Bio Diesel from Waste Vegetable Oil

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Abstract: *The world is confronted with the twin crises of fossil fuel depletion and environmental degradation. The indiscriminate extraction and consumption of fossil fuels have led to a reduction in petroleum reserves. Alternative fuels, energy conservation and management, energy efficiency and environmental protection have become important in recent years. The increasing import bill has necessitated the search for liquid fuels as an alternative to diesel, which is being used in large quantities in transport, agriculture, industrial, commercial and domestic sectors. Biodiesel obtained from vegetable oils has been considered a promising option. In this paper, an attempt has been made to produce biodiesel from waste vegetable oils and the properties of the produced biodiesel have been studied including its emission characteristics. A four stroke, single cylinder is used to study the emission and performance characteristics.The large scale production of Biodiesel and its economic aspects have also been discussed in brief.*

Keywords: *Alternative fuels, Bio diesel, Emission Characterestics,Environmental Protection, Four stroke engines, Vegetable oil,*

I. INTRODUCTION

1.1 Introduction:

In recent times, the world has been confronted with an energy crisis due to depletion of resources and increased environmental problems. The situation has led to the search for an alternative fuel, which should be not only sustainable but also environment friendly. For developing countries, fuels of bio-origin, such as alcohol, vegetable oils, biomass, biogas, synthetic fuels, etc. are becoming important. Such fuels can be used directly, while others need some sort of modification before they are used as substitute of conventional fuels. As per an estimate, India consumed about 40.34 million tons of diesel in 2000–2001, which was 43.2% of the total consumption of petroleum products [1], and two-thirds of the demand was met by import costing about Rs.200 billion. With an expected growth rate of diesel consumption of more than 14% per annum,shrinking crude oil reserves and limited refining capacity, India will have to depend heavily on imports of crude. From the point of view of protecting the global environment and the concern for long term supplies of conventional diesel fuels, it becomes necessary to develop alternative fuels comparable with conventional fuels.

Diesel fuel is largely utilized in the transport, agriculture, commercial, domestic, and industrial sectors for the generation of power/mechanical energy, and the substitution of even a small fraction of total consumption by alternative fuels will have a significant impact on the economy and the environment. Of the alternative fuels, biodiesel obtained from vegetable oils holds good promises as an eco-friendly alternative to diesel fuel.

1.2 Alternate Diesel Fuels*:*

Alternative fuels should be easily available, environment friendly and techno-economically competitive. One of such fuels is triglycerides (vegetable oils/animal fats) and their derivatives. Vegetable oils, being renewable, are widely available from a variety of sources and have low sulphur contents close to zero, and hence cause less environmental damage (lower greenhouse effect) than diesel. Besides, vegetable oils and their derivatives are produced widely in the country for food and other purposes.

1.3 Triglycerides as diesel fuels

The use of vegetable oils, such as palm, Soya bean, sunflower, peanut, and olive oil, as alternative fuels for diesel engines dates back almost nine decades, but due to the rapid decline in crude oil reserves, it is again being promoted in many countries. Depending upon the climate and soil conditions, different countries are looking for different types of vegetable oils as substitutes for diesel fuels. For example, Soya bean oil in the US, rapeseed and sunflower oils in Europe, palm oil in South-east Asia (mainly Malaysia and Indonesia) and coconut oil in the Philippines are being considered. The production of oil seeds, percentage oil recovery and their respective cost are given in [2], which indicates that the use of vegetable oils as sources of diesel would require more efforts to increase the production of oil seeds and to develop new and more productive plant species with high yield of oil. Besides, some species of plants yielding non-edible oils, e.g. jatropha, karanji and pongamia may play a significant role in providing resources. Both these plants may be grown on a massive scale on agricultural/degraded/waste lands, so that the chief resource may be available to produce biodiesel on 'farm scale'.

1.4 Properties of Vegetable Oils as Fuel

The fuel properties of vegetable oils [2,4] indicate that the kinematics viscosity of vegetable oils varies in the range of 30–40 cSt at 38 8C. The high viscosity of these oils is due to their large molecular mass in the range of 600–900, which is about 20 times higher than that of diesel fuel. The flash point of vegetable oils is very high (above 200. 8C). The volumetric heating values are in the range of 39–40 MJ/kg, as compared to diesel fuels (about 45 MJ/kg). The presence of chemically bound oxygen in vegetable oils lowers their heating values by about 10%. The cetane numbers are in the range of 32–40.

