

Table 1: Fatty Acid Compositions of Various Oil Seeds Neem Seed

Oleic acid	49.1 to 61.9%
Stearic acid	14.4 to 24.1%
Palmitic acid	13.6 to 16.2 %
Linoleic acid	2.3 to 15.8 %
Arachidic acid	0.8 to 3.4%
Myristic acid	0.2 to 2.6%

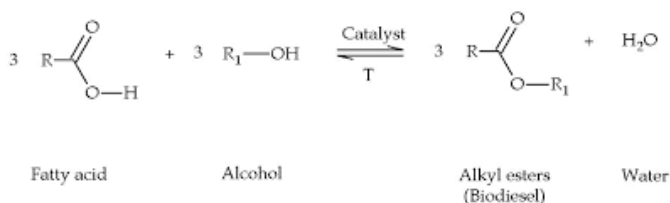


Fig.2: Chemical equation of bio-diesel production

[II] Literature survey

The determination was done on the evaporation constant by using the droplet regression rate data. The neat fuels and fuel blends have been utilized in a test engine with different load conditions to evaluate the performance, combustion and emission characteristics of the fuels. The specific fuel consumption values of these two blends have also been almost the same for the blends, B25 and B75. At the highest load, B0 records the lowest CO volume followed by B100. From the observed evaporation, performance, and emissions characteristics, it can be suggested that a blend of B75 can be optimally used in standard diesel engine settings [4]. The determination was done on the properties of various blends of bio-diesel and conventional fuel. The bio-diesel was produced using the following steps, Neem oil's free fatty acid content was reduced by esterification to under 1%. The ratio of methanol to oil should be 0.60 volume by volume (v/v), the acid catalyst should be 1% v/v H₂SO₄, and the reaction time should be one hour. The pre-treated oil was transformed into neem biodiesel by the subsequent base catalyzed transesterification procedure. The ratio of 0.24 volume percent (v/v) methanol to oil, 1.08% weight by volume (w/v) catalyst concentration, and 34-minute reaction time were found to be the ideal combinations of parameters for transesterification. The average yield from this two-step procedure was 90%. Neem biodiesel was found to have fuel qualities similar to those of diesel and to comply with the most recent American Standards for Testing of Materials Standards. [5&6].

The production of the bio-diesel from raw neem oil was done using transesterification process. The yield of the bio-diesel was good. Nabi et al. (2008) considered the bio-diesel and produced the same by using esterification process. The feed-stock, lipid/oil extraction methods were used to generate the bio-diesel [7]. The conversion of bio-diesel was low when the reaction was taking place at 30°C, but it increased as the temperature rose before decreasing below 60°C. At 55°C, the maximum yield of 94% was seen, and the regression equation for yield of neem bio-diesel R² value was 0.931 when measured against reaction temperature. Due to the intrinsic rate constants' strong dependence on temperature, the result demonstrates that reaction temperature can affect both the reaction rate and the yield of ethyl esters (neem bio-diesel) [8] the numerous options of non-edible oils as the substantial feedstock's, bio-diesel processing, and effect of different parameters on production of bio-diesel.

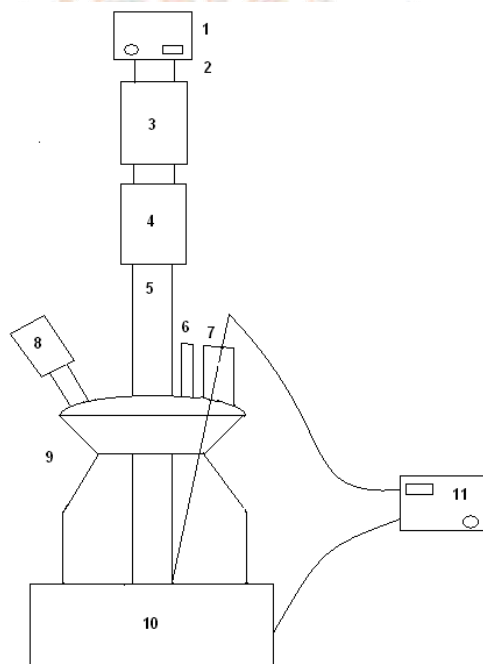
The present experimental investigation, the bio-diesel setup has been done. This would combine not only the academic mechanical teachings, but also integrate with the required industrial skills. This combination is necessary for many real-world applications, and working on this area will hopefully prove helpful in the future.

