require any engine modifications (³⁴⁵).

A. Biodiesel can be prepared from many methods. Some of them are listed below

1) Direct using or blending
2) Thermal cracking
3) Micro emulsions
4) Trans esterification

This paper focuses the Trans esterification process. Trans esterification is the most common process employed in production of biodiesel (⁴⁵⁶). Biodiesel is defined as fatty acid methyl ester (FAME) derived from triglycerides (vegetable oil/animal fats) and an alcohol with right proportion of catalyst. Usage of pure biodiesel in conventional engine has some performance issues. So blended (B2,B5,B10,B15,B20) types of Biodiesel can be used in the conventional diesel engine.

II. RAW MATERIALS

The crops which is identified for production of biodiesel are corn, sunflower, palm, olive, canola, soybean, rapeseen, cotton seed and peanuts oils, and animal-based lipid (e.g. butter). Waste animal fat is also is identified to be a good feedstock for biodiesel. Economic feasibility of biodiesel depends on the availability of low-cost feed stocks. The key issue for large scale application of biodiesel as compared to petroleum diesel is the high cost of biodiesel which is mainly concerned with cost of feedstock oils as both the edible and non-edible oils are limited. Moreover, it has been reported that nearly 60-95 % of the total production cost is related to the cost of raw materials. This thing can be overcome by the use of

Used Cooking Oil (UCO) as raw material which can effectively reduce the feedstock cost to 60-70% .Similarly, the cost of catalyst also affects the overall production cost.

Many researches have been made to use waste materials for low cost catalyst preparation to develop sustainable biodiesel production process (⁴⁵)
III. USED COOKING OIL (UCO)

Used cooking oil refers to the used vegetable oil obtained from cooking food. Repeated frying edible vegetable oil no longer suitable for consumption due to high free fatty acid (FFA) content.

If waste oil is disposed it has many problems like water and soil pollution, human health concern and disturbance to the aquatic ecosystem. In spite of disposing it and harming the environment, it can be used as an effective and cost efficient feedstock for biodiesel production as it is readily available and easily processable. If using fat of animal lipids it has many concerns in refining and processing and has certain technical problems also. UCO collected can also be used to prepare soaps and additive for lubricating oil got by by product of biodiesel as glycerine. Several researches assured that production of biodiesel from cooking oil is successful. Vegetable oil contains saturated hydrocarbons (triglycerides) which consist of glycerol and esters of fatty acids. In some places, UCO from restaurants were re-used by street sellers to fry their food, this waste oil is termed as second–used cooking oil can also be utilized by converting to biodiesel.

Infact, using waste vegetable oil reduces the need for biodiesel-producing crops and the competition with food. UCOs have different properties from those of refined and crude vegetable oils. The chemical and physical properties of WCO are different from those of fresh oil since some changes due to chemical reactions - such as hydrolysis, oxidation, acidity content polymerization, and material transfer between food and vegetable oil occur during the frying process.

IV. ACID NUMBER

Acid value (or "neutralization number" or "acid number" or "acidity") is the mass of potassium hydroxide (KOH) in milligrams that is required to neutralize one gram of chemical substance.[4] The acid number is a measure of the amount of carboxylic acid groups in a chemical compound, such as a fatty acid, or in a mixture of compounds. In a typical procedure, a known amount of sample dissolved in organic solvent (often isopropanol), is titrated with a solution of potassium hydroxide (KOH) with known concentration and with phenolphthalein as a color indicator.

The acid number is used to quantify the amount of acid present, for example in a sample of biodiesel. It is the quantity of base, expressed in milligrams of potassium hydroxide, that is required to neutralize the acidic constituents in 1 g of sample.

\[
\text{Acid Number} = 56.1 \times (\text{Veq} - \text{beq}) / \text{WOil}
\]

\( \text{Veq} \) is the volume of titrant (ml) consumed by the crude oil sample and 1 ml of spiking solution at the equivalent point, \( \text{beq} \) is the volume of titrant (ml) consumed by 1 ml of spiking solution at the equivalent point, and 56.1 is the molecular weight of KOH. \( \text{WOil} \) is the mass of the sample in grams. In this research obtained Acid value is 4.38.

V. CATALYST

Normally catalyst which is used for this process is KOH or NAOH. Catalyst not alter the reaction but only speed up the reaction. Excess of catalyst results in more soapy formation and less result in not formation of biodiesel. So as per the research we varied the composition based on acid value.

VI. METHODOLOGY

A. Filtering:

Initially the Waste cooking oil is filtered in a filter to remove slag and impurities in a separate container.

B. Heating:

The Used cooking oil (UCO) is heated upto 60°C for 30 to 60 minutes in a magnetic stirrer shown in fig.1 to avoid impurities and moisture content.

Fig. 1: Magnetic stirrer

VII. MIXING SOLUTION:

KOH is used by 1% in esterification process depend from waste cooking
Before tranesterification process, Potassium hydroxide (different composition) was first mixed with methanol (different composition) together in one container before adding to the waste cooking oil. After adding the methanol / Potassium hydroxide and waste cooking oil the agitator speed were used to mix the solvents until they became murky. This was then heated to about 60° C for 30 minutes.

