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A REVIEW OF THE ENGINE PERFORMANCE AND EMISSION ANALYSIS USING COTTONSEED BIODIESEL AND ITS BLENDS

Shubham Jain[1], Vishal Joshi[1], Dayasagar ghodake[1], Yogesh Ghule[1], Shilpa Gujar[1]

[1]Department of Mechanical Engineering, ZCOER, Pune-411041, Maharashtra, India.

Abstract - *Biodiesel is renewable, eco-friendly, biodegradable fuel which can be produce from plant seed oil, animal fat, waste cooking oil through some chemical process. Fossil fuels are on the path of demolish due to increasing its use, in the world and may not able to fulfill world energy demand in the future. Whole economy of different countries of world largely depends on fossil fuel. Gulf countries increasing crude oil rate, it causes to increase fuel rate in rest of countries. It affects the general life of people due to expensiveness of useful things of daily life. As well as exhaust of fossil fuel causing the environmental pollution and human health issues.*

To overcome on such issues, it is necessary to focus on biodiesel which can be making available in plenty of amount so as to fulfill the requirement of diesel without any changes in current setup of IC engine. It is necessary to focus on its innovation and research.

This paper provides a detailed review of engine performance and emission analysis using cottonseed biodiesel and its blends taking into account current scenarios of detrimental effects of Fossil fuels and their environmental effects.

Key Words: **Engine Efficiency; Cotton Seed; Transesterification; BSFC; Blends; Combustion.**

1. INTRODUCTION

Biodiesel is a mixture of oil extracted from plant oil, vegetables, farm wastage, waste cooking oil, animal fats, etc. Biodiesel is a good substitution of diesel fuel. All these things mainly used for producing biodiesel.

Biodiesel is generally blending of diesel and oil extracted from various sources. It is very important to consider the percentage of oil for preparing the blends because it causes vital effects on exhaust emissions. Generally, biodiesel is formed by chemical processes by adding methyl esters and acid. Selection of biodiesel is very important characteristics because research indicates that by using refined or raw vegetable oil can cause various problems in IC engine like ring sticking, gel formation of oil, and thus reduces engine life.

Viscosity is the major specifications of biodiesel that needs to observe carefully. Biodiesel is an eco-friendly, economical and harmless fuel and it can be usable in IC engine without making any changes into the machine. Biodiesel is very efficient for environment that leads to reduce carbon particles, hydrocarbons and particulate matters. Also, one thing is there to notify that biodiesel is having freezing property in very cold weather and thus may be unsuitable.

Use of biodiesel is essential because an exhaustion of petroleum-based oil started rapidly because of increasing demand of people but it is harmful for energy requirements.

Fuels has great importance because they can be burn to produce significant amounts of energy. Fossil fuel shares almost 80% of world's energy requirements. Thus, there is big scope for use of biodiesel.

Bio-fuel will help to reduce expense on crude oil as well as it also helpful in reduction of emission of harmful gasses like carbon dioxide, carbon monoxide, hydrocarbon, Sulphur, smoke and small particles in the exhaust of the engines. For production of biodiesel in India cotton seeds are available in large extent, as cotton most cultivated crop in many states across the India. Using cottonseed biodiesel production is more suitable. In the world, India is the second biggest producer of cotton after the china. From the cotton plant we get three major parameters such as cotton fiber, cotton seed, and cotton seed's cake as diet to cattle for better milk. In India production of biodiesel from cotton seed will be more economical than any other source as it is available in large extent. In the world biodiesel mostly produced and used in the countries like Europe, united states of America (USA), brazil, Indonesia, Argentina, Thailand, china about 29% of the biodiesel of the world produced in the Europe, 16% in the USA, 11% in the brazil, 10% in Indonesia, 10% in Argentina, 4% in Thailand, 4% in china and remaining 16% in other countries.

