International Journal of Engineering Research and Development
ISSN: 2278-067X, Volume 1, Issue 7 (June 2012), PP.34-37
www.ijerd.com

Production and Analysis of Chemical Properties of Chicken Fat Based Biodiesel and its various Blends

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Abstract*—This paper represents the Transesterification reaction using heterogeneous base catalyst and analysis of properties of chicken fat based biodiesel and its various blends. we compare here different properties of chicken fat based biodiesel and its various blends.*

Key words*—Biodiesel, chicken fat, alternative fuel, reaction parameters, catalyst, chemical properties of chicken fat based biodiesel.*

I. INTRODUCTION

Waste chicken fat is harmful for human health due to fat contain in the chicken. So there is large amount of chicken fat is waste so we can use that chicken fat 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 CaO catalyst for the production of biodiesel from fats produced from waste chicken fat and determined suitable condition. Calcium oxide catalyst was chosen due to its cheap price, minor toxicity, high availability and high basic strength.

II. EXPERIMENTAL

2.1 Materials:

waste chicken fat were brought from Baramati Agro chicken centre, Baramati. Methanol, phenolphthalein indicator, calcium oxide powder were all bought from SCR chemicals Pune. Water used was double distilled.

2.2Apparatus with Specification Used for Production:

1] Reactor: Make: Mahavir Electrical, Maximum capacity: 2000ml [2liters], Watt: 400 Watt, Maximum Temperature: 300˚, Volts: 250v, Ampere: 1.7Amp
2] Electronic Weighing Machine: Maximum capacity: 5kg, Minimum capacity: 0.5 gm
3] Serological water Bath: Maximum Temperature Capacity: 110˚c.
4] Separating funnel: Maximum capacity: 1liter, Make: Borosil
5] Electrical Heating Plate: Maximum temperature obtained =110˚c
6] Oswald's viscometer: Make: Borosil

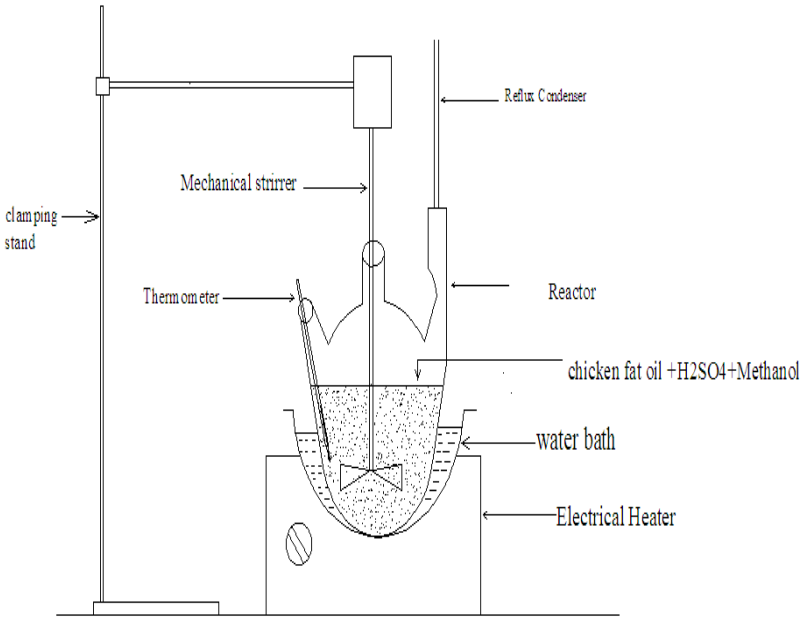

Figure 1: Schematic of Experimental setup for Chicken fat based Biodiesel Production

2.3Reaction Procedure:
Production Process Used: Batch Production Process
1] Raw Material Taken =Fresh waste chicken fat
2] Quantity taken =1500gram [1+1/2 Kg]
4] Per Kg chicken skins [chicken fat] price=35/- per kg

Step I: Feedstock Preparation & Oil Expelling*:* Later the oil from this feedstock is expelled by suitable means.
Pretreatment: First 1500gm waste chicken fat is heated to temperature 120˚for 1hour for demoisturing purpose.1000gm oil is expelled after heating and filtration.

Step II: 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 to 7 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.