[III] Objective of the project:

The objectives of this project are to use the example of biofuels to demonstrate the way that multiple objectives are developed in energy and environmental policy. Biofuels are promoted as replacements for transport fuels, but biofuel policy is also geared towards socioeconomic goals such as agricultural subsidy and strategic goals such as security of energy supply.

[IV] Design:

4.1 PRODUCTION OF BIO-DIESEL:



1.Stirrer Motor, 2.Stirrer Rod, 3.Coupling, 4.Stirrer Lubricant reservoir, 5.Glass stirrer, 6.Funnel, 7.Thermocouple, 8.Water condenser, 9.Glass Tank Reactor, 10.Heating Mantle, 11. PID Temperature controller

Fig. 3: Bio-diesel production setup

Fig. 3 demonstrates the system for producing biodiesel. It can be made using a two-step acid-base process that starts with raw neem oil, methanol as a catalyst for the base reaction, and H_2SO_4 and KOH as catalysts for the acid reaction. Acid solvent is made up of 10% methanol and 0.3% H_2SO_4 acid by volume. One litre of unprocessed neem oil is mixed at 30 rpm for 30 minutes at a temperature of $55^\circ C$ in order to separate the solution's remnants. Using a separating funnel will allow you to separate the final solution. In the second step of the base preparation process, base solvent is created by mixing 20% methanol and 0.64 percent KOH by volume. One litre of neem oil, produced by the acid process, is heated for 30 minutes at $64^\circ C$ before being mixed with the base solvent. A separating funnel can be used to separate the final solution from the glycerol.

4.2 WASHING OF BIO-DIESEL

The final solution might contain some soap. This can be eliminated by bubble washing, which involves adding 50% water to the final solution produced by the base reaction process. For the purpose of removing the solution's water content, this solution can be heated up to $100^\circ C$. The process's final byproduct is biodiesel, which is a mixture of alkyl esters Equation 1 illustrates the chemical process for producing biodiesel from neem oil in its raw form.

4.3 DE-METHANOLISATION OF THE BIO-DIESEL

The excess methanol, if any, is evaporated after washing the biodiesel by heating it for a short period of time to about 70°C (methanol's boiling point). The name of this procedure is "de-methanolization."

Table 2: Properties of Diesel, Neem oil, Neem Bio-diesel and its various blends

S. No.	Name of the properties	Neat Neem oil	Neat Diesel B-0	B-25	B-50	B-75	Neat bio diesel B100
1	Gross calorific value in MJ/kg	36.4	45.59	43.98	43.27	42.52	41.82
2	Kinematic viscosity at 40°C in cSt	31.1	2.6	3.49	4.17	4.98	6.04
3	Flash Point in °C	236	65	71	78	112	170
4	Fire Point in °C	245	70	79	88	123	183
5	Cloud Point in °C	12	-15	4	8	11	13
6	Specific gravity	0.926	0.82	0.83	0.85	0.87	0.88
7	Cetane number	43.5	46	51.6	51.7	51.8	52.4

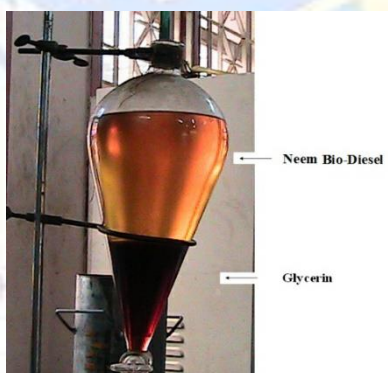


Fig. 4: Photograph Of Neem Bio-Diesel And Glycerin

Fig. 4 shows the neem bio-diesel and glycerin separation layer after transesterification process.

Solid works software has been used to create a 3d Model for the bio-diesel setup. The first step was identifying the required dimensions to create the model in solid works, by referring to engineering diagram we constructed the model using diagram in 3D (Fig. 5).

Once the 2-dimensional (2D) diagram is constructed using sketch tools (line, rectangular, construction tools) it was then converted into 3-dimensional model using design tools (extrude, revolve, intrude, shell tools).

After construction of individual parts is done, then assembly section is used to assembly the individual parts using mates' tools (concentric, perpendicular, parallel, tangent tools) once the mates are done then the complete assembly of the bio-Diesel was completed.

