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Comparing properties of biodiesel obtained from waste cooking oil and virgin cooking oil

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Abstract - *This study on biodiesel will show the comparison of a characteristic of biodiesel fuel made from the raw material VVO-Soybean oil and WVO through the transesterification method. Keeping the constant volume of alcohol-methanol (20%wt/kg oil), we've added KOH 0.7% wt for VVO and for WVO we've carried out titration process in which it's found 0.95% wt KOH has to be added. Further separation is done to separate glycerol and impure biodiesel, after the settlement of mixture. For the purification of impure biodiesel waster washing has been carried out. After Washing the biodiesels it is blended with diesel fuel in varies proportion. Certain important properties of biodiesel has been tested and compared with the international standard values. Emission of biodiesel has to be tested on diesel engine test rig to checked out the emission norms.*

Key Words: **Biodiesel, Waste Vegetable Oil, Virgin Vegetable Oil, Transesterification, Yield.**

1.INTRODUCTION

Biodiesel can vary to restore petroleum-based fuels derived from renewable sources such as oil, fat, and waste oil, thanks to the fact that rock oil oil, coal, and gas classes take measures to reduce bottom And may eventually end up in close choices. For the future. Combustion of non-renewable fossil fuels emits highly cyanogenetic gases such as CO, CO2, NO, NO2 and SO2, which square measure is referred to as greenhouse gases (GHGs), and of atmospheric phenomena. Square measure to blame for. The employment of biodiesel as another fuel is inevitably changing due to the lack of fossil fuels, and can significantly return CO and goods (PM) emissions as they contain gas. To boot, they require energy security, no toxicity, basic access, and recycling. What's more, the distinct benefits for the employment of biodiesel are not limited to its low sulfur content, superior combustion power, high biodegradability, domestic origin, and increased lubricating properties. Likewise, it is used in diesel engines during blending with standard diesel, while the engine is not modified, although biodiesel is used solely for its high density, high viscosity, high iodine content, and high volatility.

ASTM defines biodiesel as mono-alkyl esters of long-chain fatty acids (FA) derived from a renewable feedstock, such as vegetable oils, animal fats, and used kitchen oils, fuels And through wine such as fermentation. alcohol. The accepted method used for biodiesel addiction is transesterification, which converts feedstock into a carboxylic acid organic compound with associated properties in fuel oil. Stoichiometrically, the transfer of one mole of lipoid within the presence of three moles of alcohol produces 3 moles of carboxylic acid ester and one mole of glycerin, where diglycerides and monoglycerides square measure intermediate merchandise.

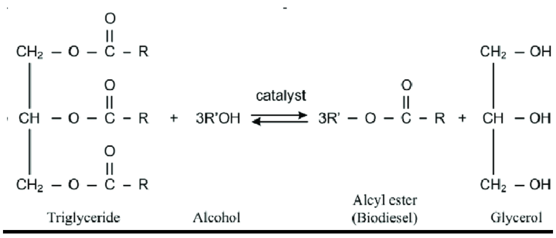

Fig -1: Transesterification Reaction

Virgin oil (VVO) and waste oil (WVO) were used as raw materials for biodiesel production. Various analyzes have been completed by VVO and WVO to date. What's more, this study attempts to compare using the same alcohol-methanol and catalyst as KOH.

WVO is economical as compared to edible oil, which is an associate in the insured option for VVO. A study on the assembly value of biodiesel infested fats and waste oils as feedstock shows a decrease in value compared to contemporary oil. Considering the issue of value, the material for this study that is waste oil is however made a victim of comparison VVO and WVO.

2. BIODIESEL PRODUCTION PROCESS

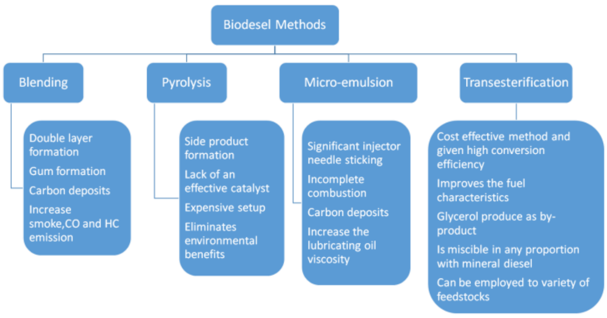

Fig -2: Biodiesel Process

2.1. Pre-processing

In pre-processing, we will complete the filtration of biodiesel. Crude soybeans and waste vegetable oil were purchased from the restaurant. Contamination in oil was filtered through a 5 micron filter cloth in the filtration unit. Samples of each 1000 ml were filtered twice.

