Production of Chicken Fat Biodiesel and its Blends

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Abstract-*As per the current situation, industrial and transportation sector have a large utilization of fuels. An internal combustion engines particularly the compression ignition (CI) play a major role in transportation, industrial, power generation and the agricultural sector. The fossil fuels have limitations in using about their depleting resources and environmental pollution issues. To overcome such a surplus issues, biodiesel becomes a beneficial option as an alternative fuel. In this evolutional study, the biodiesel obtained from the chicken fat by using the transesterification process with simple alcohol is a good option according to its availability and economic state. Biodiesel is also blended with diesel in different concentrations so as to acquire properties as per requirements. Some important physical properties of biodiesel such as flash point, cloud point, viscosity, density, cetane number etc. is also checked in the whole evaluation.*

Keywords:-Biodiesel, Transesterification, Blends, Compression ignition

I. INTRODUCTION

A number of alternative fuels such as ethanol, methanol, hydrogen, Compressed Natural Gas (CNG), liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), Dimethyl-ether (DME) and vegetable oils have been used as alternative fuels, however biodiesel has received a considerable attention to be used as a substitute fuel for conventional petroleum. Waste chicken fat is harmful for human health due to fat contain in the chicken. So there is large amount of chicken fat that is wasted, so this chicken fat can be used for production of chicken fat based biodiesel. After production it is necessary to check various chemical properties of biodiesel to check that properties are within limit or not. In this article we examined the use of solid base NaOH catalyst for the production of biodiesel from fats produced from waste chicken fat and determined suitable condition. Sodium Hydroxide catalyst was chosen due to its cheap price, minor toxicity, high availability and high basic strength. Biodiesel has already been commercialized in the transport sector in some countries and can be used in diesel engines with little or no Modification. Biodiesel and its blends with conventional diesel are environment friendly and their use in diesel engine results in reduced exhaust pollutants as compared to conventional diesel fuel.

Rudolf Diesel, the inventor of diesel engine, is the first who used peanut oil as alternative fuel for diesel engine at the 1900 world exhibition in Paris. Speaking to the Engineering Society of St. Louis, Missouri, in 1912, Diesel said, “The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become in course of times as important as petroleum and the coal tar products of present times”. However, the undesirable injection and combustion problems caused by the higher viscosity of neat vegetable oils were the main obstacles in their use as alternative fuel. This issue has been resolved by using some suitable techniques like dilution, pyrolysis, transesterification, preheating and emulsion to get methyl esters of such oils. These methyl esters of animal and vegetable oils are called biodiesel, and are being investigated for use as fuel for modern diesel engines due to their cleaner burning tendency and environmental benefits.

II. LITERATURE REVIEW

Yuan T Koble et.al.studied about chicken fat biodiesel with simple alcohol in a single-cylinder, direct injection (DI) diesel engine and its effects. A two-step catalytic process was chosen for the synthesis of the biodiesel. Methanol, sulphuric acid and sodium hydroxide catalyst were used in the reaction. To determine their effects on viscosity and flashpoint of the biodiesel, reaction temperature, methanol ratio, type and amount of catalyst were varied as independent parameters. Biodiesel combined with diesel fuel blends were used as alternative fuels for diesel engines. The seven different blends namely B5,B15, B25, B35,B45,B55 prepared. The optimization of production of biodiesel from chicken fat oil from transesterification process was evaluated on varying the various parameters such as reaction time, NAOH concentration and molar ratio.[1]

Deepthi J. et.al.evaluates the possibility of using methyl esters from animal fats as an alternative fuel for diesel. Biodiesel is an alternative fuel produced from different kinds of vegetable oils and animal fats. It is an oxygenated, non-toxic, sulphur free, biodegradable and renewable fuel that can be used in diesel engines without any significant modifications.[2]

Machadio Y.L et.al.studiedthe utilization of liquid fuels such as biodiesel produced from Jatropha oil by transesterification process represents one of the most promising options for the use of conventional fossil fuels. The Jatropha oil is converted into jatropha oil methyl ester known as biodiesel prepared in the presence of homogeneous acid catalyst. . The same characteristics study was also carried out for the diesel fuel for obtaining the base line data for analysis. The values obtained from the Jatropha methyl ester is closely matched with the values of conventional diesel and can be used in the existing diesel engine without any modification.[3]

Robinsonet.al. optimized the conversion of animal fat wastes into ethylic biodiesel by alkali-catalyzed process under mild conditions. A mix of chicken and swine fat residues was used as feedstock for biodiesel production. Moreover, optimum conditions were applied in a bench scale reactor and biofuel produced was characterized. It was observed that at high temperatures (50 ^{0}C and 70 ^{0}C), phase separation between biodiesel and glycerol was impaired.[4]

III. EXPERIMENTAL SECTION

3.1 Materials Selection:

Waste chicken fat were brought from Baramati Agro chicken centre, Baramati. Methanol, phenolphthalein indicator, calcium oxide powder were all bought from chemical lab. Water used was double distilled.