Cotton crop need hot weathercast well as it requires the temperature between 21^0c to 30^0c. It grows in tropical and subtropical areas. If temperature goes below 20^0c plant growth is affected. Frost is the enemy of cottonseed crop. It requires the 210-frost

free day in the year. It can be planted in the region where the rainfall is less in overall year there should not be rainfall and moist weather at time of ball opening such weather causes pests and diseases. It need rainfall at beginning, dry and clear atmosphere at time of ripening. Cottons in India are mainly cultivated in the state of Maharashtra, Gujarat, Uttar Pradesh, Madhya-Pradesh, Andhra Pradesh, Telangana, etc. Maharashtra is the largest cottonseed producer along these. With increase in demand of energy fuel, study and use of biodiesel fuels are must in the whole world. In India cottonseed biodiesel production is easy and due to high rate of production of cottonseed thus it will be economical and hence more usable also.

2. PREPARATION OF BIODISEL:

Gossypol, carotene is the antioxidant in bio-fuel which help to stabilize biodiesel.[1]. As percentage yield of biodiesel which depends on reaction factor such as catalyst type and its concentration, agitation rate, reaction temperature, methanol to oil ratio. Using sodium meth-oxide as catalyst at concentration of 0.75% and 6:1 molar ratio, 65^0c reaction temperature and agitation rate of 600 rpm, yield of 96.9% can be obtained [2]. Carried test on the different molar ratio such as 3:1, 4.5:1, 6:1. At a ratio of 6:1 methanol to oil molar and 1% KOH as catalyst, 97.82% yield obtained through the

Conventional method of mechanical stirrer technique. Thus, as per this technique higher amount of yield could be possible [3]. Test performed on the two types of catalysts such as homogeneous catalysts and heterogeneous catalysts. Homogeneous catalysts are conventional, whereas heterogeneous catalysts are recently invented.[4]. The methanol and ethanol both are suitable for transesterification of biodiesel, but due to having more cost of ethanol compared to the methanol, there is not more use of the ethanol. Due to lower cost of methanol, it also reduced overall biodiesel cost. So, methanol is more preferably used. By taking the proportion of 6:1 methanol to oil molar ratio, 0.6% of catalyst concentration at 550c reaction temperature for 60 minutes would yield 96% of biodiesel yield [5]. Cottonseed used in as biodiesel by some process transesterification process use in methanol and KOH as catalyst. Some blends are uses (B5, B10, B15, and B20), combustion characteristics they follow-Delay in ignition, start of combustion, premixing, diffusion and after combustion, end of combustion. Ignition delay decrease in decreasing order [6]. Natural additives increase the engine performance on its addition into the diesel with biodiesel. Trans-esterification process can be carried out to reduce high viscosity; high flash point of cottonseed oil is treated with ortho-phosphoric acid and Sulphur acid to remove the gums and fatty acids from biodiesel blend. In second step, methanol and potassium hydroxide are added to the cottonseed oil to segregate biodiesel and glycerol [7]. For improving efficiency of fuel various novel technologies including engine and fuel cells were used. First development in fuel that is the bio fuel is well approved process of transforming plant sugar into ethanol through fermentation. High octane fuel such as ethanol with majority of SI or fossil fuel IC engine in market today as well as it is blended with gasoline. Traditionally, methanol has been used during transesterification production of fatty acid methyl ester. Also, ethanol and propanol are nominated for cold performance biodiesel fuels and implementation of bioethanol leads to improvement sustainability of existing biodiesel but these may lead to price increase. To obtain synthetic hydrocarbon fuels following methods are used. Fischer-troops synthesis, hydro treatment of triglycerides [8]. Transesterification is carried out with ethanol in the existence of catalyst NaOH.

Expeller method is employed to extract oil from the cotton seed and was subjected to single stage transesterification due to presence of 20% more free fatty acid content.

Alcohol most commonly used for transesterification

1. Methanol
2. Propanol
3. Butanol
4. Amyl alcohol.

Seed contains 17-25 percent of oil weight.

The fatty acid composition of cotton oil is mainly

Linoleic (55.2 - 55.5 percent)

Palmitic (11.67 - 20.10 percent)

Oleic acid (19.2 - 23.26 percent) [9]

3. PROPERTIES:

The biodiesel observed that cotton seed biodiesel has good lubricity property as compare to the pure diesel. Stability of biodiesel is also recognized by its appearance. As there is dark color of the biodiesel, it will have the better stable.[1]. Biodiesel evaporation rate, its blends and diesel obs-erved that the time taken to evaporate completely
by pure diesel (B0) was very low than cottons bio-diesel (B100).Rate of evaporation decreases as the biodiesel proportion increases in pure diesel. Pure biodiesel (B100) has lower calorific value, as result specific fuel consumption (SFC) increases.