1.5 Utilization of vegetable oils as fuels

It has been found that these vegetable oils can be used as diesel fuels in conventional diesel engines, but this leads to a number of problems related to the type and grade of oil and local climatic conditions. The injection, atomization and combustion characteristics of vegetable oils in diesel engines are significantly different from those of diesel. The high viscosity of vegetable oils interferes with the injection process and leads to poor fuel atomization. The inefficient mixing of oil with air contributes to incomplete combustion, leading to heavy smoke emission, and the high flash point attributes to lower volatility characteristics. These disadvantages, coupled with the reactivity of unsaturated vegetable oils, do not allow the engine to operate trouble free for longer period of time. These problems can be solved, if the vegetable oils are chemically modified to biodiesel, which is similar in characteristics to diesel.

1.6 Fuel properties of biodiesel

The properties of biodiesel and diesel fuels, in general, show many similarities, and therefore, biodiesel is rated as a strong candidate as an alternative to diesel. This is due to the fact that the conversion of triglycerides into methyl or ethyl esters through the transesterification process reduces the molecular weight to one-third, reduces the viscosity by about one-eighth, and increases the volatility marginally. Biodiesel contains 10–11% oxygen (w/w), thereby enhancing the combustion process in an engine. It has also been reported that the use of tertiary fatty amines and amides can be effective in enhancing the ignition quality of the biodiesel without having any negative effect on its cold flow properties. However, starting problems persist in cold conditions. Further, biodiesel has low volumetric heating values (about 12%), a high cetane number and a high flash point. The cloud points and flash points of biodiesel are 15–25 8C higher than those of diesel.

II. EXPERIMENTAL SECTION

2.1 Process of biodiesel production

Transesterification of vegetable oils with simple alcohol has long been the preferred method for producing biodiesel. In general, there are two methods of transesterification. One method simply uses a catalyst and the other is without a catalyst. The former method has a long history of development and the biodiesel produced by this method is now available in North America, Japan and some western European countries.

2.2 Chemicals Required :

Sodium Hydroxide Pellets, Methanol Analar Grade, Waste Vegetable oil.

2.3 Apparatus Required :

Beaker (500ml), Magnetic stirrer with heating arrangement, Thermometer, Separating Funnel, Funnel, Filter paper, Holding stand for Separating Funnel, Holding stand for Funnel, 250 ml Standard Flask, Glass Rod

2.4 Procedure :

Waste vegetable oil was Collected, centrifuged and filtered to remove burned food bits, etc. Preheating was done to remove unwanted moisture present in the oil. The used oil is heated to 120 ^{0}C to remove all water present in the oil. The presence of water will decrease the yield of biodiesel and result in the formation of large amount of soap.

2.5 Preparation of Sodium Methoxide

Sodium methoxide was prepared by dissolving 4.5 gms of sodium hydroxide pellets in 250 ml of methanol in a 250 ml standard flask and shaking well. Since it is an exothermic reaction heat will be produced and it should be allowed to cool before mixing with vegetable oil.

$$CH_3OH + NaOH \longrightarrow CH_3ONa + H_2O$$

2.6 Biodiesel Production

The cleaned vegetable oil is taken in a 500ml beaker and placed on a magnetic stirrer cum heater. The oil was stirred and heated to a required temperature. After attaining required temperature, the methoxide prepared was added gradually while stirring. The temperature was maintained at constant value for 2 hrs and it is transferred into a separating funnel and allowed to settle for over night. After settling we can find two layers of product, upper layer is biodiesel and the bottom layer is glycerin. The bio diesel thus formed was separated and washed to remove soap present in the biodiesel. Washing is continued till you get a clear biodiesel .The biodiesel was analysed for its physical properties as well as for the fuel characteristics for the engine**.**

Once the glycerin and biodiesel phase have been separated, the excess reactant (methanol) and the catalyst (NaOH) is removed by simply heating and also washing continuously with water.

2.7 Methyl Ester Washing

Once separated by glycerin the biodiesel is purified by gently washing with warm water to remove residual catalyst or soaps, dried and sent to storage. This is normally the end of the production process resulting in a clear amber-yellow liquid with a viscosity to petroleum. Since the ester has an extremely high tendency to form an emulsion on contact with water, care must be taken to maintain low levels of mixing during washing.

