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Design and Installation of Biodiesel Plant

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Abstract: ***In today's world fossil fuels is the most common type of energy source used in most fields. But the fossil fuels are getting depleted as the time goes on thus more and more research is been carried out so that we could use the other forms of energy as an alternative fuel. Automobile is the most consumable area where fuel is been used and because of this there is more and more research has been carried on biodiesel .In this paper we will be looking at the Design and installation of biodiesel Plant and production of biodiesel from the waste cooking oil. Biodiesel production from waste oils is a better option to produce biodiesel and it's economical. The biodiesel was characterized based on iodine value, Cetane number, specific gravity, viscosity, cloud point, Saponification value and calorific value. Results revealed that the waste cooking oils can be converted into biodiesel as an energy source along with environmental pollution reduction.***

Keywords: Biodiesel, Free Fatty Acid, Methanol, Flash, Fire point, Viscosity, Density.

I. INTRODUCTION

The diesel engine was first developed by inventor Rudolph Diesel in 1890's. It had been the reliable, more powerful and low fuel consumable engine. The diesel engine works on the principal of compression ignition, in which fuel is injected into the engine cylinder after air is compressed at high pressure and temperature. In today's world every household has got automobiles and other equipments which run on diesel as the primary fuel. But as the time passes the petroleum sources of energy which is in the form of fossil fuels are getting depleted thus causing some serious issues for the future as the result of this situation there is more and more research has been done on the other alternative sources of fuels. Biodiesel is the one fuel which is getting more and more popularity among the others.

Biodiesel is the type of fuel which is produced from the chemical reaction of vegetable oil or animal fats with alcohol producing fatty acid esters. Biodiesel can be obtained from different products like waste cooking oil, animal fats or oils, different seeds like pongamia seeds,jatropa seeds and also from edible seeds like mustard , coconut, almond etc.

II. DESIGN AND FABRICATION OF BIO DIESEL PLANT

Components of Biodiesel plant

A. Tank

Fig1: Tank

The capacity of the tank is around 10 litres
-MATERIAL: - Mild steel sheet of 16 gauge thickness

B. Pump

Fig2: Pump

It is made of stainless steel and has a capacity of 12L/min with the speed of 8500r/min.12v

C. Heater

Fig3: Heating coil

Consumes power around 220V-240V, 60Hz, 500W.It is made of aluminium/Iron.

D. Valves

Fig 4 Valves

There are 2 types of valves used such as two way valves and single way valves and it is made from Brass –chromium.

Fig 5 :Biodiesel plant

III. PRODUCTION OF BIODIESEL FROM WASTE COOKING OIL

1) Step 1. To find the % of FFA value

$$\% \text{ of FFA} = \frac{28.2 \times \text{burette value} \times \text{Normality of NaOH}}{\text{Volume of oil taken}}$$

$$= \frac{28.2 \text{ X } 3.5 \text{ X } 0.1}{10}$$

$$= 0.987$$

If the FFA value is between 0 -0.5 then 3.5 gms of NaOH
If the FFA value is between 0.5 – 1 then 4.5 gms of NaOH

STEP 2.Weight of NaOH

$$W = \frac{NEV}{1000}$$

Where N=Normality of NaOH

E=Equivalent weight of NaOH =40

V=Volume of oil in test tube

$$W = \frac{0.1 \text{ X } 40 \text{ X } 100}{1000}$$

$$W = 0.4$$

STEP 3. kinematic viscosity

Viscosity=(At - B/t) X 10-6 m2/sec

= 1.428 X 10-5 m2/sec

where A and B are constant

A – 0.264, B – 190 when t= 40 to 85 seconds.

A – 0.247, B – 65 when t= 85 to 2000 seconds.