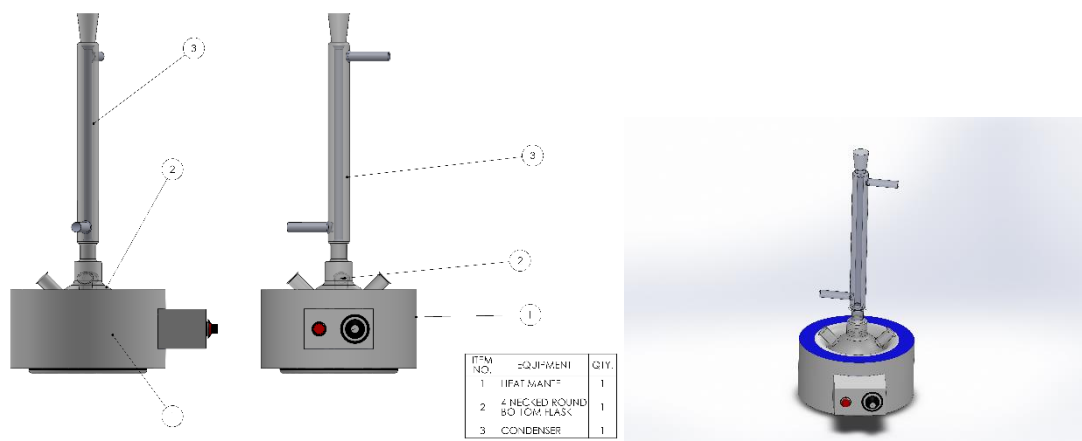


Fig 5: 3D Diagram of Biodiesel Setup

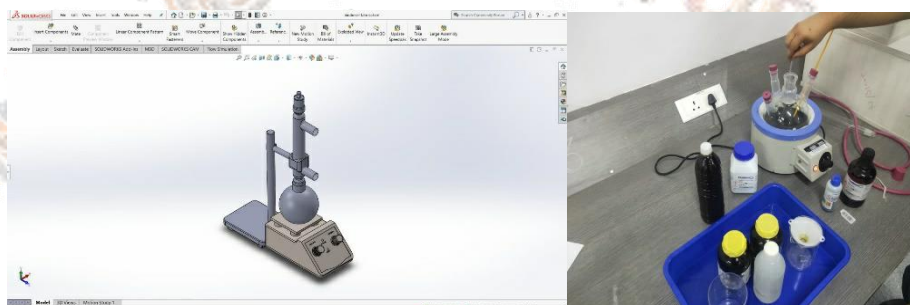


Fig. 6: Three-Dimensional Diagram Of Bio-Diesel Setup Fig 7: Experiment Conduction

[V] Methodology

Bio-diesel production is the process of producing the bio-fuel, biodiesel, through the chemical reactions of transesterification and esterification. This involves vegetable or animal fats and oils being reacted with short-chain alcohols (typically methanol or ethanol). The alcohols used should be of low molecular weight.

5.1 EXTRACTION OF OIL FROM SEED

5.1.1 EXTRACTION BY THE “OIL EXPELLER”

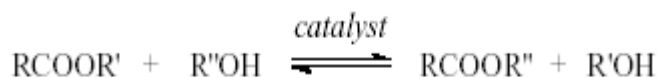
There are two different kinds of oil expellers that are effective for processing vegetable oil on a small and a large scale. The screw type of oil expeller is the most popular. In this type, a metal housing contains a screw with a large diameter. The top of the expeller receives the oil seed, which is then fed into the churning screw. The oil is extracted from the seed as it is mashed up by the screw. Vegetable oil drips from the bottom of the expeller while the cake from the oil seed oozes out of the side. The oil is then allowed to settle in a horizontal settling tank for a few days. The oil cake fragments and vegetable gums will settle at the tank's lowest point. Vegetable oil should be pumped through a number of filters because it is used as fuel. As a result, it passes through three screens in order: a 150 mesh screen, a 70 mesh screen, and a 10 to 15 mesh screen.

5.1.2 SOLVENT EXTRACTION METHOD

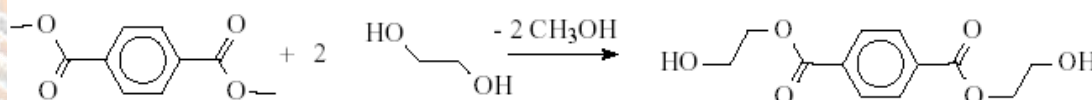
Solvent extraction is the only processing method used for seeds with less oil. Solvent extraction is a well-liked and effective method. Solvents are employed in this procedure to draw oil from the seeds. Solvent extraction uses a straightforward technology that recovers nearly all of the oil from the seeds

5.2 GENERAL ASPECTS OF TRANSESTERIFICATION

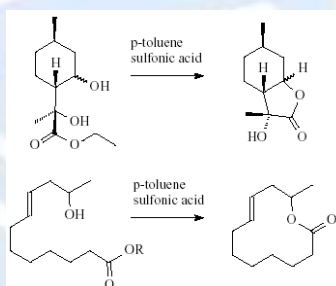
The general term used to describe the significant class of organic reactions known as transesterification is the interchange of the alkoxy moiety from one ester to another. The transesterification procedure is known as alcoholysis when the initial ester reacts with an alcohol, as demonstrated in the following reaction.



