Characteristics and Comparison of Diesel Fuel and Biodiesel produced from a Neem

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Abstract— An experimental investigation will be carrying out to analyze "Characteristics and comparison of diesel and biodiesel produced from a Neem." The Neem oil methyl ester is derived with the using of transesterification process and its properties are validated against ASTM standards and found within limits. The literature review is focused on experimentally investigating the influence of Ash content , Moisture , Specific Gravity at 40^0c , Kinematic viscosity at 40^0c, Acid value , Calorific Value , Flash point, Distillation curve , Cetane number, pour point, cloud point, low temperature flow test(lift), cold filter plugging point with diesel fuel .

I. INTRODUCTION

Biodiesel is a clean, renewable and domestically produced diesel fuel, which has many characteristics of a promising alternative energy resource. The most common process for making biodiesel is known as Transesterification. This process involves combining any natural oil (vegetable or animal) with virtually any alcohol, and a catalyst. There are other thermo chemical processes available for making biodiesel, but Transesterification is the most commonly used one due to the simplicity and high energy efficiency. The high energy efficiency of Transesterification an important aspect of Biodiesel, which makes it favorable in the competitive energy market. The chemistry lies in transforming the Fatty acid chains into Alkyl Esters of respective fatty acids present in different feed oils used and isolation of glycerol present in the Triglyceride molecule in the oils and fats. Biodiesel fuel can be made from new, used or non-edible vegetable oils, which are non-toxic, biodegradable, renewable resources. Oils are chemically reacted with methanol to produce chemical compounds known as fatty acid methyl esters. Biodiesel is the name given to these esters when they are intended for use as fuel. Glycerol (used in pharmaceuticals and cosmetics, among other markets) is produced as a co-product.

A. *Neem Oil Biodiesel*

Neem oil is a vegetable oil pressed from fruits and seeds of Neem, an evergreen tree which is widespread to the Indian Subcontinent and in many tropical areas. In recent periods, a climatic change called global warming has been sensed on our planet. It is believed that it's the initiation of the destruction of Earth. A wake up call is being alarmed for the sapiens to respond to this disorder which later becomes a disaster.

One such factor is Carbon Emission by the vehicles and diesel generators due to the use of petroleum. Use of petrol and diesel is supposed to emit more carbon to the atmosphere than any other aspect. To stop the use of these two non-renewable resources, an alternative fuel called Bio-fuel is discovered.

Bio-fuel is a fuel just like normal fluid or Oil which is bio-degradable in nature emitting low carbon when burnt. Bio-fuels previously extracted from the seeds like Jatropha, sugarcane and Neem Oil. Particularly Neem Oil has tickled the researchers for its use in the production of the Bio-fuel.

Neem oil is proved to contain methyl ester which is considered to be the base of a bio diesel. This bio diesel contains alkyl esters of the fatty acids which is the product of the Transesterification process of the Neem oil. Extraction of this diesel is complicated but its results are more efficient like low carbon emission, increases the engine performance, brake specific fuel is saved and reduces the smoke density.

In the new era of Bio-fuel, Neem Oil even though has its own identity as a medicinal plant, creates a new spot as a bio diesel. Neem oil is a vegetable oil pressed from the fruits and seeds of the Neem. It is the most important of the commercially available products of Neem for organic farming and medicines.

Neem oil is generally red as blood, and has a rather strong odor that is said to combine the odours of peanut and garlic. It is composed mainly of triglycerides and contains many triterpenoid compounds, which are responsible for the bitter taste. It is hydrophobic in nature and in order to emulsify it in water for application purposes, it must be formulated with appropriate surfactants.

II. BIODIESEL PRODUCTION AND ITS PROPERTY

A. *Transesterification: - Turning Neem in to fuel*

The most common process used for manufacturing Biodiesel is Transesterification'. Transesterification is the process of using an alcohol (e.g., methanol or ethanol) in the presence of a catalyst, such as sodium hydroxide or potassium hydroxide, to chemically break the molecule of the raw renewable oil into methyl or ethyl esters of the renewable oil with glycerol as a by-product‖. Transesterification is not a new process. It was conducted, as early as 1853, by scientists E. Duffy and J. Patrick. One of the first uses of transesterified vegetable oil was powering heavy-duty vehicles in South Africa before World War II. The name "biodiesel" has been given to transesterified vegetable oil to describe its use as a diesel fuel. The methyl ester of vegetable oil, or biodiesel, is very similar to diesel fuel. Its

viscosity is only twice that of diesel fuel and its molecular weight is roughly 1/3 of vegetable oil. Most Diesel engines were designed to use highly lubricating, high sulfur content fuel. Recent environmental legislature has forced diesel fuel to contain only a minimum amount of sulfur for lubricating purposes. Thus, the slightly higher viscosity of biodiesel is helpful and lubricating to most Diesel motors. Waste fryer oil, a commodity that is considered toxic waste can also be transesterified into biodiesel.