Also we've heated up the raw oil upto 60-70 ^{0}C which can make oil free from moisture.

Fig -3: Trapped contaminant

2.2. Transesterification

The method described here is for making FAMEs biodiesel. The reaction is called transesterification, and the process takes place in four stages. The first step is for mixing alcohols with catalysts, usually a strong base such as NaOH or KOH. The alcohol / catalyst is then reacted with fatty acids so that the transesterization reaction occurs. The response to change is seen in Figure 4.

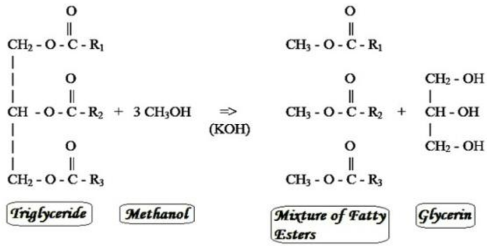

Fig -4: Chemistry of biodiesel production

The catalyst is prepared by mixing methanol and strong bases such as sodium hydroxide or potassium hydroxide. During preparation, KOH breaks down into ions of K + and OH-. OH-ablates hydrogen to form water from methanol and leaves CH3O- available for the reaction. Methanol should be as dry as possible. When OH-ion reacts with the H + ion, it reacts to form water. Water will increase the likelihood of a side reaction with free fatty acids (fatty acids that are not triglycerides) to create an unwanted reaction. Enzymatic processes can also be used (called lipases); Alcohol is still needed and only the catalyst replaced. Lipids are slower than chemical catalysts, higher in cost, and produce lower yields.

Once the catalyst is prepared, the triglyceride will react with 3 moles of methanol, so additional methanol has to be used in the reaction to ensure complete reaction. Three attached carbons react with hydrogen to OH-ions and form glycerin, while the CH3 group reacts with free fatty acids to form fatty acid methyl esters.

Figure 5. is a graphic of the required amount of chemicals required to react and the overall yield of biodiesel and glycerin. The amount of methanol added is about twice the required amount so the reaction is completed. With 1 litre of fat and 200 mL of alcohol, the reaction will produce 920 mL of biodiesel and 80 mL of glycerin in WVO and VVO receives approximately 940 mL of biodiesel and 60 mL of glycerin. The reaction usually occurs between 40–65 ° C. As the reaction temperature is high, the reaction rate will increase, typically 1–2 hours at 60 ° C versus 2–4 hours at 40 ° C. If the reaction exceeds 65 ° C, a pressure vessel is required because methanol will boil at 65 ° C. It also helps to increase the methanol to oil ratio. Doubling the ratio of 3 moles to 6 moles of alcohol will complete the reaction rapidly and completely.

Figure 5. Shows a schematic of the process for producing biodiesel. Glycerol is produced and has to be separated from biodiesel. Both glycerol and biodiesel are required to remove alcohol and be recycled in the process. Water is added to both biodiesel and glycerol to remove unwanted side products, especially glycerol, which can remain in the biodiesel. The wash water is separated to resemble solvent extraction (it contains

some glycerol), and the trace water is evaporated with biodiesel. Acid is added to glycerol to provide neutralized glycerol.

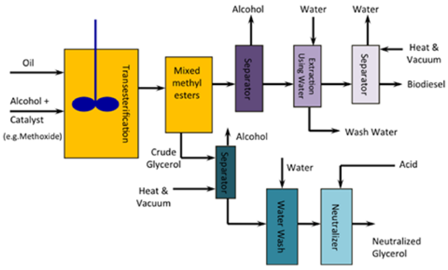

Fig -5: Schematic of biodiesel process using transesterification

Fig -6: Mixing of lye and oil using magnetic stirrer

Fig -7: Noticeable colour change

2.3. Titration for WVO

One hundred percent virgin or lightly used waste vegetable oil (WVO) requires 7 grams per litre of oil for the biodiesel reaction. Heavily used oil may require significantly more and must be tested to evaluate its acidity. Scaling is a general method that is used to determine the appropriate amount of lye (base) required for a particular batch of WVO.

