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Tung Biodiesel as an alternative fuel for CI engine: Review

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***Abstract*— Biodiesel has received much consideration in the previous decade because of its capacity to replace fossil fuels, which are likely to run out within a century. It is produced from oils and fats by transesterification with alcohols. In a nation like India, where edible oils are still imported, it investigate it is beneficial to explore the possibility of using such non edible oils in CI engines which are not in practice as cooking oil. The Tung biodiesel is considered as alternative fuels to diesel. Tung oil transesterification with methanol to obtain Tung oil methyl ester, to reduce the kinematic viscosity within the diesel range .Therefore, the investigation on Tung oil considered as fuel for CI engine was undertaken.**

***Keywords*— Tung oill, Non edible oils ,Transesterification,C.I engine, Bio diesel.**

I. Introduction

Energy is the most essential factor of economic growth of the world and plays important role in sustaining the modern economy and society. Future decisive economic growth depends mainly on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. Hence energy security is most important issue of world politics for more than five decades. energy market have depended heavily on fossil fuels such as coal , crude oil and natural gas that provides most of the world's supply of primary energy needs. Fuel produced from biomass , known as " bio- fuel ."Biofuels can be broadly divided into first-generation and second-generation fuel. First generation fuels or conventional biofuels are generally derived from sugar, starch, and vegetable oil source. While second-generation biofuels are produced from sustainable raw materials. The main classification of biofuels shown in Figure.

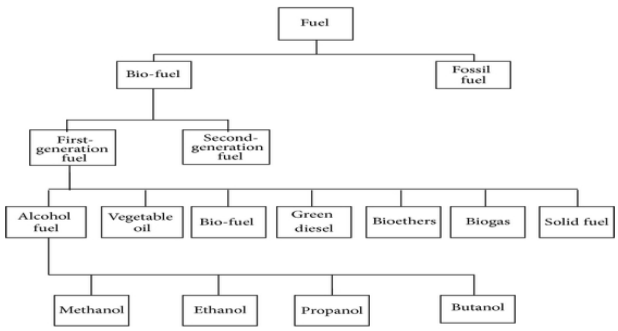

Figure 1: Classification of biofuels.

Biofuels are strongly emerging as partial substitutes for fossil fuel from the economic as well as environmental angle. Biofuels include , vegetable oils such as jatropha oil , karanja oil , castor oil , jojoba oil, cottonseed oil, neem , mahua oil tung oil, palm oil, soybean oil, sunflower, etc. are being studied as a promising alternative to oil -based fuels full fill future energy needs .Vegetable oils can be used as alternative fuels because they are biodegradable, non-toxic and significantly reduce pollution. Biodiesel is a non-toxic, sulphur-free, biodegradable, and oxygenated and environment friendly alternate diesel fuel. Biodiesel (fatty acid alkyl esters) is an alternative diesel fuel derived from the reaction of vegetable oils or lipids and alcohol with or without the presence of a catalyst [2]. One of the important features of biodiesel fuel is that its use does not require any significant change in the diesel engine [3]. Tung Biodiesel is a vegetable oil-based fuel that can be used to replace diesel oil.

A. TUNG BIODIESEL (VERNICIA FORDII)

Tung is produced in large quantities in Southeast Asian countries. Considerable amounts are also produced in the USA, Latin America and Europe. Tung oil or "China wood oil" is a quick-drying vegetable oil extracted from the seeds of the Tung tree (*Aleurites fordii*, family Euphorbiaceae), a tree native to central and western China. China is the largest Tung oil producing country, In India Tung plantation found in North-east. The total expected availability of Tung oil in India is about 2 million tons [3]. The current production of Tung oil is low Tung oil is left unused due to various reasons. Therefore, the oil can be used for various purposes. One of the most effective methods is to use it for biodiesel production. Tung (vernicia fordii.) considering as a wild oilseed plant of the sub-tropical region is now been credited as a promising biofuel crop very much ideally suited for growing in the waste lands of the country. This potential biodiesel crop can be about major economic activity providing income and employments opportunities to the rural communities. The seeds of the oil seed plant Tung contain 20 to 35 per cent by weight viscous oil. It is a medium-sized deciduous tree growing upto 20m tall with spreading crown & belonging to the family of Euphorbiaceous. It is a plant with many attributes, multiple uses and potential.

