Production of Biodiesel from Waste Cooking oil and Utilization of its By-Product

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Abstract - *Due to adverse effect of conventional fuels to environment and rise in crude oil's price, the need for sustainable and environmentally friendly alternate source of energy has gained importance in recent years. Biodiesel is replacement of diesel because of its unique properties like reduction in greenhouse gas emission, non-sulfur emission, low toxicity and biodegradability.*

In this research biodiesel has been produced by use of two different types of waste cooking oil (WCO) from Hotel WCO (Sample - 1) & Gobi chat center WCO (Sample - 2) through transesterification process, here both WCO belongs to sun pure oil brand. Methanol as a catalyst and NaoH & KoH as base catalyst separately used to produce biodiesel. WCO is heated in the microvan at the reaction temperature of 60^{0}c - 70^{0}c and the methanol is added to the heated WCO of about 20%, 25% & 30% & by varying NaoH & KoH i.e., 0.1%, 0.2%, 0.3%, 0.4% & 0.5%. Samples has been kept with magnetic stirrer at agitation rate of 200 - 250 rpm for 30 - 40 mins. By-products like biodiesel and glycerol were produced. Washed by hot water at 40^{0}c since it is simple and reasonable and don't affect the economy of biodiesel and obtained glycerol can be used as a by-product for soaps, candles etc. The physical characteristics of obtained biodiesel are compared with both common diesel and ASTM standards. The yield of biodiesel obtained from Hotel WCO is more compared to Gobi chat center WCO, that is yield of biodiesel obtained is 82% at optimum condition of 20% methanol and 0.5% NaoH, due to a variation of a base catalyst, methanol to oil ratio, mixing intensity, reaction time and moisture content and at same optimum condition by using KoH as a base catalyst the yield of biodiesel obtained is 87%. The cost of obtained biodiesel is determined based on the rate of used chemicals (NaoH & KoH) and feedstock WCO. The cost of obtained biodiesel is Rs.109/- and Rs.104/- which is more compared to common diesel but the cost of biodiesel will be beneficial if it is blended with diesel and blended biodiesel emission will be less which is helpful for human health and environment.

Keywords: **Transesterification, Waste cooking oil, Biodiesel, Methanol, Sodium hydroxide & potassium hydroxide.**

1. INTRODUCTION

Today it's essential to use alternative fuel (biofuels) because of energy security, environmental concerns and socioeconomic reasons. Escalating oil prices and depletion of oil reserves necessitate better alternatives of energy from fossil fuels. Besides, the side effect of petroleum-based fuels over the years there has been steady increase in amount of pollution produced by these fuels. The use of these energy sources over many years have resulted to the rise in global temperature levels known as global warming [11].

Biofuels are produced through contempory process from biomass, rather produced by the very slow geological process involved in the formation of fossil fuels such as oil. Biofuel can be produced from plants or from agriculture, commercial and industrial wastes. Different types of biofuels are present they are first generation biofuels, second generation biofuels and third generation biofuels. First generation biofuels are made up of sugar, starch waste vegetable oil using conventional technology; the first-generation biofuels include bio alcohols, biodiesel, vegetable oils, bio ethers and bio gas. Second-generation biofuels are made up of various types of non-food biomass. It includes Cellulostic biofuels and waste biomass. Third-generation biofuels are made up of microorganisms like algae which include algal fuel [9]

Biodiesel comprised of mono-alkyl; esters of long chain fatty acids derived from vegetable oil or animal fats. It has similar physico-chemical properties of conventional fossil fuel and can consequently, entirely or partially substitute fossil diesel in compression ignition engines. Biodiesel is safe, non-toxic and biodegradable compared to petroleum diesel. It is oxygenated and essentially free of sulfur and aromatics making it a clear burning fuel with reduced emission of SO_X, CO, unburnt hydrocarbons and particulate matter [13]

Use of vegetable oils as frying oils produces significant amounts of used oils which may present disposal problem. Their use for biodiesel production has the advantage of their low price. WCO or used vegetable oil is described as a renewable fuel as it does not add any extra carbon dioxide gas to the atmosphere, as opposed to fossil fuels, which cause change in atmosphere. Transesterification process had followed to produce biodiesel, which refers to catalyzed chemical reaction involving WCO and an alcohol to yield fatty acid alkyl estered glycerol [7]

This paper reviews on the production of biodiesel by the waste cooking oil which is obtained from 2 locations one is from hotel (Sample - 1) and another is from Gobi chat center (Sample – 2). The hotel oil is used 1 – 2 times for cooking purpose and Gobi chat center oil is used 3 – 4 for cooking purpose. Biodiesel is one of the useful by - product which is not harmful to environment, if the engine is using this fuel it emits no harmful gases and keeps the environment pollution free. This biodiesel is obtained through transesterification process, it is the process of separating the fatty acids from glycerol to form fatty acid esters and free glycerol [7]. Fatty acid esters commonly known as biodiesel can be produced in batches or continuously by trans esterifying triglycerides such as animal fat or waste vegetable oil with lower molecular weight alcohols in the presence of a base or an acid catalyst. The large waste vegetable oil molecule is reduced to about 1/3rd of its original size, lowering the viscosity making it similar to diesel fuel. The resulting fuel operates similar to diesel fuel in an engine [11]. Besides, it deals with the factors affecting biodiesel production process and yield of biodiesel such as temperature, reaction time, methanol to oil molar ratio, agitation rate, amount of catalyst, moisture content and free fatty acid.