B. *Process for Making Bio diesel from Neem Oil*

Neem oil was obtained commercially. Chemicals such as Sodium hydroxide, Methanol, Sulphuric acid, Phosphoric acid were purchased from Merck. All the chemicals used were of analytical reagent grade. Biodiesel fuel blend can be conventionally prepared by using alkali or acid as catalyst.100gm of refined Neem oil is mixed with 12gm of alcohol and 1gm of sodium hydroxide (NaOH) which acts as catalyst.

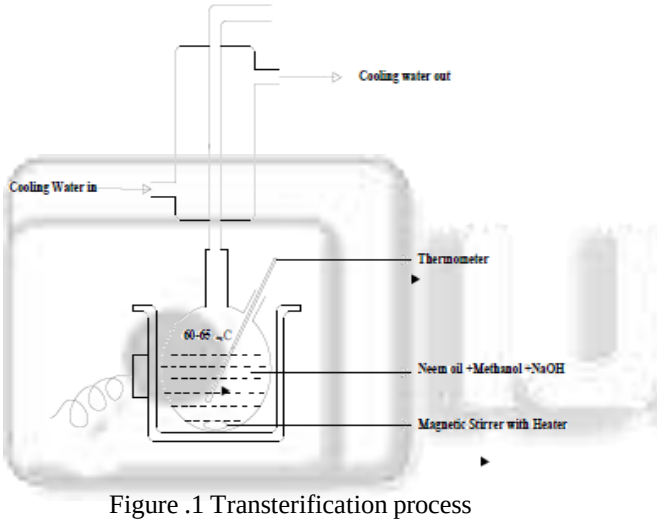

Figure .1 Transterification process

The experiments were conducted in a manner similar to Soxhlet extraction apparatus. This mixture is taken in a 500ml round bottomed flask .The amount of catalyst that should be added to the reactor varies from 0.5% to 1% w/w. Using magnetic stirrer and heater equipment the above mixture is thoroughly mixed and maintained at a temperature of 50-55 ^{0}C for two hours. The mixture is now allowed to settle for 24 hours at which two separate layers are obtained. The top layer will be methyl ester of Neem oil (fatty acid methyl ester (FAME) i.e., .biodiesel) and the bottom one glycerin. Using a conical separating funnel the glycerin is separated at the bottom. To separate the FAME (fatty acid methyl ester) from glycerol, catalyst (NaOH) and methanol, washing was carried out with warm water. Further water and methanol will be removed by distillation. Then the NaOH, Glycerol, methanol and water was treated with phosphoric acid for neutralizing the catalyst. Finally glycerin is obtained as a byproduct in case of alkali Transesterification process. Fig.1.1 shows the experimental set up of the process. Acid catalyst production is the second conventional way of making the biodiesel. The most commonly used acid is sulfuric acid. This type of catalyst gives very high yield in esters but the reaction is very slow, requiring almost always more than one day obtaining the final product.

C. *Important Properties of Bio diesel*

1) *Ash content*

The biodiesel may contain materials that are in the form of abrasive solids, soluble metallic soaps and unresolved reaction catalysts. The sulfated ash determination indicates gross levels of ash forming compounds in the biodiesel. The primary ash-forming materials that may be present in biodiesel are calcium, magnesium, sodium and potassium.

2) *Moisture*

Moisture is determined by the method of Kari fisher method .The content of water in petroleum products plays an important role in predicting quality and performance of the product. If moisture is present, premature corrosion and wear, diminished lubrication, filter plugging, decreased effectiveness of additives and bacterial growth may take place.

3) *Specific gravity at 40 ^{0}C*

The purpose of this test is to measure the relative density of a fuel sample and determine if it is within the permissible limits. Two pieces of special equipment are required to perform this test one is Specific gravity hydrometer(s) which cover the range of 0.750 - 0.800 (at 60°F) (16°C) and other is A clear glass container which is at least as tall as the hydrometer.

4) *Kinematic viscosity at 40 ^{0}C*

Kinematic viscosity for NOME is 5 cst. Kinematic viscosity is the resistance of a fluid to flow under gravity. The viscosity is the important in determining optimum handling, storage and operational conditions. Fuels must have suitable flow characteristics to ensure that an adequate supply reaches injectors at different operating temperatures. It is determined by using Ostwald viscous meter.