Figure 1: Tung tree **Figure 2:** Tung fruit, seed

A. TRANSESTERIFICATION

Transesterification is the most common and important method which is used to reduce the viscosity of vegetable oils. It is also termed as alcoholysis, is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acid, glycerol and alkyl ester. The transesterification reaction is represented by the general equation

RCOOR' + R" RCOOR" + R'OH

If methanol is used in the above reaction, it is called as methanolysis. The reaction of triglyceride with methanol is represented by the general equation:

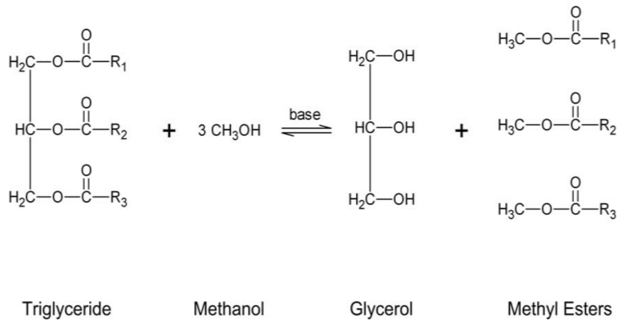

Figure 3: Transesterification reaction

R is a mixture of various fatty acid chains. The alcohol used for producing biodiesel is usually methanol (R′ = CH3).**[1]**

B. PROPERTIES OF FUELS

Some properties of the optimized biodiesel were compared with those of diesel in accordance with the specifications provided by the ASTM standards. It was observed that properties of Tung biodiesel given in Table 1 were conforming to the latest biodiesel standards. Calorific value of optimized tung oil biodiesel , was lower than diesel fuel 9100 kcal / kg. The flash and fire point of Tung seed biodiesel were observed to be higher than of diesel fuel. The cloud and pour point were also observed to be lower for biodiesel fuel.

Property of oil	ASTM standards	Diesel	Tung oil(B100)biodiesel
Density kg/m^3	------------	850	885.8
Kinematic viscosity (cSt)	1.9-6.0	2.049	4.60
Flash point, ^{O}C	>130	78	194
Fire point, ^{O}C	>53	83	180
Cloud point, ^{O}C	-3 to 12	<10	-2
Pour point, ^{O}C	-15 to 10	-6	-6
Calorific value, kJ/kg	> 33000	42000	39000.0
Carbon residue, (%)	<0.05	0.0214	0.0150%
Ash content,%	0.02% max	0.02	0.02
FFA, %	<2.5	-----	0.12
pH	-----	-------	7.5

Table 1 Properties of diesel and Tung oil biodiesel according to ASTM standards.

II. LITERATURE REVIEW

Gerhard Knothe et al.(2005) [1] in their book described the technical concept of using vegetable oils or animal fats or even used oils as a renewable diesel fuel. Biodiesel is the form in which these oils and fats are being used as neat diesel fuel or in blends with petroleum-based diesel fuels. The concept itself may appear simple, but that appearance is deceiving since the use of biodiesel is fraught with numerous technical issues. Accordingly, many researchers around the world have dealt with these issues and in many cases devised unique solutions. This book was an attempt to summarize these issues, to explain how they have been dealt with, and to present data and technical information. Countless legislative and regulatory efforts around the world have helped pave the way toward the widespread application of the concept. This book addressed these issues also. To complete the picture, chapters on the history of vegetable oil-based diesel fuels, the basic concept of the diesel engine, and glycerol, a valuable by-product of biodiesel production, were included.