Apparatus used for production:

- **Reactor**: Mahavir Electrical, Maximum capacity: 2000ml [2liters], Watt: 400 Watt, Maximum Temperature: 300˚, Volts: 250v, Ampere: 1.7Amp
- **Electronic weighing machine**: It is used to weigh the amount of chicken fat, salt and edible oil to be used for the experiment.
- **Serological water bath**: Direct heating of solution i.e chicken fat oil+H_2SO_4+Methanol is not recommended. Therefore serological water bath is best method for heating process so as to get the desired product. The maximum temperature capacity is of 110°C.
- **Seperating funnel**: It is used to separate additional oil from the biodiesel extracted from the chicken fat.
- **Electrical heating plate**: Maximum temperature obtained is 110°C.
- **Viscometer**: It is used to measure the viscosity of the liquid i.e Biodiesel obtained later.

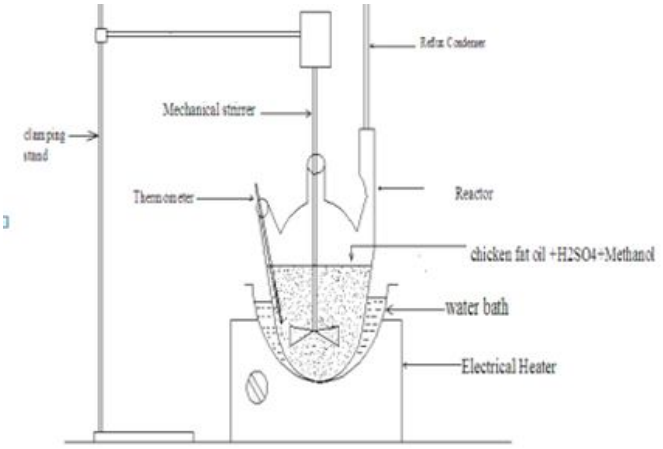

Figure 1: Schematic of Experimental setup for Chicken fat based Biodiesel Production

3.2 Experimental Procedure:

The experimental procedure for production of biodiesel is categorised as follows:

Step 1: Feedstock Preparation & Oil Expelling: Later the oil from this feedstock is expelled by suitable means. Pre-treatment: First 2000gm waste chicken fat along with 53.5gm salt and 200-300ml of edible oil is heated to temperature 120˚for 1hour for demoisturing purpose.1000gm oil is expelled after heating and filtration.

Step 2: Oil pH Balance:This oil primarily consists of many impurities & is chemically imbalanced. Before it can be actually used it has to be pre-treated to make it suitable for the production process. This is done by performing heating for moisture removal, filtering for impurities removal. A pH value of is should between 6 to7 is suitable for production process. Filtration and separation of solid chicken fat particles and chicken fat oil is done. pH of chicken fat oil= 6.5.

Step 3: Mixing of alcohol and catalyst: The catalyst is typically sodium hydroxide (caustic soda) or calcium oxide (lime) can also be used. It is dissolved in the alcohol using a standard agitator or mixer.

3.1 Reaction: The alcohol/catalyst mix is then charged into a closed reaction vessel and the oil or fat is added. The system from here on is totally closed to the atmosphere to prevent the loss of alcohol. The reaction mix is kept just above the boiling point of the alcohol (around 160 °F) to speed up the reaction and the reaction takes place. Recommended reaction time varies from 1 to 8 hours, and some systems recommend the reaction take place at room temperature. Excess alcohol is normally used to ensure total conversion of the fat or oil to its

esters. Care must be taken to monitor the amount of water and free fatty acids in the incoming oil or fat. If the free fatty acid level or water level is too high it may cause problems with soap formation and the separation of the glycerine by-product downstream.

3.1.1 Reaction I=Esterification

1000ml chicken fat oil +3 ml concentrated H_2SO_4 +500ml Methanol [CH_4OH]

Reaction Temperature set = 60˚c, Reaction Time = 1Hour [60min.]

Calculation of Free Fatty Acid (FFA) = Burette Reading ×Normality ×28.2 2gm (quantity of oil taken) FFA= 0.2 ×0.25 ×28.2 2 = 0.705.