2. MATERIALS & METHODOLOGY:

2.1 Materials

In this study the materials used are waste cooking oil obtained from hotel and Gobi chat center, catalyst or alcohol like methanol and base catalyst sodium hydroxide (NaoH) and potassium hydroxide (KoH). The equipment like magnetic stirrer and separating funnel are used to conduct experiment.

2.2 Methodology

In this study through transesterification method/ process conducted as follows:

2.2.1 Heating of WCO

The waste cooking oil is kept at the micro – oven at 60 - 70^{0}c.

2.2.2 Mixing of WCO with Catalyst (alcohol) and Base catalyst

The typical process is mainly done by mixing waste cooking oil with base catalyst (NaoH and KoH) with common alcohol (methanol) in magnetic stirrer at agitation rate of 250 – 300rpm.

2.2.3 Chemical Reaction

The WCO, alcohol (methanol) and base catalyst (NaoH &KoH) mixture is discharged into closed separating funnel for the reaction to take place.

2.2.4 Separation

After the reaction is completed, the two by – product exists i.e., glycerol and biodiesel. The glycerol phase is much denser than biodiesel phase, making biodiesel to be floated. The two by – products are separated through separating funnel.

2.2.5 Biodiesel Washing

After the separation biodiesel is washed with hot water of about 40 – 50^{0}c in separating funnel.

2.3 Experimental Procedure

WCO obtained from Hotel and Gobi chat center is heated at 60 – 70^{0}c, then the transesterification process is carried out by using methanol and different NaoH & KoH. After the process completed, the two by- products are obtained one is biodiesel and another is glycerol which gets settle down. By water washing of biodiesel pure biodiesel will be obtained and glycerol by purification it can be used as one of the by-products for soaps and candles formation.

Fig - 2.1: Heating of biodiesel at 60-70^{0}c.

Fig - 2.2: A sample containing mixture of WCO & NaoH placed on magnetic stirrer for agitation rate at 250rpm.

Fig - 2.3: Photographic view of obtained by-product biodiesel & glycerin in separating funnel.

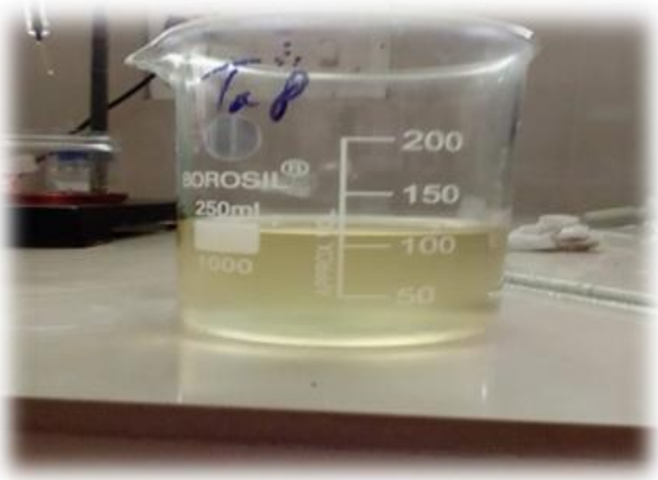

Fig -2.4: Obtained biodiesel present in beaker.

Fig - 2.5: Obtained glycerin preset in beaker.

Fig – 2.6: Water wash of obtained biodiesel from WCO.

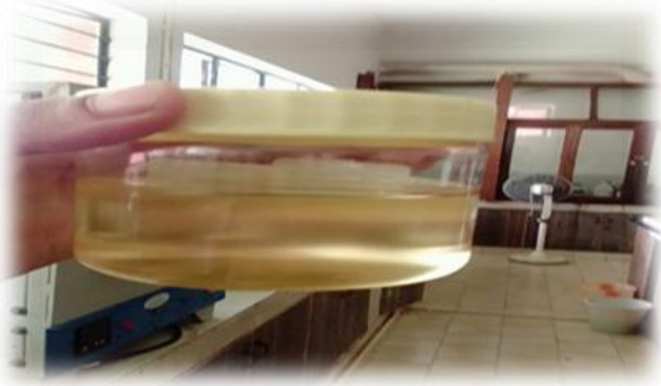

Fig -2.7: A view of biodiesel obtained after water wash.