Mustafa Balat , Havva Balat (2001) [2] studied that the problems with exchanging triglycerides for diesel fuels were mostly related with their high viscosities, low volatilities and polyunsaturated character. The viscosity of vegetable oils, when used as diesel fuel, can be reduced in at least four different methods: (1) dilution with hydrocarbons (blending), (2) emulsification, (3) pyrolysis (thermal cracking), and (4) transesterification (alcoholysis). Transesterification was the most widely recognized technique and prompts monoalkyl esters of vegetable oils and fats, now called bio-diesel when utilized for fuel purposes. The primary components influencing transesterification were molar proportion of glycerides to liquor, impetus, response temperature and weight, response time and the substance of unsaturated fats and water in oils. The ordinarily acknowledged molar proportions of alcohol to glycerides are 6:1–30:1. Bio-diesel is a cleaner-burning diesel substitution fuel produced using common, renewable sources, for example, new and utilized vegetable oils and creature fats. Much the same petroleum diesel, bio-diesel operates in compression-ignition engines or Diesel engines.
Codd *et al.* (1975) [3] reported that vegetable oils are natural products, therefore, subjected to some variation in composition and content of fatty acids. It is clear from the table that dissimilar to diesel fuel, vegetable oils contain critical measure of oxygen notwithstanding carbon and hydrogen. The presence of various unsaturated fats is likewise needy to various components, for example, botanical, climatic conditions, soil structure, rainfall and temperature.

Fangrui Maa, Milford A. Hannab (1995) [4] described the four primary techniques to make biodiesel, direct use and blending, micro emulsions, thermal cracking (pyrolysis) and transesterification. Of the few techniques accessible for creating biodiesel, transesterification of normal oils and fats was the strategy for decision. The reason for the procedure is to bring down the thickness of the oil or fat. Despite the fact that mixing of oils and different solvents and miniaturized scale emulsions of vegetable oils brings down the thickness, engine performance problems, such as carbon deposit and lubricating oil contamination, still exist. Pyrolysis produces more bio gasoline than biodiesel fuel. Transesterification is essentially a sequential reaction. The normally accepted molar ratio of alcohol to glycerides is 6:1. Base catalysts are more effective than acid catalysts and enzymes. The recommended amount of base used to use is between 0.1 and 1% w/w of oils and fats. Higher reaction temperatures speed up the reaction and shorten the reaction time. The reaction was slow at the beginning for a short time and proceeds quickly and then slowed down again Base catalyzed transesterification were fundamentally completed inside 60 minutes.
Ulf Schuchardta et al. (1998)[5] reviewed the transesterification of vegetable oils with methanol as well as the main uses of the fatty acid methyl esters. The general viewpoints about this methodology and the relevance of different types of catalysts (acids, alkaline metal hydroxides, alkoxides and carbonates, enzymes and non-ionic bases, such as amines, amidines, and guanidine and triamino (imino) phosphoranes) were depicted. Special attention was given to guanidine, which can be easily heterogenized on organic polymers. However, the anchored catalysts show leaching problems. New strategies to obtain non-leaching guanidine-containing catalysts are proposed. At long last, acquired by transesterification of vegetable oils, are portrayed.

M.Mathiyazhagan et al. (2011)[6] researched on the non-edible oils as feed stocks for biodiesel production to reduce the cost of biodiesel. Typically alkali base catalyzed strategy was taken after for biodiesel production process. However the non-edible oils having high FFA content which is not reasonable for ordinary transesterification process. Consequently a two-stage catalyzed strategy was utilized to set up the biodiesel. High FFA content of non-edible oils were effectively converted over into biodiesel fuel.

II. CONCLUSION

Tung biodiesel fulfils the important fuel properties as per ASTM specification of biodiesel. Engine works smoothly on Tung methyl ester with performance compared to diesel operation. Tung biodiesel can be successfully substituted as alternative fuel for CI engine.

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