Transesterification will be used interchangeably with alcoholysis of carboxylic esters throughout this review. Since transesterification is an equilibrium reaction, the reactants are essentially mixed together to effect the transformation. However, the adjustment of the equilibrium is significantly sped up by the presence of a catalyst, which is typically a strong acid or base. Alcohol must be used excessively in order to produce a large yield of the ester. Transesterification is not only useful on a small scale in laboratories. This reaction is used in a number of pertinent industrial processes to create various compounds. An illustration of the process used to create PET (polyethylene terephthalate), which involves trans esterifying dimethyl terephthalate with ethylene glycol while using zinc acetate as a catalyst, is shown in the following reaction.

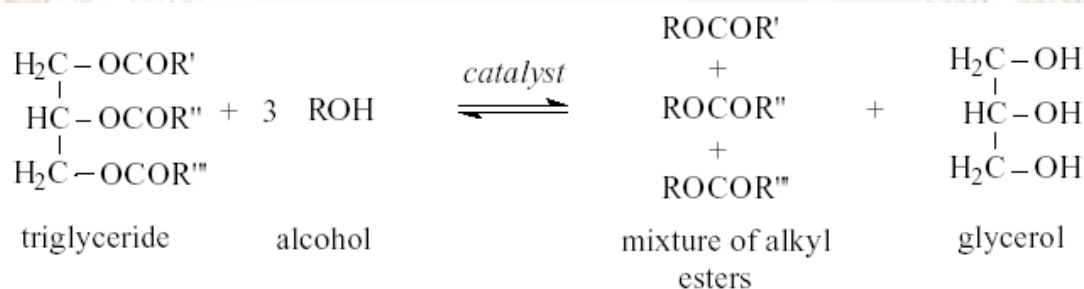


Furthermore, a large number of acrylic acid derivatives are produced by transesterification of methyl acrylate with methyl alcohol, in the presence of acid catalyst. If the alcohol and the ester groups are present in the same molecule simple lactones or macrocycles are formed by an intermolecular transesterification as it is shown in the following reactions.



5.3 TRANSESTERIFICATION OF VEGETABLE OIL

The following reaction illustrates how a triglyceride reacts with an alcohol during the transesterification of vegetable oil to create a mixture of fatty acids alkyl esters and glycerol. Di and mono glycerides are produced as intermediaries during the overall process,

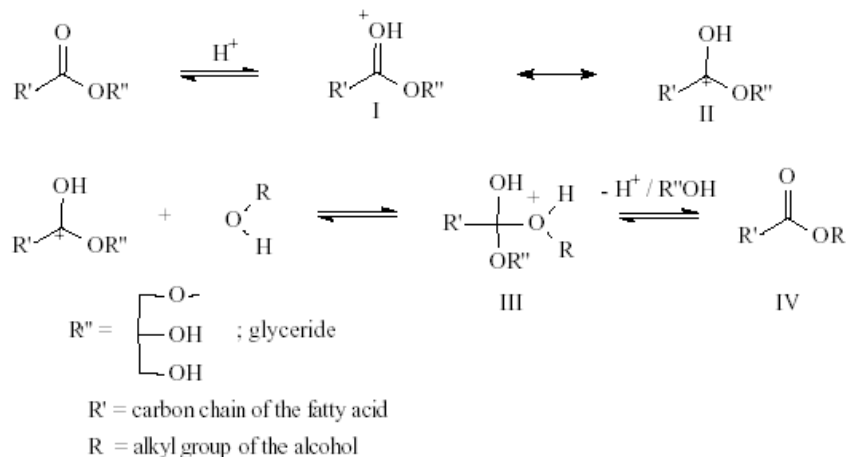


which consists of three consecutive and reversible reactions. One mole of a triglyceride and three moles of alcohol are needed for the stoichiometric reaction. To increase the yields of the alkyl esters and enable their phase separation from the glycerol formed, more alcohol is used from the glycerol formed.