3.1.2 Reaction II = Transesterification

5gm NaOH [Base catalyst] + 150ml methanol + 1503[first reaction Proceed] =1658ml

Reaction Temperature set = 60˚c, Reaction Time = 1Hour [60Min.]

Indicator Used =Phenolphthalein
Quantity taken =1to2 drops

Quantity we get pure chicken fat biodiesel after Transterification from 1500gm chicken fat=1000 ml

Quantity of methanol recovery is done after esterification is done = 50 ml

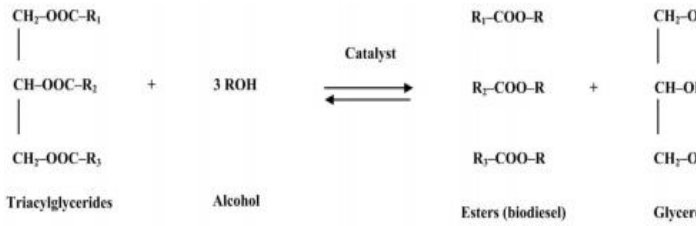

Figure 2: Reaction for transesterification process

Step 4: Separation Process of Glycerin and Biodiesel

4.1 Separation: Once the reaction is complete, two major products exist: glycerin and biodiesel. Each has a substantial amount of the excess methanol that was used in the reaction. The reacted mixture is sometimes neutralized at this step if needed. The glycerin phase is much denser than biodiesel phase and the two can be gravity separated with glycerin simply drawn off the bottom of the settling vessel. In some cases, a centrifuge is used to separate the two materials faster. A successful reaction produces two liquid phases: ester and crude glycerol. The entire mixture then settles and glycerol is left on the bottom and methyl esters (Biodiesel) is left on top. Crude glycerol, the heavier liquid will collect at the bottom after several hours of settling. Phase separation can be observed within 10 min and can be complete within 2 h after stirring has stopped. Complete settling can be taken as long as 18 hours. The more nearly neutral the pH, the quicker the glycerol phase will coalesce. This is one reason to minimize the total catalyst use. In some batch systems the reaction mixture is neutralized at the beginning of the glycerol/ester phase separation step. There are three categories of equipment used to separate the ester and glycerol phases. Decanter systems rely solely on the density difference and residence time to achieve the separation. For relatively small throughput, or batch processes, the 1 to 8 hours required for complete separation of the phases may be acceptable. For lower extent of reaction, the separation is slower, and the decanter will have to be much larger. The primary determinant for designing a decanter for biodiesel production is the desired residence time. This, plus the product mixture flow rate determines the size of the unit. Decanter units should be rather tall and narrow to allow physical separation between the ester and the glycerol withdrawal points. L/D ratios of 5 to 10 can work well. The temperature in the decanter affects the solubility of the alcohol in both phases, and the viscosity of the two liquids. The increased viscosity will slow the coalescence rate in the system. An alternative method is to allow the reactants to sit for at least an hour after mixing while keeping the brew above 100°F (38°C), which keeps the glycerin semi-liquid (it solidifies below 100°F). Then carefully decant the biodiesel. This can be done by draining the reactants out of the bottom of the container through a transparent hose. The semi-liquid glycerin has a dark brown color; the biodiesel is honey-colored. Keep a watch on what flows through the sight tube: when the lighter-colored biodiesel appears divert it to a separate container. If any biodiesel stays with the glycerin it is easy to retrieve it later once the glycerin has solidified. If you left the mixture in the tank until the glycerin gelled, reheat the tank just enough to liquefy the glycerin again. Don't stir it!

4.2 Alcohol Removal: Once the glycerin and biodiesel phases separated, the excess alcohol in each phase is removed with a flash evaporation process or by distillation. In others systems, the alcohol is removed and the mixture neutralized before the glycerin and esters have been separated. Care must be taken to ensure no water accumulates in the recovered alcohol stream.

4.3 Glycerin Neutralization: The glycerin by-product contains unused catalyst and soaps that are neutralized with an acid and sent to storage as crude glycerin. In some cases the salt formed during this phase is recovered for use as fertilizer.

In most cases the salt is left in the glycerin. Water and alcohol are removed to produce 80-88% pure glycerin that is ready to be sold as crude glycerin. In more sophisticated operations, the glycerin is distilled to 99% or higher purity and sold into the cosmetic and pharmaceutical markets.

4.4 Methyl Ester Wash: 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 petro diesel. In some systems the biodiesel is distilled in an additional step to remove small amounts of color bodies to produce a colorless biodiesel.

Step 5: Product Quality: Prior to use as a commercial fuel, the finished biodiesel must be analyzed using sophisticated analytical equipment to ensure it meets ASTM specifications.