3. ANALYSIS OF PHYSICAL CHAECTERIZATION OF OBTAINED BIODIESEL FROM WCO AND COMPARE WITH BOTH COMMON DIESEL AND ASTM STANDARDS

To know about the Physical characteristics of biodiesel produced from WCO, it is necessary to do test of biodiesel parameters in accordance with the specification of American society of testing and materials standards. The physical characterization of biodiesel includes viscosity, density, flash and fire point and the instrument used are viscometer, pycnometer and pensky martens' apparatuses

[12]. By using NaoH as a base catalyst, methanol as a catalyst and WCO from Hotel they obtained biodiesel physical characteristics are within ASTM standards i.e., viscosity-4.608mm^2/sec at 40^{0}c, density-873kg/m^3, flash and fire point 90^{0}c & 101^{0}c.

By using KoH as a base catalyst, methanol as a catalyst and WCO from Hotel they obtained biodiesel physical characteristics are within ASTM standards i.e., viscosity-4.147mm^2/sec at 40^{0}c, density-842.2kg/m^3, flash and fire point 82^{0}c & 93^{0}c.

By using NaoH as a base catalyst, methanol as a catalyst and WCO from Gobi chat center they obtained biodiesel physical characteristics are within ASTM standards i.e., viscosity-3.225mm^2/sec at 400c, density-866kg/m3, flash and fire point 840c & 950c. By using KoH as a base catalyst, methanol as a catalyst and WCO from Gobi chat center they obtained biodiesel physical characteristics are within ASTM standards i.e., viscosity-3.686mm^2/sec at 40^{0}c, density-838.5kg/m^3, flash and fire point 90^{0}c & 95^{0}c.

4. EFFECT OF VARIOUS REACTION VARIABLE ON BIODIESEL YIELD

The yield of biodiesel in the process of transesterification is affected by several process parameters which include reaction time, reaction temperature, catalyst, mixing intensity and molar ratio of alcohol and oil [12].

The influence of reaction temperature on the yield of biodiesel during the conversion from waste cooking is studied at the temperature of 60-700c. At room temperature, there is up to 72% conversion after 30 minutes, and this indicated that the methyl esterification of free fatty acids could be carried out appreciably at room temperature but might require longer reaction time. However, some of the decrease in biodiesel yield at reaction temperature of 60-70^{0}c was due to gasification of methanol solvent. Hence temperature has stronger influence [7].

The increase in fatty acid ester (biodiesel) conversion observed when there is an increase in reaction time. The reaction is slow at the beginning due to the mixing and dispersion of alcohol and oil. After that the reaction proceeds very fast. However, the maximum biodiesel conversion was achieved within < 40 min. further increase in reaction time does not increase the yield product. Besides longer reaction time leads to the reduction of end product due to the reversible reaction of transesterification resulting in loss of biodiesel [9].

In this study, much methanol usage in the reaction could inhibit the separation of biodiesel from product mixtures, thus reducing the yield of biodiesel. This means the glycerol readily dissolve in excessive methanol and subsequently shifted the catalytic reaction to the backward direction, therefore lowering the yield of biodiesel. Therefore, optimum value of methanol to oil molar ratio (20, 25, 30:100ml) can be used for subsequent experiment.

The quantity of catalyst required in reaction determines product yield. In this study the quantity of catalyst consumed during the reaction was varied from 0.1-0.5%. The yield of biodiesel generally increases with increasing amount of catalyst due to availability of more active sites by addition of large amount of catalyst in the transesterification process.

Mixing is very important in the transesterification process, adequate mixing between these two types of feedstock (oil and catalyst) is necessary to promote contact between two feed stocks (biodiesel and glycerin), therefore to enhance the transesterification reaction mechanical mixing (magnetic stirrer) commonly used. In general mixing intensity must be increased to ensure good and uniform mixing of the feedstock (product). Agitation speed plays very important role in the formation of end product, because agitation of oil and catalyst mixture enhances the reaction. At 250-300 rpm higher conversion of end product were obtained because the lower stirring speed shows lower product formation. On the other hand, higher stirring speed favors the formation of soap. This is due to the reverse behavior of transesterification reaction [11].

5. YIELD OF OBTAINED BIODIESEL FROM WCO

The yield of obtained biodiesel from WCO Hotel oil & Gobi chat center) by varying catalyst and base catalyst is determined from the formula, [11]

Yield of biodiesel= (Mass of obtained biodiesel /Mass of waste cooking oil used) *100 in %.