. Depending on the type of catalyst used, various factors, such as the type of catalyst (alkaline or acid), alcohol/vegetable oil molar ratio, temperature, purity of the reactants (primarily water content), and free fatty acid content, have an impact on how the transesterification proceeds.

5.4 ACID-CATALYZED PROCESSES

The following reaction illustrates the mechanism of acid-catalyzed transesterification of vegetable oils. regarding a mono glyceride. It can, however, be expanded to include di- and triglycerides as well.

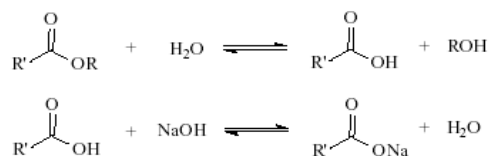


The molar ratio of alcohol to vegetable oil is one of the key variables affecting transesterification in acid catalyzed processes. Alcohol in excess promotes the formation of the products. On the other hand, too much alcohol makes it difficult to recover the glycerol, so the ideal alcohol to oil ratio must be determined empirically while taking into account each distinct process. The protonation of the ester's carbonyl group results in the carbocation II, which, following the alcohol's nucleophilic attack, produces the tetrahedral intermediate III. This intermediate then consumes glycerol to create the new ester IV and regenerates the catalyst H+. This mechanism states that the reaction between the carbocation II and the water present in the reaction mixture can result in the formation of carboxylic acids. In order to prevent the competitive formation of carboxylic acids, which lower the yields of alkyl esters, an acid-catalyzed transesterification is suggested to be performed in the absence of water

5.5 BASE-CATALYZED PROCESSES

Vegetable oil transesterification is carried out more quickly by base-catalyzed reaction than by acid-catalyzed reaction. Industrial processes typically favor base catalysts, such as alkaline metal alkoxides and hydroxides as well as sodium or potassium carbonates, due to this reason as well as the fact that alkaline catalysts are less corrosive than acidic compounds. The following reactions illustrate the mechanism of base-catalyzed transesterification of vegetable oils..

The base and alcohol react in the first step, creating an alkoxide and the protonated catalyst. A tetrahedral intermediate is produced by the alkyl ester and corresponding anion of the diglyceride being nucleophilically attacked by the alkoxide at the carbonyl group of the triglyceride. The latter deprotonates the catalyst, regenerating the active species, enabling it to interact with a second molecule of alcohol and begin a new catalytic cycle. The same mechanism transforms diglycerides and monoglycerides into an amalgam of alkyl esters and glycerol. The most effective catalysts are alkaline metal alkoxides, which give extremely high yields (up to 98%) in a short amount of time (30 min) even when applied at low molar concentrations (0.5 mol%). However, they are ineffective for standard industrial processes because they require the absence of water. Although less active than metal alkoxides, alkaline metal hydroxides (KOH and NaOH) are less expensive. However, they are a good alternative because they can produce vegetable oils with the same high conversion rates by simply increasing the catalyst concentration to 1 or 2 mol%. However, even when an alcohol/oil mixture devoid of water is used, the alcohol's reaction with the hydroxide in the system results in the production of some water. Water causes some of the produced ester to hydrolyze, which leads to the formation of soap as demonstrated in the reactions that follow.



R' = carbon chain of the fatty acid

R = alkyl group of the alcohol

Due to the formation of emulsions, this unfavourable saponification reaction significantly lowers ester yields and makes recovering glycerol much more challenging.

When used at a concentration of 2 or 3 mol%, potassium carbonate produces high yields of fatty acid alkyl esters while reducing the production of soap. The following reaction, which does not hydrolyze the esters, demonstrates how bicarbonate can form in place of water...



R = alkyl group of the alcohol

[VI] Conclusions:

An alternative domestic fuel that can lead to a more reliable energy supply is bio-diesel. To reduce the initial viscosity issues, the biodiesel fuel production process has undergone significant evolution. Currently, is a non-toxic, biodegradable alternative to fossil fuel that is becoming more and more appealing and can be produced from various renewable sources. As a potential source of alternative energy, neem oil has promise. Oil cannot, however, eliminate dependence on foreign oil in any reasonable amount of time. Increasing Neem oil production would require a significant investment of resources. Recent developments in instrumentation technology are helping to meet these needs.. The emphasis should be on investing in the agriculture sector to utilize the potential that is already present. This can be done by establishing model seed procurement centers, pre-processing and processing facilities, oil extraction units, transesterification units, and other similar facilities. The systematic collection and planned plantation of neem oil, which has the potential to replace biodiesel, will ease the burden of importing crude oil..

[VII] References

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