At the B50 and B75 specific fuel consumption were same at the different brake load. So, these blends can use in any diesel engine without any modification.[10].

To find supercharging effect on diesel engine performance with oil extracted from cottonseed, performance tests of constant speed maintain temperature of steady jacket of 55^0c with oil extracted from cottonseed under natural conditions at fuel injection pressures 180 bar, 210 bar as well as 240 bar. He experimented the specific gravity: 0.911, kinematic viscosity: 46.9cst, gross calorific value: 39400 kj/kg.[11]. Brake power of engine speed drops when ratio of blend of biodiesel increases to 50% or 100% respectively. At B50, brake power drops up to 5.6% and at B100 it reduces up to 9.7%.[12]. With content of 10% mass of biodiesel in mineral diesel tends to increase in viscosity, cetane no. And flash point and decreases Sulphur content regarding the thermal stability of vegetable oil, palm oil is steady. Among all biodiesel types the cotton seed is most stable one due to higher percentage of polyunsaturated ester contains in the composition. Furthermore, biodiesel presents appropriate thermal and physiological properties for use as fuel.[13].

No.	Name of the properties	ASTM code	B0	B25	B50	B75	B100
1	**Specific gravity**	D445	0.8200	0.8391	0.8537	0.8671	0.8825
2	**Acidity**	-	0.065	0.067	0.070	0.083	0.26
3	**Kinetic viscosity at 40 °C in cSt**	D2217	2.6	3.49	4.17	4.98	6.04
4	**Flash point in °C**	-	65	71	78	112	170
5	**Fire point in °C**	-	70	79	88	123	183
6	**Cloud point in °C**	-	-15	4	8	11	13
7	**Gross calorific value in kj/kg**	D4809	45,596	43,976	42,268	42,523	41,819
8	**Cetane number**	-	51	52.4	51.8	51.6	51.5

Table -1: Properties of cotton seeds biodiesel and its diesel blends.

4. PERFORMANCE AND EMISSION ANALYSIS:

While testing cotton seed biodiesel on IC engine it found that there is less emission of exhaust gases such as nitrogen oxide (NOx), carbon dioxide (CO_2), as compare to pure diesel.[1]. Heterogeneous catalysts having the more advantages over the homogeneous catalysts, because of it requires less energy and water. Homogeneous catalysts require more energy and water, increases cost of water treatment also. Homogeneous catalysts cannot recycle whereas heterogeneous one can be recycled. Using heterogeneous catalyst such as the calcium oxide (CaO) at the concentration of 3%, the yield of 92% was obtained.[4]. The start of combustion advanced from 399 ^{0}c in between that range for each blend. Pressure in combustion chamber increase. It results in reduced pressure rise rate. When cetane number of biodiesels increases ignition delay will be lower. Higher NOx.[6]. The experiment gives the calorific value, flash point, fire point and viscosity has been enhanced for B50, B100a and B50a respectively compared to B100. CO emission is reduced for B100a, and B50a about 9% and 5% respectively compared to B100 the nitrogen oxide (NO) emission is reduced about 5.8% and 6.9% for B100a and B50a respectively.[7]. That oxygenated bio-fuel produces low intrinsic NOx and soot emission as compare to hydrocarbon fuels in basic experiments.[8]. Brake thermal efficiency is lower in biodiesel fuel as compare to diesel. Specific fuel consumption increases because of less calorific value in blends emission of HC was less due to presence of oxygen content. NOx is higher due to rise in operating temperature engine.[9].

Study objective efficiency considering the use of biodiesel in diesel engine is to find the boundary affecting the efficiency of gross indicated fuel conversion.When there are many differences in gross fuel conversion efficiency in diesel and B20, it seems that the difference in efficiency of different engine control parameters in fuels[14].Preparing a blend of diesel – biodiesel – ethanol with less than 99% concentration must be used. It seems that ethanol contain must kept as at most 5%. It gives best results. By using leash blends, the emission of CO, CO_2 also PM, Soot and Smoke remains same in diesel fuel exhaust only NOx emissions increase which is not acceptable [15].