Yield of biodiesel obtained from WCO is (Sample-1- Hotel oil, Sample-2- Gobi chat centre oil) by varying the catalyst. The obtained biodiesel yield from sample – 1 WCO using the base catalyst NaoH and KoH by varying from (0.1 - 0.5gms) with varied methanol (20, 25,30ml) is shown in table 5.1 and 5.2. The obtained biodiesel yield from sample – 2 WCO using the catalyst NaoH and KoH by varying from (0.1-0.5gms) with varied methanol (20, 25,30ml) is shown in table 5.3 and 5.4.

Table -5.1 Yield of obtained biodiesel from Hotel WCO

SI. No	Waste cooking oil (ml) (Sample -1- vishnubhavan hotel oil)	Methanol (ml)	NaoH (gms)	Yield (%)
1.	100	20	0.1	72.00
2.	100	20	0.2	73.82

3.	100	20	0.3	77.10
4.	100	20	0.4	80.00
5.	**100**	**20**	**0.5**	**82.30**
6.	100	25	0.1	71.00
7.	100	25	0.2	73.00
8.	100	25	0.3	78.10
9.	100	25	0.4	81.00
10.	**100**	**25**	**0.5**	**82.00**
11.	100	30	0.1	72.00
12.	100	30	0.2	74.00
13.	100	30	0.3	77.55
14.	100	30	0.4	81.00
15.	**100**	**30**	**0.5**	**82.50**

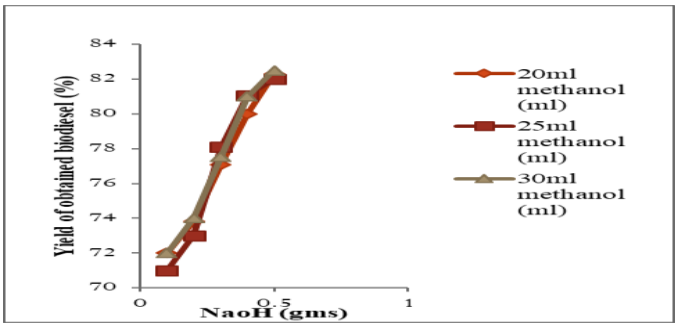

Fig -5.1: Yield of obtained biodiesel from Hotel WCO.

The above figure 5.1 shows the variation of yield of obtained biodiesel from WCO (Hotel oil) using NaoH as a base catalyst and methanol as a catalyst. Here the base catalyst (NaoH) is varied from 0.1% - 0.5% and catalyst is varied at (20%, 25% &30%). At 20% methanol the normal increase in biodiesel yield takes place with respect to increase in base catalyst concentration. At 20% and 30% methanol the initial same yield is obtained then the yield increases due to the mixing intensity. Mixing intensity is very important in this process initially it will be slow process but it plays best role in the yield of biodiesel. At 25% catalyst usage, the base catalyst concentration and agitation speed plays an important role in increase in the yield of biodiesel. The lower the agitation speed shows lower yield formation and on other hand higher agitation speed favors formation of soap, this is due to reverse behavior of transesterification reaction. Hence the agitation speed is kept 250-300rpm at a constant rate.

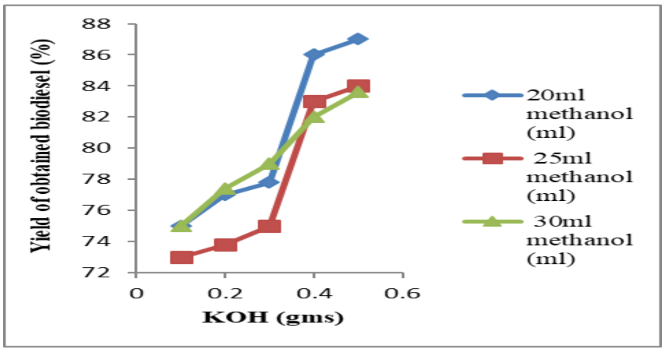

Fig- 5.2: Yield of obtained biodiesel from Hotel WCO.

Sl. No	Waste cooking oil (ml) (Sample -1- vishnubhavan hotel oil)	Methanol (ml)	KoH (gms)	Yield (%)
1.	100	20	0.1	75.00
2.	100	20	0.2	77.00
3.	100	20	0.3	77.80
4.	100	20	0.4	86.00
5.	**100**	**20**	**0.5**	**87.00**
6.	100	25	0.1	73.00
7.	100	25	0.2	73.80
8.	100	25	0.3	75.00
9.	100	25	0.4	83.00
10.	**100**	**25**	**0.5**	**84.00**
11.	100	30	0.1	75.00
12.	100	30	0.2	77.40
13.	100	30	0.3	79.00
14.	100	30	0.4	82.00
15.	**100**	**30**	**0.5**	**83.60**

Table- 5.2: Yield of obtained biodiesel from Hotel WCO.

