Investigation of Storage Potential of Different Biodiesel and Their Blends

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Abstract: *As we know that biodiesel is easily influenced by oxidative attack and acidity is always a prime concern for their long term usage. To look over these difficulties we have to investigate their potential for storage purpose. For which we have to study the changes occurred in Acid number during a given set of time under thermal cyclic condition. We use diesel fuel and three biodiesel fuel blends (B100, B40, and B20) for this study. Amongst base fuel of three biodiesel, COME and JOME shows the major increase in Acid Number while the third biodiesel namely NOME shows least increase in Acid number. The Acid numbers of diesel and fuel blends are between (0.1-0.4) mg KOH.g^{-1} under thermal cyclic condition throughout the period.*

Keywords: *Biodiesel, Storage potential, blends, Renewable energy, Acid number (AN).*

I. INTRODUCTION

Worldwide the countries have been facing a power deflect; the crisis is more critical among the developing nations. The world fuel reserves are decreasing rapidly day by day, due to which the demand of alternate source is arises from all parts of the world. Solution of long term energy problem will come only through research in the field of renewable energy resources [1]. The uses of renewable energy sources (vegetable oils, animal fats) instead of conventional energy sources have received much attention in recent past [2, 3]. The increased power demand, depleting fossil fuel resources and environmental pollution have led the world to think seriously for the alternate source of energy. The main reason behind to switch over these alternative resources are sustainability, renewability and pollution reduction. In India the energy generation is around 70% from fossil fuels i.e. coal, crude oil, natural gas etc in which oil is imported around of 80% of domestic consumption [4, 5, 6,].

To fulfill the gap between supply and demand renewable energy is a better alternative. Due to limited oil reserves in India we depend on substantial imports for fulfilling our present and future needs. The bulk demand of oil is from commercial transport sectors and in order to reduce the load from this section it is necessary to explore possibilities of developing substitute fuels like biomass (biodiesel). This led new employments and self dependency because fuel can be managed from local sources and thus provides rural development opportunities. The renewable energy resources are available worldwide, this encourages finding other possibilities in non conventional energy [7]. Also the environment has suffered a lot much destruction due to the haphazard use of these fossil reserves. In the path of this chase the innovation of using vegetable oil emerged in the last part of the 19th century. According to many researches vegetable oils can be used as an alternative fuel for diesel engines without any modification [8, 9].

Vegetable oil having common physical and chemical properties with diesel fuel but there are certain problem associated with this, namely higher viscosity, low volatility, high density and this will cause problem such as sticking of piston, carbon deposition and gumming. To protect engine from these difficulties direct usage of vegetable oil is avoided thus reduction in viscosity and improving fuel properties is our major concern. This could be happen by several ways such as emulsification, dilution of vegetable oil, transesterification and pyrolysis [10, 11].

From the above process transesterification is mostly preferred; in this process the vegetable oil is reacted with alcohol to form ester [17]. By this process biodiesel is formed which contains about 8-10% of oxygen, which led to the reduction in carbon monoxide, hydrocarbon and other emissions. Thus the oxygen content is main factor behind the emission control. Biodiesel having so many advantages over diesel fuel such as low sulphur content, fuel lubricity, environmental friendly, non toxic, higher biodegradability. Apart from this there are certain disadvantages also associated with it i.e. up to some extent oxides of nitrogen is increased, secondary slight decrease in brake power, torque while increment in fuel consumption as compared with petro diesel. Biodiesel can be prepared from different feedstock generally soyabean oil, cottonseed oil, rapeseed oil, jatropha oil, neem oil etc and they all show same result in performance parameters [12, 13].

Instead of that it is difficult to use B100 i.e. 100 percent biodiesel directly to the diesel engine because still viscosity, density and volatility are a matter of concern when compared with petro diesel. To overcome from this difficulty we use [14].In this study we have to concentrate over the storage stability of biodiesel because biodiesel is very much prone to oxidation than diesel fuel. The storage stability is based on the changes occurred in acid number of the biodiesel over 6 months of period under thermal cyclic condition [15].