STEP 4. Density

Density = (W2 –W1)/60 X 1000 Kg/m3

= 875.25 kg/m3

STEP 5. Absolute Dynamic Viscosity

= Kinematic viscosity X density N-s/m2

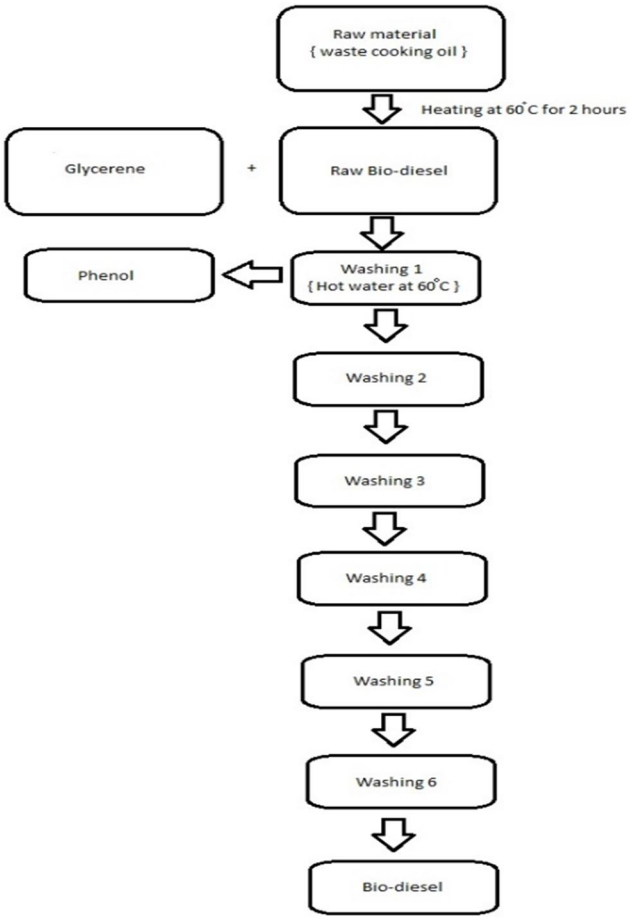
= 0.01244 N-s/m2

A. Finding the FFA Value of the Sample

To find out the FFA value of waste cooking oil which we are going to use for production of biodiesel.

After calculation we found the FFA value of about 0.987 as it is stated that if the value of FFA is less than 0.5 the quantity of NaOH should be 3.5 gm per litres of waste cooking oil , and we get more than 0.5-1 then we need to use NaOH of about 4.5gms as we got 0.987 we use 4.5 gms of NaOH .NaOH is used as a catalyst. Thus for 5litres of raw waste cooking oil we used 22.5 gms of NaOH. Methanol used was 300ml for 1 litres of biodiesel preparation. Thus we used 1.5 litres.

B. Process Flow Diagram For Biodiesel Production



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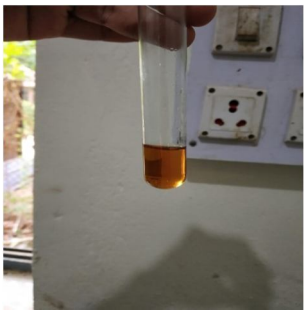
There is a tank 1 in which we pour the 5 litres of waste cooking oil and heat it for some period of time till it reaches a temperature of 60ºC.Using a thermostat to control the temperature at 60 degree celcius after reaching a temperature of 60 degree pour the solution of methanol and NaOH as a catalyst after mixing it with methanol, stir it till it gets well mixed and pour it in the tank 1 and heat it using a heater for about 2 hours approximately, using a pump or stirrer move the oil. Use the condenser so that the methanol does not get evaporated. Keep it for a day a so that it gets settled and a after a day there are 2 layers formed, bottom layer is a layer of glycerol which is in a raw form and we can use it for soap and and other detergent products. After separation of glycerol, pump the oil into the next tank for the next process.

Evaporation process now began as purified water is used for cleaning the oil and to remove the impurities and methanol. Heat the water for 50-60degrees celcius continuously. After continous washing the oil, collect the impure water which gets collected at the bottom, wash it till we get the cleaning water as clean as the water . After getting clean water as the output drain all the oil from the tank and heat it till 100-120 degrees so that all the water and methanol gets evaporated, carry out this process in closed vessel with a small opening at the top . Heat it till we see a clean fuel with no impurities. After heating it keep it for cooling so that it reaches the room temperature or cool it by using water as heat exchanger.

After cooling we get the final product in the form of biodiesel which after carrying out certain blends over test which tends to tells the percentage of biodiesel, which mixture of biodiesel can be helpful for engine to perform better mostly the blends used are B20,B8 ,etc.