The fig 5.2 shows the variation of yield of obtained biodiesel from WCO (Hotel oil) using KoH as a base catalyst and methanol as a catalyst. Here the base catalyst is varied from 0.1%-0.5% and catalyst is varied at (20%, 25% & 30%). In this graph the normal increase in yield of biodiesel can be observed at 30% methanol this is due to increase in catalyst concentration. The drastic increase in the yield of biodiesel for 20% and 25% methanol is due to reaction time. The reaction is slow at the beginning due to the mixing dispersion of alcohol and oil. After that the reaction proceeds very fast. However, the maximum biodiesel conversion was achieved within 40mins. Besides, longer reaction time leads to reduction of end product (biodiesel) due to reversible reaction of transesterification resulting in loss of mono alkyl esters or biodiesel as well as soap formation.

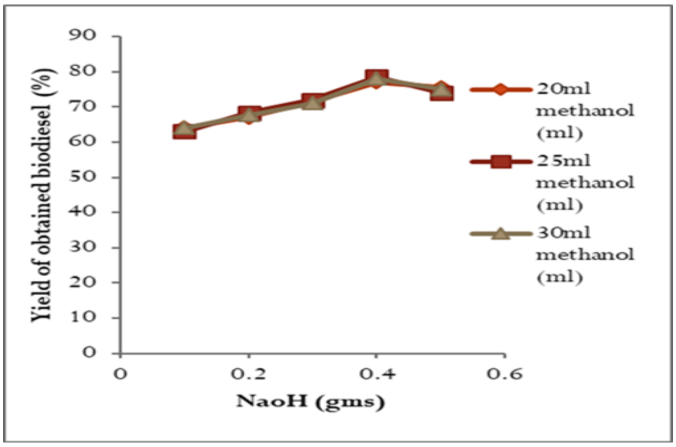

Figure – 5.3: Yield of obtained biodiesel from Gobi chat center waste cooking oil.

Table - 5.3: Yield of obtained biodiesel from Gobi chat center WCO.

SI. No	Waste cooking oil (ml) (Sample -2 – Gobi chat center oil)	Methanol (ml)	NaoH (gms)	Yield (%)
1.	100	20	0.1	64.00
2.	100	20	0.2	67.00
3.	100	20	0.3	71.40
4.	**100**	**20**	**0.4**	**77.00**
5.	100	20	0.5	75.60
6.	100	25	0.1	63.00
7.	100	25	0.2	68.30
8.	100	25	0.3	72.00
9.	**100**	**25**	**0.4**	**78.50**
10.	100	25	0.5	74.00
11.	100	30	0.1	64.00
12.	100	30	0.2	67.70
13.	100	30	0.3	71.00
14.	**100**	**30**	**0.4**	**78.00**
15.	100	30	0.5	75.00

The figure 5.3 shows the variation of yield of obtained biodiesel from WCO (Gobi chat center oil) using NaoH as a base catalyst and methanol as a catalyst. Here the base catalyst is varied from 0.1%-0.5% and catalyst is varied at (20%, 25% & 30%). In this graph at 20%, 25% and 30% catalyst usage give the same rise and fall of yield of biodiesel this is due to a reaction temperature. The increase in temperature beyond the optimum level leads to decrease in the yield of biodiesel, this is due to higher reaction temperature accelerates the transesterification of triglyceride and causes methanol to vaporize results in decrease in the yield of biodiesel after reaching certain optimum condition.

Table – 5.4: Yield of obtained biodiesel from Gobi chat center WCO

SI. No	Waste cooking oil (ml) (Sample -2 – Gobi chat center oil)	Methanol (ml)	KoH (gms)	Yield (%)
1.	100	20	0.1	73.00
2.	100	20	0.2	75.30
3.	100	20	0.3	74.00
4.	100	20	0.4	76.00
5.	**100**	**20**	**0.5**	**77.70**
6.	100	25	0.1	74.00
7.	100	25	0.2	74.70
8.	100	25	0.3	75.00
9.	100	25	0.4	75.80
10.	**100**	**25**	**0.5**	**76.20**
11.	100	30	0.1	74.20
12.	100	30	0.2	75.00
13.	100	30	0.3	75.80
14.	100	30	0.4	76.30
15.	**100**	**30**	**0.5**	**77.40**

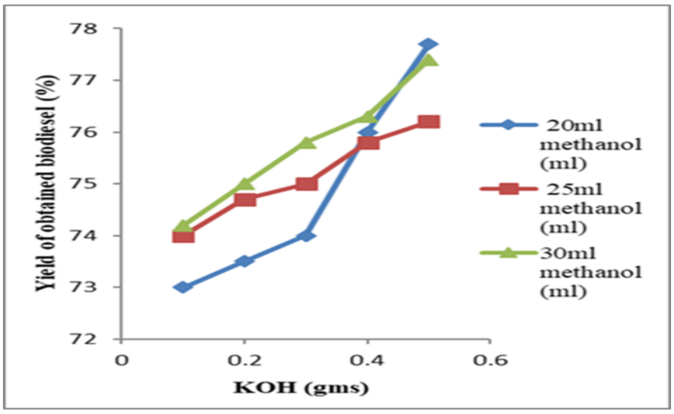

Figure – 5.4: Yield of obtained biodiesel from Gobi chat center WCO.