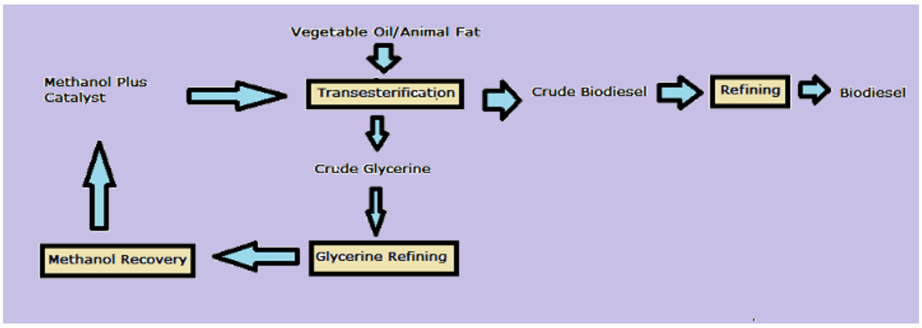

Figure 1: Biodiesel production via transesterification process.

II. EXPERIMENTAL METHODOLOGY

2.1 Production of fatty acid methyl ester

Production of biodiesel via transesterification process was carried out in a biodiesel reactor of 10 liters capacity, in which raw vegetable oil is heated to about 75°C. After this a mixture of methanol 35% and 0.75% of potassium hydroxide is added to the heated vegetable oil (10L) in the biodiesel reactor. After this mixture at a constant temperature was stirred for around 50 minutes, then we leave it for cooling following which separation of glycerol and ester takes place. The glycerol and fatty oil methyl ester were separated and taken in another vessel for further process. After separation by using heated distilled water washing process takes place which removes unreacted methanol and catalyst about three washing process was required, though some loss of ester takes place. After distillation process which was carried out at 65°C for removal of water content, then esterifies oil i.e. FAME (fatty acid meth ester) left to cool down.

Figure 2 Biodiesel Reactor

2.2 Fuel and Blends

Conventional diesel fuels was obtained from Indian oil and blended with biodiesel derived from cottonseed oil, jatropha oil, neem oil. The crude oil was obtained from local market and biodiesel is prepared by esterification process. The properties of diesel, biodiesels and its blend are carried at laboratory. Biodiesel and its blends with petro diesel were stored in a 500 ml bottles.

III. STORAGE CONDITION

The biodiesels and its blends were obtained in a partial oxidative surrounding in tightly kept bottles. Set of fuels were stored in room temperature over the time in thermal cyclic conditions (15°C to 40°C) over a period of six months from January to June. Test of samples was performed once per month at second week of every month.

Figure 3 B100 Test samples of COME, JOME and NOME biodiesel

3.1Acid Number

For determination of AN of all fuels and their blends and to indicate relative change that occurred during storage a procedure (titration) is adopted. In this procedure a known amount of sample dissolved in organic solvent, is titrated with a solution of potassium hydroxide with known concentration and phenolphthalein as a color indicator. The acid number is used to quantify the amount of acid present, for biodiesel, It is the quantity of base, expressed in milligrams of potassium hydroxide that is required to neutralize the acidic constituents in 1g of sample. For each AN determination approximately 25g of base fuel or blend was used.

IV. Result and Discussion

4.1 Properties of Fuel

The chemical properties of diesel, biodiesel and its blends were carried out in laboratory. The properties of diesel and biodiesel base fuel B100 shown in table:

Table 1 Fuel Properties of Diesel and COME, NOME, JOME.

Properties	Test method	Diesel	COME	NOME	JOME
Kinematic Viscosity@40°C,cst	D455	2.64	5.561	4.5	5.8
Density @15°C,kg/m^3	D128	835	880	873	893.2
Flash Point, °C	D94	56	190	165	167
Net Calorific Value, MJ/kg	D240	43.8	40.83	38.8	38.92
Water and Sediment % volume	D2709	0.01	0.015	0.018	0.02
Sulfer, %wt	D4294	0.30	0.003	0.004	0.01
Specific Gravity @ 15°C	D5355	0.85	0.889	0.83	0.92

The test fuel during this study are neat COME, JOME, Neem biodiesel (NOME) and its blends of 20% and 40% by volume with diesel fuel is used. Experiment was carried out over six months under thermal cyclic condition (15°C - 40°C).

4.2 Storage Stability

The test sample of COME, JOME, and Neem biodiesel (NOME) base fuels and its blends (B20) and (B40) were stored in 500 ml glass bottle under thermal cyclic condition for a period of about six months. After the close inspection of sample, we have obtained subsequent results as shown in figures.