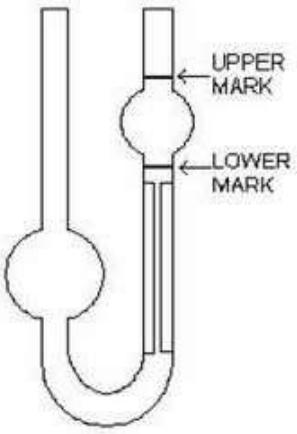

Figure. 2 viscous meter

5) *Acid value*

Acid value is determined by the method as per IS-1448 (P: 1) - 1971.The value of acid for NOME is 0.45 mg KOH/gm. The acid number is a sum parameter for all acidic components to indicate the level of free fatty acids present

in biodiesel, as well as the presence of process acids and degradation by products. The acid number correlates to the fuels long term stability and corrosively; the smaller the value the higher the quality.

6) *Flash point*
Flash point is determined by the method as per IS-1448 (P:21) .Flash point for NOME is 150^0 C. The lowest temperature at which the vapour of a combustible liquid can be made to ignite momentarily in air is identified as the flash point and correlates to the ignitability of the fuel. For users, a low flash point in biodiesel can result in premature ignition, causing irregular timing, excessive fuel blow by into the crankcase oil, and excessive emissions.

7) *Calorific value*
It is measured by continuous recording calorimeter (ASTM D 1826 -93).In this method all heat generated by combustion of fuel is imparted to the stream of air and heating value is measured by rising the temperature of air. The combustion gas and streaming of air are controlled in a fixed volumetric proportion area for metering the flow. The calorific value for NOME is 9650 kcal/kg.

8) *Cetane number*
Cetane number relates to the readiness of the fuel to self-ignite when exposed to the high temperatures and pressure in the diesel engine combustion chamber. The number is also indicating if the relative fuel stability.

9) *Distillation curve*
(ASTM D86) The distillation curve is determined by relating the fraction of a fuel sample which is removing by heating a fuel sample to progressively higher temperatures. Typically, the curve is characterized by the initial point, the temperature at which the first drop of liquid leaves the condenser, the temperature at each 10% of the liquid and the end point.

10) *Pour point*
The pour point is the lowest temperature at which movement of the fuel sample can be determined when the sample container is tilted. The sample must be cooled following the procedure described in ASTM D 97

11) *Cloud point*
The cloud point is the temperature at which a cloud of Wax - castles first appears in a fuel sample that is cooled under Conditions described by ASTM D2500. The cloud point is determined by visually inspecting for a haze in the normally clear fuel.

12) *Low temperature flow test (lift)*
The LIFT is designed to evaluate whether a fuel can be expected to pass through an engine fuel filtration system. The procedure is defined in ASTD4539.

13) *Cold filter plugging point*
The cold filter plugging point, as defined by International Petroleum Standard IP -309 and ASTM D 6371-99, is similar to the LEFT test. It determines the lowest temperature where 20 ml of fuel can be drawn through a 45 micron screen in 60 seconds with 200 mm of water (1.96 kpa) of vacuum.

III. RESULT AND DISCUSSION

The properties of Diesel and Neem oil biodiesel are carried out by the help of SVM AGRO PROCESSOR, NAGPUR and department of mechanical engineering in L.D. Engineering College. Comparison and characteristics of Diesel and Neem oil biodiesel is as per below table.

SR. NO	Parameter	Units	Diesel	Results (NOME)
1	Density: 15 Deg C	kg/m3	836.4	885.0
2	Kinematic Viscosity at 40^0C	cst	3.311	5.00
3	Flash Point (PMCC)	Deg C	82	150
4	Water content	mg/kg	9	60
5	Acid Value	mg KOH/gm	2	0.45
6	G calorific value	Kcal/kg	10800	9650

Table. 1 Comparison Characteristics of diesel and Neem oil biodiesel

IV. CONCLUSION

The comparison of diesel with Neem oil biodiesel Neem oil methyl ester is investigated and the key results are summarized in below:

A. The Neem biodiesel kinematic viscosity was higher and diesel has less viscosity compared to that of NOME Using blends of diesel and Neem oil biodiesel results in an acceptable viscosity (near to diesel), which helps in the increased life of the fuel injector nozzle and the engine.

B. BSFC increased for all blends compared to that of diesel. This was due to the low heat value of biodiesel to diesel blends.

C. The brake thermal efficiency of Neem oil biodiesel is lower than that of diesel for all Engine break loads.

D. Biodiesel can be used as surfactant to maintain the blend stability of diesel and NOME They can be used directly in the diesel engine without any modification.

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