The above figure 5.4 shows the variation of yield of obtained biodiesel from WCO (Gobi chat center) using KoH as a base catalyst and methanol as a catalyst. Here the base catalyst is varied from 0.1%-0.5% and catalyst is varied at (20%, 25% &30%). In this graph 25% and 30% usage of methanol the increase in the yield of biodiesel occurs with increasing the amount of catalyst. This is due to an availability of more active sites by addition of large amount of base catalyst in transesterification process. For 20% methanol the drastic increase in biodiesel yield takes place, this is due to a reaction time initially the reaction will be slow then the reaction proceeds faster, after the yield reaches optimum condition there is no further increase in the yield of biodiesel even though the rise in reaction time takes place.

6. COST BENEFIT ANALYSIS:

For the cost analysis some assumption has been made to calculate the cost of chemicals used, and raw material cost (cost of WCO) to determine the cost for the production of 1 litre of biodiesel in the laboratory scale. Biodiesel produced from methanol and base catalyst NaoH and KoH by using WCO is low cost, when compared to diesel, raw materials used in WCO and alcohol present in methanol which is easily available with minimum cost and base catalyst used is NaoH and KoH. Hence the cost estimation of biodiesel obtained from WCO (Sample – 1 Hotel oil and Sample-2- Gobi chat centre oil) using the catalyst methanol and base catalyst NaoH and KoH is shown in table 6.1 ,6.2, 6.3, 6.4.

Table- 6.1: Cost estimation for 1-liter biodiesel produced from Vishnu bhavan hotel WCO using catalyst methanol and Base catalyst NaoH

SI. NO	MATERIAL USED	QUANTITY OF MATERIAL	COST (Rs.)
1.	Methanol	375ml	52.5/-
2.	KoH	4.5gms	7.2/-
3.	Waste cooking oil	1500ml	45/-

To produce 1 liter of biodiesel by using chemical like methanol and NaoH (base catalyst) and raw material like hotel waste cooking oil, the cost per liter of biodiesel produced which is Rs.104.25/-. It seems to be higher than the cost of per liter of diesel in the market is Rs.77/- but its cost become beneficial as the biodiesel would only be used in the diesel blends of B_{10} or B_{20}. Also, the cost become of less importance as the emission from the biodiesel blends reduce which supports the health of human as well as the environment. [4].

Table -6.2: Cost estimation for 1-liter biodiesel produced from Hotel WCO using catalyst methanol and Base Catalyst KoH.

SI.NO	MATERIAL USED	QUANTITY OF MATERIAL	COST (Rs.)
1.	Methanol	375ml	52.5/-
2.	NaoH	4.5gms	6.75/-
3.	Waste cooking oil	1500ml	50/-

To produce 1 liter of biodiesel by using chemical like methanol and KoH and raw material like Hotel WCO, the cost per liter of biodiesel produced which is Rs.104.7/-It seems to be higher than the cost of per liter of diesel in the market Rs.77/-but its cost become beneficial as the biodiesel would only be used in the diesel blends of B_{10} or B_{20}. Also, the cost become of less importance as the emission from the biodiesel blends reduce which supports the health of human as well as the environment.

Table - 6.3: Cost estimation for 1-liter biodiesel produced from Gobi chat center WCO using catalyst methanol and Base catalyst NaoH

SI.NO	MATERIAL USED	QUANTITY OF MATERIAL	COST (Rs.)
1.	Methanol	375ml	52.5/-
2.	NaoH	4.5gms	6.75/-
3.	Waste cooking oil	1500ml	45/-

To produce 1 liter of biodiesel by using chemical like methanol and NaoH (base catalyst) and raw material like Gobi chat center WCO the cost per liter of biodiesel produced which is Rs.109.25/-. It seems to be higher than the cost of per liter of diesel in the market is Rs.77/- but its cost become beneficial as the biodiesel would only be used in the diesel blends of B_{10} or B_{20}. Also, the cost become of less importance as the emission from the biodiesel blends reduce which supports the health of human as well as the environment [4].

Table - 6.4: Cost estimation for 1-liter biodiesel produced from Gobi chat center waste cooking oil using catalyst methanol and Base catalyst KoH

SI.NO	MATERIAL USED	QUANTITY OF MATERIAL	COST (Rs.)
1.	Methanol	375ml	52.5/-
2.	KoH	4.5gms	7.2/-
3.	Waste cooking oil	1500ml	45/-

To produce 1 liter of biodiesel by using chemical like methanol and KoH and raw material like Gobi chat center WCO, the cost per liter of biodiesel produced which is Rs.109.7/-It seems to be higher than the cost of per liter of diesel in the market is Rs.77/- but its cost become beneficial as the biodiesel would only be used in the diesel blends of B_{10} or B_{20}. Also, the cost become of less importance as the emission from the biodiesel blends reduce which supports the health of human as well as the environment

7. CONCLUSIONS

Biodiesel is one of the biofuels which is environmentally friendly.