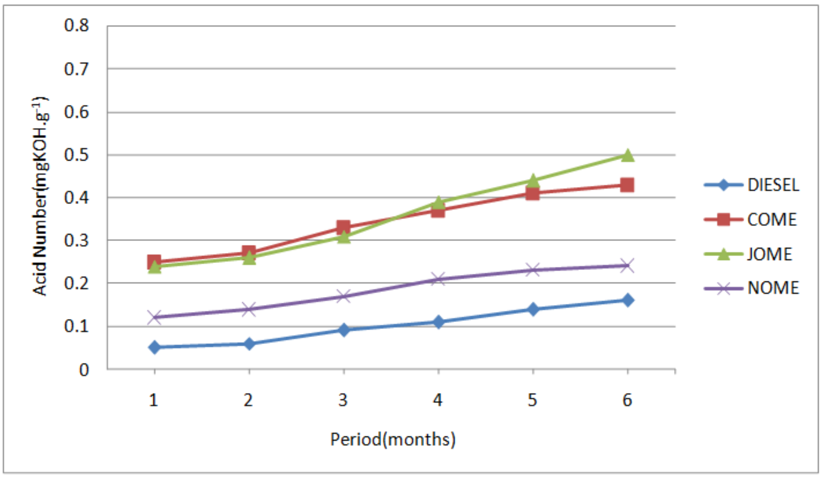

Figure 4 Acid number of all three biodiesel base fuels B100 of COME, JOME, NOME and Diesel as a function of storage duration (6 months) under thermal cyclic condition(15° to 40°C).

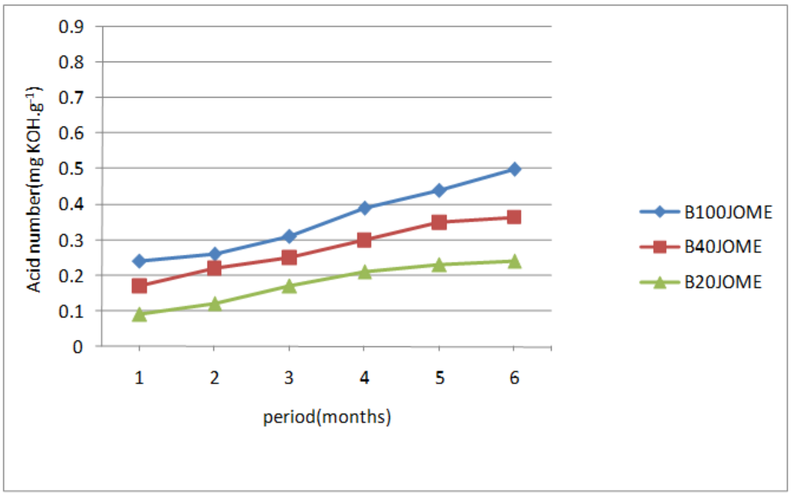

Figure 5 Acid number of JOME biodiesel base fuel B100 and its blends B40 and B20 with diesel as a function of storage duration (6 months) under thermal cyclic conditions (15° to 40°C).

In Fig. 4, the acid number is plotted over time (storage periods in months) for diesel and base fuel (B100) of all three biodiesel under thermal cyclic condition. The result presents that the acid number of JOME and COME shows larger increase in AN. While the third one NOME shows little increment i.e. below (0.3 mg.KOHg^{-1}).All fuels shows steady increment in AN. The acid number of diesel fuel was within the limit of the ASTM Standard. Among the three Biodiesel JOME debase more and touching the ASTM standard of 0.5 mg.KOHg^{-1}. NOME biodiesel evidently a superior base fuel with lesser AN and remain stable for months. Initially, the acid number of COME and JOME is below 0.3 mgKOH.g^{-1} but as time proceeds we have observed that, there is an increase in acid number away from the limit because of elevated amount of free water and sediments, sulphated ash.