**VIII. TRANESTERIFICATION**

Transesterification process and any methanol evaporation the resultant biodiesels were left to lie for at least 8 hours. Separations were used to separate the top (methyl ester) and bottom (glycerol) layers of the biodiesel samples (A,B,C,D,E,F,G). The top layer was mainly composed of free fatty acid methyl esters. The bottom deposit was mostly made up of glycerol, salts, soap, other impurities and excess methanol as it is a very polar compound i.e. it partitions more with polar glycerol as opposed to the non-polar methyl esters.

**IX. WASHING**

The top methyl ester layer was separated and removed from every production sample. The water washing process was then used on some of the biodiesel batches. Once separated from the glycerin the biodiesel is sometimes purified by washing gently with warm water to remove residual catalyst or soaps, dried, and sent to storage. In some processes this step is unnecessary. This is normally the end of the production process resulting in a clear amber-yellow liquid with a viscosity similar to petrodiesel. In some systems the biodiesel is distilled in an additional step to remove small amounts of color bodies to produce a colorless biodiesel.

**X. SAMPLES**

The samples (A,B,C,D,E,F,G,H) shown in fig 2 are prepared on different compositions it is shown in fig 5 and table 1.

<table>
<thead>
<tr>
<th>S.no</th>
<th>Samples</th>
<th>UCO (ml)</th>
<th>Methanol (ml)</th>
<th>KOH grams</th>
<th>Temperature (°C)</th>
<th>Glycerol (ml)</th>
<th>Bio diesel (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A</td>
<td>100</td>
<td>20</td>
<td>0.98</td>
<td>70</td>
<td>26.464</td>
<td>80</td>
</tr>
<tr>
<td>2.</td>
<td>B</td>
<td>100</td>
<td>15</td>
<td>1.6</td>
<td>70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>C</td>
<td>100</td>
<td>15</td>
<td>1.146</td>
<td>70</td>
<td>26.6</td>
<td>83.40</td>
</tr>
<tr>
<td>4.</td>
<td>D</td>
<td>100</td>
<td>17</td>
<td>1.207</td>
<td>70</td>
<td>29.20</td>
<td>82.8</td>
</tr>
<tr>
<td>5.</td>
<td>E</td>
<td>100</td>
<td>10</td>
<td>1.109</td>
<td>70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>F</td>
<td>100</td>
<td>12</td>
<td>1.153</td>
<td>70</td>
<td>27.648</td>
<td>79.35</td>
</tr>
<tr>
<td>7.</td>
<td>G</td>
<td>100</td>
<td>15</td>
<td>1.250</td>
<td>70</td>
<td>26.049</td>
<td>83.12</td>
</tr>
</tbody>
</table>

Table 1: Samples compositions
Sample B and E results in soapy formation shown in fig 4. This shows that excess of catalyst results in increase in saponification and not formation of biodiesel.

Fig 5: Sample B soapy formation

XI. ANALYSIS
In this the samples C and D are taken into research to analyse the properties and performance in engine. The samples C and D are taken into account and B20 (20% Biodiesel+80% Petroleum diesel) is prepared. This samples C\textsubscript{B20} and D\textsubscript{B20} are tested in single cylinder four stroke diesel engine with electrical dynamometer as shown in fig 6, to analyse the performance. The analysis of speed with respect to load for petroleum diesel, samples C\textsubscript{B20} and D\textsubscript{B20} are displayed in fig 7.

Fig 6: Single cylinder four stroke diesel engine with electrical dynamometer
In this analysis it is observed that at initial condition (without load) petroleum diesel reaches maximum speed and Bio diesel (C\textsubscript{B20} and D\textsubscript{B20}) showed good performance but not better than petroleum diesel. But in load condition Biodiesel (C\textsubscript{B20} and D\textsubscript{B20}) showed similar results like petroleum diesel.

CONCLUSION

There exist a variety of potential feed stocks in India that could be utilized to produce bio diesel. These feedstocks vary significantly in price depending on supply and demand condition as well as market structural conditions. Feedstock costs would normally be between 50 and 75 percent of the cost of producing biodiesel and thus a reliable source of low priced feedstocks is critical to success. The processing technology for producing bio diesel is well established and presents little technological risk. The production of bio diesel is a very efficient process returning about 3.2 units of energy for each unit used in production. Varying quantity of KOH showed different result and sample C\textsubscript{B20} and D\textsubscript{B20} showed a better results in Biodiesel yield and performance in engine. From this research it is cleared that Bio diesel is thus an excellent renewable fuel source. It can be very easily integrated into the existing petroleum distribution system from the handling, chemical, physical and performance perspectives. It is recommended that further research should be carried out in the Biodiesel by varying composition, changing catalyst, varying reaction time, using dual catalysts to find better performance.

REFERENCES