1). Physical characteristics of obtained biodiesel from WCO (Hotel oil) are within ASTM standards, hence this biodiesel can be considered as a partial replacement fuel or additional material for diesel.

2). Different variables that effect on yield of biodiesel that is temperature, reaction time, methanol to oil molar ratio, base catalyst loading and mixing intensity.

3).The optimum condition for biodiesel production are 20ml methanol (catalyst) ,0.5% NaoH(base catalyst) at 60-700c reaction temperature,30 - 40 minutes reaction time and agitation rate of 200-250rpm it is same by using another base catalyst at KoH - 0.5%.

4). The yield of biodiesel for Hotel oil is more compared to Gobi chat center oil, this is due to a usage of Hotel WCO is less and free fatty acid content is also less compared to Gobi chat center oil and compared to Gobi chat center oil.

5). The maximum biodiesel yield obtained is about 87% by using Hotel WCO as a raw material, methanol as a catalyst & KoH as a base catalyst. By using NaoH as a base catalyst with same catalyst and waste cooking oil the maximum yield of biodiesel obtained is about 82% under the optimum condition.

6). To produce 1 liter of biodiesel by using chemical like methanol and NaoH (base catalyst) and raw material like Gobi chat center waste cooking oil, the cost per liter of biodiesel produced which is Rs.109.25/-.and to produce 1 liter of biodiesel by using chemical like methanol and KoH and raw material like Gobi chat center WCO, the cost per liter of biodiesel produced which is Rs.109.7/-.The cost of obtained biodiesel per liter seems to be higher than the cost of per liter of diesel in the market of Rs.77/- .Its cost become beneficial as the biodiesel would only be used in the diesel blends of B_{10} or B_{20}. Also, the cost become of less importance as the emission from the biodiesel blends reduce which supports the health of human as well as the environment.

7). In this process two by-products is obtained that is biodiesel and glycerin/glycerol which can be utilized for further for various purposes, as per the review which has been done on utilization of by-product obtained from waste cooking oil based on it the produced biodiesel which is partially blended with common diesel and can be used in diesel engine and glycerol/glycerin can be used as a chemical in cosmetics, soaps and candles after the proper treatment.

Since instead of throwing/pouring the waste cooking oil without treatment to the environment and making unhealthy environment through this paper which shows use of this WCO which is less in cost for biodiesel production which is more helpful to nature because unused WCO can be used for good purpose for biodiesel production and produced biodiesel is non-toxic, biodegradable and renewable fuel it can be used as partial replacement with diesel fuel and utilized in diesel engine which emits less emission compared to other fuel, it is considered as one of the eco-friendly fuel.

REFERENCES

[1]. Abdelfattah, M.S. Mansour, Y.O. Fouad, (2016). “Biodiesel production optimization from waste cooking oil using nano heterogeneous catalyst”. International journal of chemical and biochemical science, ISSN 2226-9614.

[2]. Adeyinka sikiruyusuff, John olusojiowolabi, (2019). “Synthesis and characterization alumina supported coconut chaff catalyst for biodiesel production from waste frying oil”. International journal of chemical engineering, ISSN 1026-9185, Vol30, No 1, pp 42-49.

[3]. Adeyinka sikiru Yusuf, Abdulwahabgiwa, oyindomolaaanuoluwapo, (2019). “D-optimal experimental design of biodiesel production from waste cooking oil ABUAD cafeterias”. International journal of scientific and engineering research, ISSN: 2229-5518, Vol 6.

[4]. Ahmad Mohammad Shirazi, Asadilahakram, Shahin Rafiee, Elnaz bagherikalhor, (2015). “Energy and cost analyses of biodiesel production from waste cooking oil”. International journal of renewable and sustainable energy reviews, ISSN 1364-0321, pp.44-49.

[5]. Jibril golibuta, Omprakash sahu, (2018), “Development of heterogeneous alkali catalyst from waste chicken eggshell for biodiesel production.” International journals of renewable energy, ISSN 0960-1481, pp.144-152.

[6]. Kaviyarasu.S, Ubaidullahjaffar Ali, K. Yuvaraj, P. Shanmughasundaram, (2018). “Production and performance analysis of biodiesel from used cooking oil with nano-fluid alumina”. International journal of creative research thoughts, ISSN: 2320-2882, Volume 6.