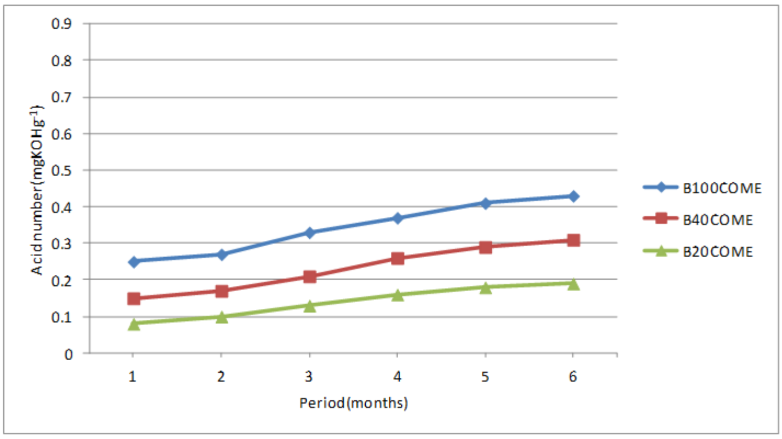

Figure 6 Acid number of COME biodiesel base fuel B100 and its blends B40 and B20 with diesel as a function of storage duration (6 months) under thermal cyclic conditions (15° to 40°C).

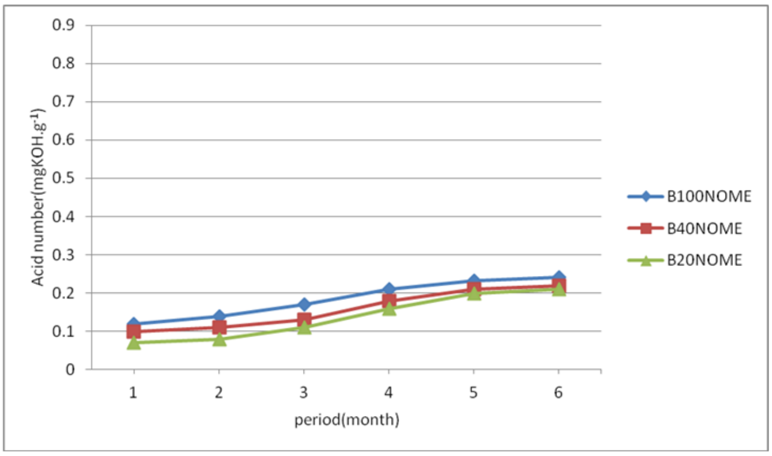

Figure 7 Acid number of NOME biodiesel base fuel B100 and its blends B40 and B20 with diesel as a function of storage duration (6 months) under thermal cyclic conditions (15° to 40°C).

This elucidates the larger increase in acid number over couple of months. In Fig 5-7 shows the graph between AN as a function of period (in months) under thermal cyclic condition of all the biodiesel blends (B40, B20) of JOME, COME, NOME respectively. Fascinatingly, the acid number of all fuel blends increased at a rate in contrast to diesel. While, that of base fuel has increased at a faster pace than the blends [16]. We have observed that there is an increase in acid number of (B40) blend within limits prescribed by ASTM as shown in the figure.

Acid number values started to go up steadily over the storage period. It is clear from the figure, that the acidity of any blend was decided by the acidity of (B100) base fuel mixed with diesel. The acid numbers of (B40) blend of JOME and COME biodiesel are less than or near to 0.4 mgKOH.g^{-1} during the storage period. While that of NOME biodiesel it is less than 0.3 mgKOH.g^{-1}. The acid number of (B20) blend of JOME, COME and NOME is below 0.2 mgKOH.g^{-1} or approaching to 0.2 mgKOH.g^{-1}. Consequently the outcome show that even (B100) with acid number close to 0.5-0.6 mgKOH.g^{-1} can produce blend approaching to standard for storage all along time under deliberate situation.

V. Conclusion

Amongst all three biodiesel base fuel i.e. JOME, COME and NOME (B100) and its blends, the JOME and COME biodiesel showed the major increase in acid number during 6 months of storage at thermal cyclic situation while the third one i.e. NOME shows least increment of AN. The acid number for diesel fuel and all blends i.e. (B20) and (B40) stay in the range of 0.1mgKOH.g^{-1} to 0.4mgKOH.g^{-1} under thermal cyclic condition all through the storage period which is adequately lower than the ASTM standard 6751 limit i.e. 0.5mgKOH.g^{-1}. All blends illustrate a lesser raise in acid number than of base fuel. Consequently, the larger stability of blends over biodiesel base fuel was shown. Among all three biodiesel the NOME shows greater stability.

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