Mixing of alcohol and catalyst: The catalyst is typically sodium hydroxide (caustic soda) or calcium oxide (lime). It is dissolved in the alcohol using a standard agitator or mixer. **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 glycerin by-product downstream.
Reaction I=Esterification
1000ml chicken fat oil +3 ml concentrated H2SO4 +500ml Methanol [CH4OH]
Reaction Temperature set = 60˚c, Reaction Time = 1Hour [60Minits]
Calculation of Free Fatty Acid:

$$\text{FFA} = \frac{\text{Beurett Reading} \times \text{Normality} \times 28.2}{2\text{gm (quantity of oil taken)}}$$

$$\text{FFA} = \frac{0.2 \times 0.25 \times 28.2}{2} = 0.705.$$

Reaction II = Transesterification
5gm CaO [Base catalyst] + 150ml methanol + 1503[first reaction Proceed]
=1658ml
Reaction Temperature set = 60˚c, Reaction Time = 1Hour [60Minits]
Indicator Used =Phenolphthalein
Quantity taken =1to2 drops
Quantity we get pure chicken fat biodiesel after Transterification from 1500gram chicken fat=1000 ml
Quantity of methanol recovery is done after esterification is done = 50 ml

2.4Separation Process of Glycerin and Biodiesel:
2.4.1Separation: 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 deg F (38 deg C), which keeps the glycerin semi-liquid (it solidifies below 100 deg 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!

2.4.2 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.

2.4.3 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.

2.4.4 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.

2.4.5 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

III. RESULT AND DISCUSSION

Sr. No.	Characteristics	Unit	Test Method	B100	B10	B15	B20	B25	B30
1	Density	gm/cc	ASTM D1448	0.87	0.837	0.837	0.839	0.839	0.840
2	Calorific value	Mj/kg	ASTM D6751	39.34	44.96	44.16	44.33	43.23	43.60
3	Content of hydrocarbon	%	ASTM	94	90	90	90	91	91
4	Content of oxygen	%	ASTM	11	-	-	-	-	-
5	viscosity	Cst	ASTM D445	5.4	3.6	3.68	3.71	3.8	3.98
6	Flash point	˚c	ASTM D93	174	78	78	79.5	80.5	82
7	Pour point	˚c	ASTM D2500	12.3	-20	-20	-20	-18.5	-17
8	Cloud point	˚c	ASTM D2500	14	-16	-16	-16	-13	-12
9	Calcium and magnesium combine	mg/kg	EN14538	2	0.3	0.3	0.36	0.46	0.83
10	Methanol content	%	EN14110	0.06	-	-	-	-	-
11	Water and sediment	Vol.%	ASTM D2709	0.02	0.01	0.01	0.01	0.01	0.01
12	Sulfated ash	Wt.%	ASTM D874	0.03	1.0	0.9	0.82	0.85	0.88
13	Cetane number	-	ASTMD 613	58.4	47.8	47.87	47.98	48.34	48.76
14	Carbon residue	%	ASTM D4530	0.024	0.045	0.045	0.041	0.038	0.035
15	Acid number	-	ASTM D664	0.8	0.35	0.35	0.32	0.320	0.325
16	Free glycerin	Wt.%	GC	0.004	-	-	-	-	-
17	Phosphorus content	Wt.%	ASTM D4951	0.010	0.1	0.1	0.1	0.1	0.1
18	Sodium and potassium combined	mg/kg	EN14538	5	0.9	0.92	1.2	1.6	1.9
19	Oxidation stability	Hrs.	EN14112	6	2.5	2.5	2.5	2.56	2.59
20	Cold soak filtration	seconds	ASTM D 6751	360	160	162	165	171	183

IV. CONCLUSION

The CaO catalyst is good heterogeneous catalyst for the production of biodiesel from oil of waste chicken skin. When the reaction was carried out with a molar ratio of methanol to oil of 6:1, a reaction time of 60 minute, catalyst concentration of 0.5% wt., and reaction temperature of 60°C, the conversion of skin-chicken oil was 67 % over the catalyst. The easy preparation, low cost of CaO, high basic strength as well as the easy removal of a heterogeneous catalyst underline the advantage of CaO as catalyst comparing to the homogeneous alkali base catalysts such as KOH and NaOH. Calorific value of B10 of chicken fat biodiesel blend is more than other four blends, density of B10 and B15 is less than other four blends. According to Bharat stage III viscosity Should be within range 2-4.5 which is fulfill by all the four blends, flash point of B100 is more than other four Blends, pour point of B10, B15 and B20 is more than other blends, cloud point of B10, B15 and B20 is more than other blends, According to Bharat stage III Cetane number should minimum 51 which is fulfill by of B100 is 58.4 .oxidation stability of B100 is maximum than other four chicken fat biodiesel blends. Carbone residue of B100 is less than other blends. Cold soak filtration point of B100 is maximum than other five blends.

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