[7]. Kambiztahvildari, Yasamannaghavianaraki, Reza fazaeli, Sogol mirpanji, (2015). “The study of Cao and Mgo heterogenic nano-catalyst coupling on transesterification reaction efficacy in the production of biodiesel from recycled cooking oil”. Journals of environmental health science and engineering, ISSN 4020-1015.

[8]. Leila fereidooni, Mehdi mehrpooya, (2017). “Experimental assessment of electrolysis method in production of biodiesel from waste cooking oil using zeolite/chitosan/KoH catalyst. “Journal of energy conversion and management, ISSN: 0196-8904, Vol 147.

[9]. Munwariqbal, Ina mullah, Javediqbal, Shazianouren, Habib -Ur-rehaman, Jan nisar, Sahar.Sanasadaf, Haqnawazbhatti, (2018). “Biodiesel production from waste cooking oil: an efficient technique to convert waste into biodiesel”. International journal of research and development in technology, ISSN 2210-6707, Vol40, pp.220-226.

[10]. Madhu Agarwal, Jharnagupta (2017), “Biodiesel production from a mixture of vegetable oils using marble slurry derived heterogeneous catalyst”, International journal of engineering and bioscience, ISSN 2572-1151, Vol-4.

[11]. Md ehsan, Md tofajjal Hossain Chowdhury, (2015), “Production of biodiesel using alkaline based catalyst from waste cooking oil: a case study”. International conference on thermal engineering, ISSN 1877-7058, pp.638-645.

[12]. Mohammed abdualraqeeb, Bhargavi.R, (2015). “Biodiesel production from waste cooking oil”. Journal of chemical and pharmaceutical research, ISSN: 0975-7384, pp. 670-681.

[13]. Nasar mansir, Siowwateo, Idris rabiu, yunhintaufiq-yup, (2018). “Effective biodiesel synthesis from waste cooking oil and biomass residue solid green catalyst”. International journal of chemical engineering. ISSN 1385-8947, pp, 137-144.

[14]. Raul Hernandez Altamirano, Issisromero, Gabriela mijangos, Araceli Martinez ponce, (2019). “In-situ transesterification of jatropha curcasL.seeds using homogeneous and heterogeneous basic catalyst”. International journal of fuel useage, Vol 235, pp.277-287.

[15]. Summit.S. Dhawan, Gopinath Halder, Shubham ghosh, Bissessar karmakar, (2019). “Parametric optimization of biodiesel production from waste cooking

oil via tagunch approach". Journal of nano structure in chemistry, Vol 155, pp.269-280.
[16]. Suchadasirisomboonchai, Chanatipsamart, Maidinamuabudwayiti, Guoqing guan (2015). "Biodiesel production from waste cooking oil using calcined scallop shell as catalyst". International journal of energy conversion and management. Vol 95, pp. 242-247.
[17]. Sanjib kumarkarmee, Raffel dharma patria and carol sze kilin, (2015). "Techno-economic evaluation of biodiesel production from waste cooking oil-A case study of Hong Kong. 'International journal of molecular science, ISSN 1422-0067, pp.46-53.
[18]. Sandhya babel, Sirintraarayawate, Ekaratfaedsura, Hanggarasudrajat, (2016). "Production of biodiesel from waste cooking oil using transesterification with KoH on carbon support from waste material and egg shell as the catalyst". International journal of biochemical engineering. ISSN 2408-2384, Vol 14, pp.986-900.
[19]. Tadistesfaye, AnbessieDegfie, Yedilfan setargemekonnen, (2019). "Optimized biodiesel production from waste cooking oil using calcium oxide nano catalyst". Journal of environmental chemical engineering, ISSN: 3971-3984.
[20]. U. Rashid, B. hazmi, YH taufiq-yup, ML Ibrahim, (2020). "Super magnetic nano-bifunctional catalyst from rice husk: synthesis, characterisation and application for conversion of used cooking oil to biodiesel". International journal of chemical engineering. Vol 10, pp.225-234.
[21]. Yiehua tan, Lit Zhengsheng, Yen san chan, Jibrailkansedo, (2019), "Life cycle assessment of waste cooking oil for biodiesel production using waste chicken eggshell derived Cao as a catalyst via transesterification". International journals of biocatalyst and agricultural biotechnology, ISSN: 1878-8181.
[22]. Yen san Chan, Yei hue tan, Jibrailkansedo, N.M. Mubarak, Mohammad Omar Abdullah, Mostafa ghasemi, (2019). "Life cycle assessment of waste cooking oil for biodiesel production using chicken egg shell derived Cao as a catalyst via trans esterification". Journal of biocatalysts and agricultural biotechnology, ISSN: 1878-8181, Vol 21.
[23]. Zahoor Ullah, Mohammad azmibustmanzakaria, (2015). "Biodiesel production from waste cooking oil by acidic ionic liquid as a catalyst". Brazilian journal of chemical engineering, ISSN: 0960-1482, Vol 77, PP.521-526.

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