Fig6: filtered waste cooking oil

Figs7: separation of raw biodiesel and glycerine



Figs8: biodiesel

C. By –products of Biodiesel

Figs9: glycerine

Figs10: phenol

D. Apparatus Used To Find Biodiesel Properties

Figs11: hyrometer

Fig 12: Claveland Flash and Fire point Apparatus

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Fig 13: Saybolt Viscometer apparatus

IV. FUEL PROPERTIES

Table 1: Fuel properties

Fuel Properties			
Properties	Oil	Diesel	Biodiesel
Flash point	327'c	52-96'c	270'c
Fire point	300-330'c	62-110'c	285'c
Viscosity	0.8 mm3/sec	4.09 mm2/sec	11.428 mm2/sec
Density	910-930 kg/m3	832 kg/m3	875 kg/m3
Calorific value	42000 KJ/Kg	43000 KJ/kg	-

The tested properties of biodiesel obtained from our biodiesel plant. We obtained above result flash point 275^0C and fire point 285^0C

A. Cost Of 1 Litre Bio-Diesel

Table 2: cost of 1 litres of Biodiesel production

Cost of 1 litres of biodiesel produced		
Sr No.	Materials	Price
1	Filtered waste cooking oil	Rs 26
2	Methanol	Rs 30
3	NaOH or KOH	Rs 5
4	Meter cost	Rs 10
5	Property testing	Rs 10
	Total	Rs 81

Table 3: By –products produced

By –Products produced

Sr no.	Products	Price
1	Phenol	Rs 10
2	Glycerine	Rs 10
	Total	Rs 20

V. PRIOR APPROACH

Alan Try Putra Samad, Dwini Normayulisa Putri, Meka Saima Perdani, Tania Surya Utami, Rita Arbianti, Heri Hermansyah (1)said that the design of portable biodiesel plant from waste cooking oil has been done simultaneously based on biodiesel standard of SNI7182: 2012. Design of biodiesel production involves several processes including esterification, transesterification, decantation,vacuum evaporation, and ultra-filtration. Production of biodiesel has been simulated using several software packages. Based on the simulation conducted, the esterification process was able to convert 92.8% of FFA into FAME by using sulphuric acid as the catalyst with 10% w/w of FFA. Transesterification showed the biodiesel yield of 90% by using NaOH as the catalyst with 1% w/w of triglyceride. Evaporation on vacuum system was able to obtain biodiesel with methanol content less than 0.5% with lower energy consumption. Purification of biodiesel using ultra-filtration requires considerable energy but it was able to produce the purity rate of biodiesel up to 99.8% with relatively shorter time.

Baste S. V., Bhonsale A. V. and Chavan S. B.(2)stated that as India's dependency on foreign oil is increases by 70% in coming years. This study focuses on investigation of karanja oil as potential source of biodiesel. Biodiesel is made from renewable sources like vegetable oil and animal fat which is non toxic and biodegradable. The emission of carbon monoxide is reduced by 80% when biodiesel is used in place of diesel fuel under full load condition. At the end by seeing performance and emission test performed on CI engine we can concluded that 20% blend of Karanja oil biodiesel and diesel can be safely used in diesel engine without any modifications.

JasanpreetSingha, NarinderKumarb, S.K. Mahlac(3),said that interest of alternative fuels in recent years increased due to increased oil price, strong emission norms and increase in environmental pollution. The biodiesel is rise as a potential substitute for diesel fuel since it is produced from renewable source and causes lesser emissions. An experimental examination has been done to analyze the performance and emission characteristics of CI engine charge with rice bran oil and its blends such as B5, B10, and B15 with diethyl at various load conditions. The experimental study shows that RBO-DEE blend has been used smoothly without making much change in engine design. In performance characteristics thermal efficiency rises by 11.6% at 10% of DEE addition in rice bran oil under full load condition and brake power also increased as oxygen supply improves the combustion process. In exhaust emission characteristics as DEE percentage increases level of unburnt hydrocarbon and carbon monoxide decreases.

V. Nageswara Reddy, G Sreenivasa Rao, K Thirupathi Reddy (4),suggested that biodiesel is gaining increased attention since it isnon-pollutant, non toxic, and renewable source of energy. It is obtained from oils and fats by transesterification with alcohols. Non edible, low cost, low grade high free fatty acid rice bran oil as raw material is consider to lower the cost of biodiesel. An upgraded engine design can be leads to low fuel consumption with good engine performance. This research work focused on production of biodiesel from crude rice bran oil and rice bran oil, study of engine performance and exhaust mission characteristic between produced biodiesel and diesel and optimization of compression ratio of compression ignition engine using blends of biodiesel. At the end after comparative analysis based on engine performance and emission of exhaust results of B10, B20

VI. CONCLUSION

A. We have successfully carried out the fabrication biodiesel plant and also the production of biodiesel from the plant.
B. We used waste cooking oil for production of Biodiesel and found the FFA of about 0.987 single Step transesterification reactions.
C. We used 22.5gms of NaOH and 1.5 litres of methanol for 5 Litre of waste cooking oil.
D. We produced biodiesel about 3.5 litres from 5 litres waste cooking oil.
E. We also have found by–products like glycerine, phenol.