Titration equipment:

• Electronic scale or beam balance • 2 beakers or jars • a graduated dropper / syringe • Lye (KOH + Methanol) • Isopropyl alcohol • Distilled water

Following are the steps to complete a titration test:

1. Measure 1 gram of lye on a scale.
2. Measure 1 litre of distilled water in a beaker.
3. Completely mix gram of lye with a litre of water until it dissolves.
4. Measure 10 ml of isopropyl alcohol into a separate beaker.
5. Make a full mixture of 1 ml of vegetable oil in alcohol.
6. With graduated degree, add 1 ml litre of lye / water mixture to the oil / alcohol mixture.
7. Immediately check the pH level of the oil / alcohol mixture with a piece of litmus paper or an electronic pH meter.
8. Repeat step 7, keeping track of the drops used until the oil / alcohol mixture reaches a pH level between 8 and 9 - usually no more than 4 drops.
9. Calculate the amount of lye required for the biodiesel reaction by adding 7 (the amount of lye used for virgin oil) to the number of drops from step 7. For example: Suppose 3 drops of Lye/ water are used in a titration. Adding 7.0 + 2.5 = 9.5. This hypothetical batch of oil requires 9.5 grams of lye per litre.

Fig -8: Titration

3. PURIFICATION
3.1 Titration for WVO

The mixture was transferred to a separate funnel, separating the glycerol. The glycerol layer was dried and the biodiesel layer was collected. One litre of WVO oil requires 200 ml of methanol and 9.5 grams of KOH and 7 grams of KOH will be required for VVO. This will separate the glycerin due to density differences.

Fig -9: *Separation glycerol and biodiesel using separation funnel*

3.2 Water washing

As discussed, the initial reactants used in the process should be as dry as possible. Water can react with triglyceride to form free fatty acids and diglycerides. It can also separate sodium or potassium from hydroxide, and ions can react with free fatty acids to form Na + and K + soaps. Water can help make a free fatty acid, and that free fatty acids can react with K + ion to make soap. The potassium that was being used as a catalyst is now fatty acid and unusable. It also complicates separation and recovery. All oils may contain naturally free fatty acids. Refined vegetable oil contains less than 1%, while crude vegetable oil contains 3%, waste oil 5% and animal fat 20%. Animal fat is a less desirable feedstock.

Well reaction simply washes biodiesel better. Because it has less oil and more biodiesel in the mixture and biodiesel washes better than oil.

When reacting, a good rule of thumb is to use 30% of the original catalyst and methanol. Be sure to heat the fuel back before reacting.

1) To wash biodiesel, you have to use almost the same amount of water as you need fuel to wash.

For example, if washing 1 litre of biodiesel, expect to pass through 1 litre of water. How accurate water is used will depend on how aggressive the water is sprayed, how hot the biodiesel is, how hot the water is and how dirty the fuel is. All these factors can affect the amount of water required for washing.

2) Do not spray aggressively first. It's bound to make a mess

The first wash is the one with which you have to be most careful. Spray very aggressively and this forces the soap to pour into a mess. In general, if you have a manual mist-washing system, heat the biodiesel, turn on the mists, and then watch the biodiesel carefully to ensure that the emulsion is not starting to form.

Emulsions can be broken using salt water and also prevented by adding a little vinegar to the water, but the best way to keep them is to go easily with water on the first wash cycle. You will notice that the first wash water will always appear to be the most cloudy and white. It is working due to the removal of water magic and soap. Over time you realize how hard you can spray with the first wash, but always recommend doing it as easy as possible on the first wash cycle and can be more aggressive with the spray on subsequent washes.

3) In general, check at least 2-3 mist wash cycles and then soap levels. Continue washing the soap until the soap comes out completely.