Based on performance, emission of single cylinder, fourstroke diesel engines with a rated power of 3.5kw, 17.5 compression ratio at 1500 rpm, the result of injection operating pressure for 20 percent blend of oil extracted from cotton oil methyl ester and 15 lpm hydrogen dual fuel mode was identified.The engine also operated with a B20 injection pressure of 220 bar, the brake thermal efficiency improved by 33 percent. BSFC of 15 lpm of hydrogen with B20 reduces by 37 percent. Emissions were greatly reduced except for NOx at exhaust [16]. For cotton seed methyl ester, it is noticed that specific energy consumption is more when comparing with diesel operation because of low heating value of cotton seed oil methyl ester (csome). There is increase in NO emission for csome 40 by 74% and for csome 100 by 11% at full load condition. There is increase in HC emission for csome 20 by 10% at full load condition. However, there is reduction in HC emission for csome 100 by 24%. There was increase in smoke for cost by 10% and for cost 20 by 8% at full load.[17]. Refining of biodiesel is necessary to reduce smoke in exhaust of engine. Maximum 77% yield can get at 20% methanol, 0.5% Noah, 55^0c reaction temperature. There is less emission of exhaust gasses like CO, PM, smoke. But nitrogen oxide (NOx) emission is slightly increased than that of diesel. Thermal efficiency is also lower than pure diesel.[18]. Compared with varying degree of unsaturation, this blend lowers Brake thermal efficiency and increase the exhaust gas temperature of a single cylinder diesel engine resulting in reduced CO, HC and smoke emissions and increased NOx emissions.

Came: 20% cottonseed oil methyl ester + 80% neat diesel, Nd: neat diesel came compared with Nd[19]. Varying the blends:

(Cottonseed oil biodiesel + diesel + ethanol)
01. 20% + 75% + 5%
02. 40% + 55% + 5%
03. 60% + 35% + 5%
04. 80% + 15% + 5%

By 01 blend it decreased from 6 percent to 7 percent compared to conventional max-load (BP) diesel fuel. (BSFC) increased from 2 to 9 percent. (BTE) increased from 1 to 2 percent. Ethanol also decreased the density of biodiesel blends by adding ethanol to the heat content or calorific value of blend decrease. The viscosity of kinematics decreases[20]. Single cylinder diesel engine use. Reduces the time of ignition delay with cotton seed B20 biodiesel as compared to main diesel (because cetane number and oxygenated fuel higher) crank angle decreases 9.5deg ca to 8. 5degca.premixed combustion phase is increased and diffusion combustion phase is decrease. (Higher premix phase so higher NOx), NOx increases and CO and HC emissions decreases, BSFC increases [21]. Iso-butanol can be used as additives in biodiesel for decreases its viscosity and increase its volatility. It plays important role to meet specifications of biodiesel with standard specifications. Using iso-butanol as additives in biodiesel (B20+10%), increases the volatility of fuel. Due to this there are decrease in specific fuel consumption (SFC), increase in brake thermal efficiency (BTE) as well as reduction in emission of exhaust gasses like carbon dioxide (CO_2), nitrogen oxide (NOx) and carbon monoxide (CO). But there is slightly increases the hydrocarbon (HC) emission. Thus, using iso-butanol as additives in biodiesel, it could be beneficial to match its properties with ASTM standards to use it in actual practice[22]. Effect of butanol acetone mixture as an additive blend with biodiesel. NOx increases when only cottonseed biodiesel uses but with Butanol–acetone mixture, NOx reduced as compared to biodiesel. BP slightly lower. SFC was higher than all biodiesel. CO emission reduced by 40%. After adding the Butanol–acetone mixture uhc emission were increases a bit, as compared to neat biodiesel and diesel Butanol–acetone mixture is eco-friendly fuel.[23].

5. CONCLUSION

It can be concluded that using biodiesel as fuel in IC engine will have less emission of engine exhaust gasses such as CO_2, CO, SOx, HC and particulate matters.

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