F. As we found the viscosity of Biodiesel about 11 mm^3/sec and also found flash and fire point 275^0C and 285^0C, density 875 kg/m^3. As compared to diesel Viscosity is very high values we can't use 100% Biodiesel for Diesel vehicle so blending is needed in order to make it useful.

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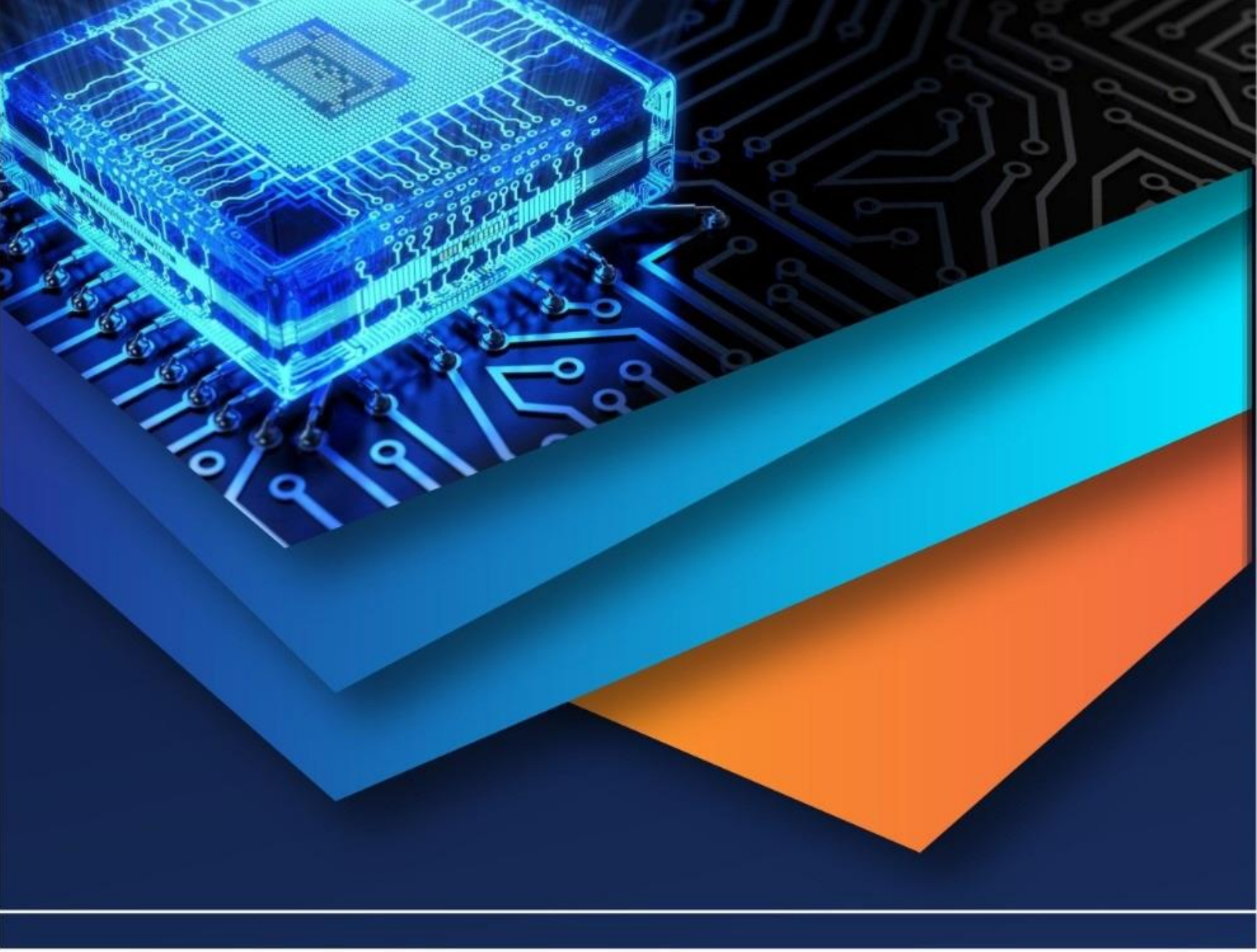

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