Biodiesel will vary in the amount of soap produced during the reactions. Generally, the higher the titration, the more soap is produced. More soap means it must be washed longer to get it out. But in general, usually 2-3 mist wash will eject the majority of soap.

To test the soap, start what is called a "shake up" test. Basically, half fill a jar filled with washed biodiesel, then fill it with the rest of the water. Cap it and then shake the living crap out of it. Then, let it settle for about 20–30 minutes. Return and check the clarity of the water at the bottom. If it is still foggy and cloudy, you still need to continue washing.

Fig -10: *Water separation from biodiesel*

4) Drying Biodiesel.

When the water washing is done heat up the biodiesel upto the boiling temperature of water. This will evaporate the water and methanol and we'll left out with biodiesel.

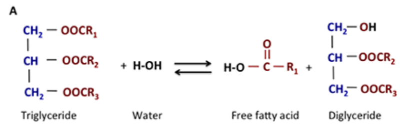

Fig -11: *Side reaction of triglyceride with water*

Fig -12: *Drying of biodiesel*

4. BIODIESEL BLENDING

Biodiesel are often blended and employed in many various concentrations. the foremost common square measure B5 (up to five biodiesel) and B20 (6% to twenty biodiesel). B100 (pure biodiesel) is often used as a blendstock to supply lower blends and is never used as a transportation fuel.

Low-Level Blends

The American Society for Testing and Materials (ASTM) created specifications for a good style of merchandise, as well as typical fuel (ASTM D975). This specification permits for biodiesel concentrations of up to B5 to be known as fuel, with no separate labeling needed at the pump. Low-level biodiesel blends, such as B5, square measure ASTM approved for safe operation in any compression-ignition engine designed to be operated on original diesel. This could embody light and heavy diesel cars and trucks, tractors, boats, and electrical generators.

B20

B20 could be a common biodiesel mix within the US. B20 is widespread as a result of it represents a decent balance of price, emissions, cold-weather performance, materials compatibility, and skill to act as a solvent. Most biodiesel users purchase B20 or lower blends from their traditional fuel distributors or from biodiesel marketers.

B20 should meet prescribed quality standards as such by ASTM D7467. The U.S. Department of Energy's Vehicle Technologies workplace has supported work to check and improve biodiesel quality, serving to a lot of fuel meet ASTM standards.

B20 and lower-level blends are often employed in current engines while not modifications. Engines operative on B20 have similar fuel consumption, horsepower, and force to engines running on fossil diesel. B20 with two hundredth biodiesel content can have I Chronicles to twenty less energy per gallon than rock oil diesel, however several B20 users report no noticeable distinction in performance or fuel economy. Biodiesel conjointly has some emissions edges, particularly for engines factory-made before 2010. For engines equipped with selective chemical change reduction (SCR) systems, the air quality edges square measure identical whether or not running on biodiesel or rock oil diesel. However, biodiesel still offers larger gas edges than typical fuel. The emissions profit is roughly commensurate with the mix level; that's, B20 would have two hundredth of the emissions reduction good thing about B100.

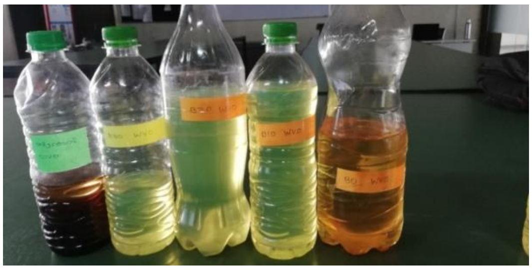

Fig -13: *Waste Vegetable blend*

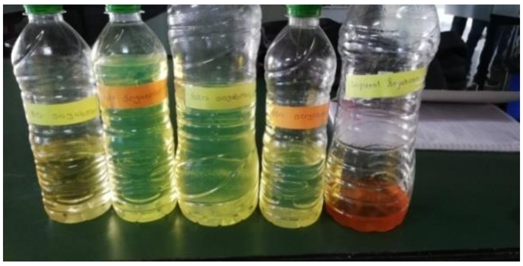

Fig -14: *Soybean Blends*

5. PROPERTIES OF TESTED BIODIESEL

Table -1: WVO properties

WVO							
Blend	Density (kg/m^3)	Absolute Viscosity (ns/m^2)	Kinematic Viscosity (m^2/s)	Flash Point (^0C)	Fire Point (^OC)	Cloud Point (^OC)	Pour Point (^OC)
B100	914	17613.694	19.27	157	159	+1.4	-1.0
B30	843.87	12598.97	14.93	70.9	73	-4.7	-14.0
B20	839.7	12519.92	14.91	66	66.5	-6.2	-17.0
B10	840.6	15833.7	14.54	69.4	72.3	-7.9	-19.0