The most important aspects of biodiesel production to ensure trouble free operation in diesel engines are:

- Complete Reaction
- Removal of Alcohol
- Removal of Glycerin
- Removal of Catalyst
- Absence of Free Fatty Acid

Step 6: Preparation of blends

In this process, Biodiesel is blended with diesel fuel as per required concentrations at 40°C with continuous stirring at 300rpm for 15min.

For example: Blend B10(10% of biodiesel blended in 90% of diesel fuel) is prepared by mixing 100ml of biodiesel extracted from chicken fat with 900ml of diesel fuel at 40°C with constant stirring at 300rpm for 15min. Similarly blends B5, B15, B25, B35, B45, B55, B75 are prepared and send for characterization to get various properties of Biodiesel blends.

Figure 2: Biodiesel B75 produced in IBDC, Baramati Lab.

Figure3: Biodiesel Blends

The above picture shows Biodiesel and its Blends that were produced at Indian Biodiesel Corporation lab, Baramati. The blends shown here are B5, B15, B25, B35, B45, B55, B75 and B0 (pure diesel).

IV. RESULT AND DISSCUSSION

As the biodiesel an its blends has been prepared. It is then send for property analysis, where different properties of a fuel such as Density, Calorific value, Viscosity etc. are measured and compared with reference to ASTM 6751. It is shown in the tabular form below in table: 1.

Table 1: Properties of chicken fat biodiesel and its blends

SR.NO	PROPERTIES	ASTM 6751	Reference		Diesel	Chicken fat Biodiesel Blends						
			Unit	Limit	B00%	CB5	CB15	CB25	CB35	CB45	CB55	CB75
1	Density	D1448	gm/cc	0.8-0.9	0.83	0.836	0.839	0.34	0.842	0.85	0.856	0.862
2	Calorific value	D6751	MJ/kg	34-45	42.5	42.25	42.01	42	41.59	41.2	39.6	39
3	Cetane no.	D613	*	41-55	49	49.39	49.44	49.5	49.52	49.65	49.81	49.9
4	Viscosity	D445	mm^2/s	3–6	2.7	*	*	*	*	*	*	4.1
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA	NA	NA	NA
6	Flash Point	D93	°C	*	64	*	*	*	*	*	*	132
7	Fire Point	D93	°C	*	71	*	*	*	*	*	*	149
8	Cloud Point	D2500	°C	*	-4	*	*	*	*	*	*	7
9	Pour Point	D2500	°C	*	-9	*	*	*	*	*	*	2
10	Ash	D	%	*	0.05	*	*	*	*	*	*	0.05

- **Density**: Density of the fuel is tested by Hydrometer and is then compared with ASTM standards.
- **Calorific Value**: Bomb calorimeter is used to measure the calorific value of the fuel. And all the blends are properly fit into ASTM standards.
- **Cetane number**: Accurate measurements of the cetane number are rather difficult, as it requires burning the fuel in a rare diesel engine called a Cooperative Fuel Research (CFR) engine, under standard test conditions. The operator of the CFR engine uses a hand-wheel to increase the compression ratio (and therefore the peak pressure within the cylinder) of the engine until the time between fuel injection and ignition is 2.407ms.
- **Viscosity**: Viscometer was used to determine the viscosity of the fuel and only the blend CB75 has shown the desired value as per ASTM651.
- **Pour point:** The automated online instrument produced by Precision Scientific Development is used to monitor any distillate fuel stream having pour point between -58 and +10°C at an accuracy of 1°C. In this instrument about 2ml of sample is retained in shallow layer in test cell which is refrigerated by use of Peltier effect in a thermo electric cooler.
- **Flash point:** It is determined by heating a small sample of biodiesel blend in a cup at a low constant rate with a continual stirring. At regular interval stirring is stopped and a small flame is directed into the cup. Flash point is the smallest temp.at which application of test flame causes the vapor over the sample to ignite.

V. CONCULSION

1. From the studied papers, we conclude that the Biodiesel can be used as a main source of fuel without any modifications in engine.
2. According to our survey, we found that chicken fat can become an effective source for biodiesel due to its readily availability.
3. From our experimentation, we achieved different blends from biodiesel.
4. Our result concluded that, the density of B25 does not fit into reference limits as per ASTM6751.And also blends B5 and B25 has shown properties more similar to B0 or diesel fuel.
5. B5 and B25 can be economically used for the engines and it can become a nice alternative for diesel.
6. Finally, we concluded that, these blends can be used for engine analysis so as to compare different parameters.

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