III. RESULTS AND DISCUSSION

3.1 **Comparison Of Properties Of Biodiesel With Waste Vegetable Oil And Diesel**

The properties of Biodiesel obtained from waste vegetable oil are compared with that of the oil itself and also with the commercial diesel as given in Tables 3.1

Table 3.1: Properties

Properties	waste vegetable oil	Bio diesel from waste vegetable	Commercial Diesel Fuel:
Moisture by D & S method	0.2%	0.1%	-

Inorganic acidity	Nil	Nil	-
Acidity as mg KOH/gm oil	0.32	0.12	-
Density at 15 ^{0}C (gm/cc)	0.9240	0.8966	0.84
Ash content	0.006%	0.004%	-
Kinematic viscosity at 40^{0}C (cSt)	27.2	6.3	4 – 5
Flash Point by TMCC	212 ^{0}C	196 ^{0}C	76 ^{0}C
Fire Point by TMCC	220 ^{0}C	204 ^{0}C	80 ^{0}C
Pour point by TMCC	Below –11 ^{0}C	–11 ^{0}C	–16 ^{0}C
Insoluble in hexane	0.008%	0.006%	-
Gross calorific value (kcal/kg)	10,125	10,425	10,900
Sulfur content	0.09%	0.06%	45
Carbon residue	0.46%	0.33%	-
Saponification Value	188	-	-
Iodine Value	141.5		

3.2 Effect Of Operating Parameters On Biodiesel Yield

3.2.1 Effect of Temperature

The low level of temperature was chosen as the room temperature and the high level was chosen as 105 ^{0}C. Higher temperature not only decreased the time required to reach maximum conversion but also the cost of energy for heating the apparatus would not exceed the value of time saved. Therefore, high temperature of 85 ^{0}C is considered to be the optimum temperature for conversion. The pressure is maintained at atmospheric level using the condenser.

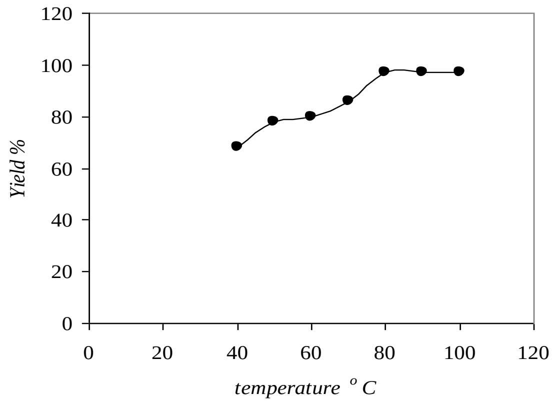

Fig 3.1 Effect of temperature on Biodiesel Yield

3.2.2 Effect of concentration of Methanol

The next step of the experimental design was used to determine the optimum values of methanol concentration. Inspection of result shows that concentration of methanol is the most important independent factor that affects the degree of conversion. Increasing the methanol concentration up to 100 % excess than the stoichiometric proportion will yield an optimum conversion. There is a higher yield at higher concentration of methanol but the energy required for the recovery of methanol becomes higher.

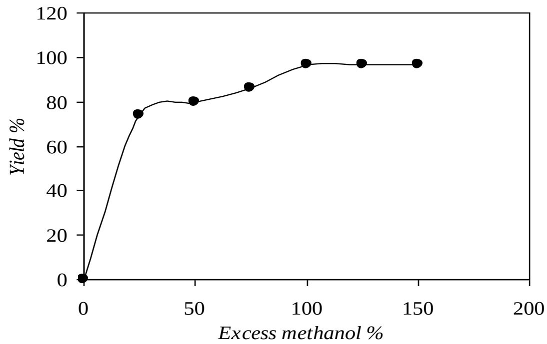

Fig 3.2 Effect of excess methanol on Biodiesel Yield

3.2.3 Effect of Catalyst Concentration

The next in optimizing the process for production of Biodiesel was to study the effect of catalyst concentration on the biodiesel yield. It is clearly shown that the biodiesel yield increases and then reaches the optimum conversion at 5-6% of the weight of the catalyst. Hence, this value was chosen for the production of biodiesel from the waste oils.

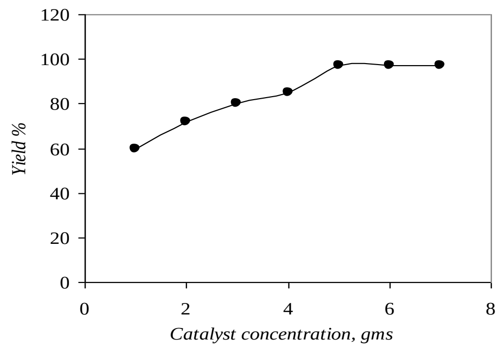

Fig 3.3 Effect of catalyst concentration on Biodiesel Yield

IV. CONCLUSION

Waste vegetable oil was transesterifed using methanol in presence of alkali (NaOH) and the biodiesel obtained was studied for fuel properties. The effect of temperature, catalyst concentration and the concentration of methanol on yield of biodiesel were studied and the optimum values of the above variables are fixed for the high yield. The properties of bio diesel was compared with the diesel. The calorific value, flash & fire point slightly varies with that of diesel. The performance characteristics of diesel engine is being carried out.

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