Table -2: WVO properties

SOYBEAN							
Blend	Density (kg/m^3)	Absolute Viscosity (ns/m^2)	Kinematic Viscosity (m^2/s)	Flash Point (^0C)	Fire Point (^OC)	Cloud Point (^OC)	Pour Point (^OC)
B100	886	15833.7	17.87	158.6	160	+1.7	-0.5
B30	856.12	12944.53	15.12	68	69.5	-5.9	-11.0
B20	841.83	12560.1	14.92	66.5	67.5	-6.4	-15.0
B10	839.79	12315.6	14.66	68.9	69.5	-8.9	-17.0

1) Density:

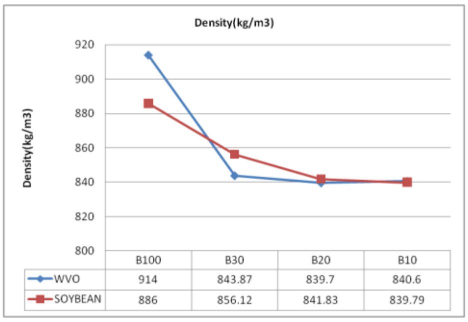

Chart -1: Density

2) Dynamic viscosity & Kinematic Viscosity:

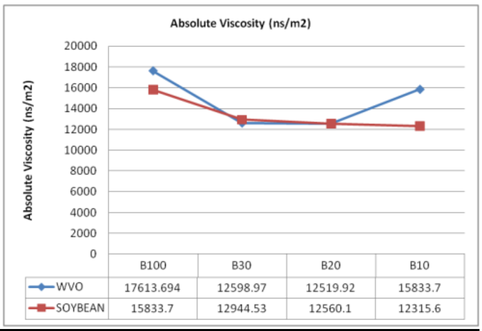

Chart -2: Absolute Viscosity

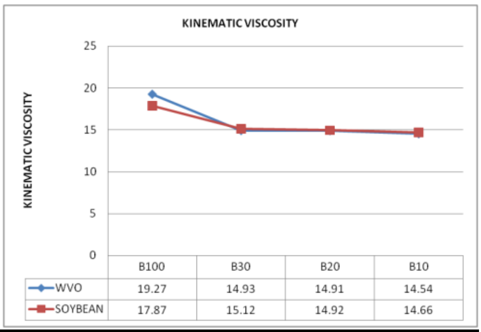

Chart -3: Kinematic Viscosity

3) Flash Point and Fire Point:

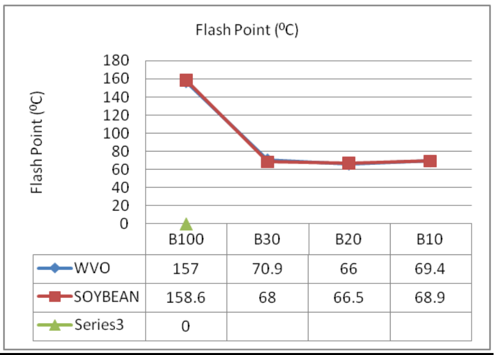

Chart -4: Flash Point

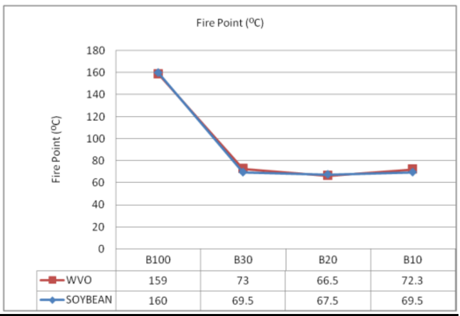

Chart -5: Fire Point

4) Cloud Point and Pour Point:

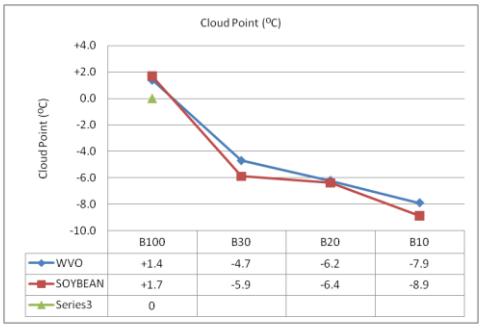

Chart -6: Cloud Point

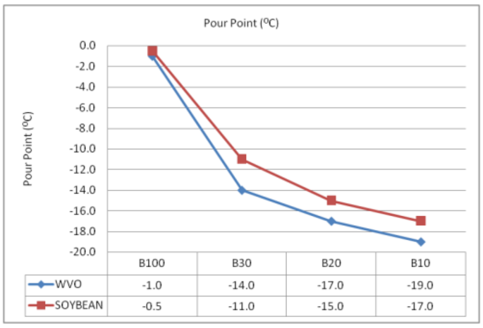

Chart -7: Pour Point

6. EMISSION

A four-stroke single cylinder diesel engine is that employed for testing. A schematic drawing of the experimental setup including the necessary measuring devices were shown. A mechanism consuming; 4.5 kW maximum power, was directly coupled to determine the engine brake power where external controllable electric load bank with variable loads was used. Obtained Results are satisfactory according to emission norms published for biodiesel.

The present study was carried out to investigate the exhaust emissions of a diesel engine fuelled with two types of biodiesel fuel; Soybean and waste cooking oil biodiesel blends B10, B20, B30 and compared to diesel fuel. The engine had been equipped to measure fuel consumption and engine speed. The engine received air through an air box fitted with an orifice for measuring the air consumption. A pressure differential meter was used to measure the difference in pressure between the two sides of the orifice. A standard sharp-edged orifice was fitted to the airbox to enable measuring the intake air consumed by the engine. The diameter of the orifice hole had been calculated to be 16 mm. Fuel consumption rate had been determined using a glass burette and stopwatch. The engine speed had been measured using a digital tachometer. The output power of generator was consumed by a series of electric lamps. The engine had been warmed up before taking all readings. When it reached its stable condition, the experiments had been started and measurements recorded. Firstly, the engine was operated with diesel fuel. Then, will run with soybean and waste cooking oil biodiesel blends by volume percentage of 10,20 and 30% with diesel oil. For every operating condition, the engine speed was checked and varied from idling speed to 1500 rpm, the engine load was adjusted at full load. An exhaust gas analyzer will be used to measure exhaust emissions concentrations such as CO, HC and NOx emissions from the engine during experimental tests for diesel- biodiesel blends. It had the facility to print out test results on a printer. Exhaust gas analysis measuring ranges were (0–10%) for CO, (0–20%) for CO_2, (0–2000 ppm for CH, (0–4000 ppm) for NO and (0–1000 ppm) for NO_2.

7. CONCLUSIONS

Optimal conditions of waste vegetable biodiesel and soybean biodiesel made were 1:0.2 oil-to-methanol volumetrical magnitude relations, around 7% wt KOH at 40 ^{0}C reaction temperature. The study provided proof that waste oil and soybean oil may be used as a considerable supply of biodiesel as fuel in diesel engines preferably waste vegetable biodiesel. Because, made biodiesel was of fine quality among the array of ordinary method specifications and therefore the production yield was up to mark optimum conditions. Moreover, this analysis indicated that the assembly of biodiesel from WVO & VVO had a touch important variations and conjointly the research highlighted that waste vegetable oil may be used potentially by following this innovation.


Fig -15: *End product biodiesel and Glycerol*

SHORT-FORMS USED:

- WVO: Waste Vegetable Oil
- VVO: Virgin Vegetable Oil
- KOH: Potassium hydroxide
- NaOH: Sodium hydroxide
- Lye: Catalyst + Alcohol
- FFA: Free Fatty Acid
- FAME: Faster Adoption and Manufacturing of Hybrid and Electric vehicle

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