International Journal of Latest Trends in Engineering and Technology
Special Issue AFTMME-2017, pp. 173-177
e-ISSN:2278-621X

COMPARATIVE INVESTIGATION THE PROPERTIES OF COTTONSEED METHYL ESTER BLENDS D80-B10-E10 AND D60-B20-E20 WITH DIESEL

Varinder Singh[1] & Sandeep Singh[2]

Abstract-Biodiesel is nontoxic and renewable fuel which used at place of diesel in CI engine without any major modification. Biodiesel had better lubrication property, less emission and clean burning as compare to diesel. In the present work, the transesterification process was used for production of cotton seed oil methyl ester because yield and reaction type was less as compare to other biodiesel production process. Ethanol was used as oxygenated fuel that was mix in blend of cotton seed oil methyl ester and diesel. Because ethanol had high calorific value and high cetane no. ethanol would reduce the consumption of diesel, content of HC and CO in engine emission and ignition lag in CI engine.

An experimental study was carried out compare the properties of blend D80-B10-E10 and D60-B20-E20 with diesel and pure biodiesel. The optimum blend was selected on the basis of properties. Results showed that the properties of blends were very near to pure diesel The properties were include density, viscosity, flash point and fire point, cloud point and pour point, carbon residue content and ash residue content and calorific value. Cloud point of blend D80-B10-E10 was 33.33% and D60-B20-E20 was 66.66% and pour point temp of blend D80-B10-E10 was 62.5% and D60-B20-E20 was 25% more than diesel. Calorific value blend D80-B10-E10 was 3.96% and D60-B20-E20 was 7.93%, Flash point blend D80-B10-E10 was 12.3% and D60-B20-E20 was 26.15% and fire point temp blend D80-B10-E10 was 11.42% and D60-B20-E20 was 24.28% less than diesel.

Keywords: ethanol, biodiesel, hydrocarbon, carbon monoxide, compression ignition.

1 INTRODUCTION

Diesel engines are widely used in transportation, agricultural appliances and construction machines owing to their high fuel efficiency and durability. However, the NOx and smoke emissions are the main exhaust emissions of diesel engines and there is a trade-off relationship between them [1].environmental policies, reduction in underground fossil fuel, escalating prices and increased demand for energy have triggered interest in more advanced and novel combustion technologies that use renewable and alternative fuels as energy sources. There is continuous pressure on emission control through periodically tightened regulations throughout the world. In this situation, there is an urgent need to promote use of alternative fuels as substitutes for diesel engine [2].Biodiesel is the name of a clean burning alternative fuel produced from domestic, renewable resources. It can be used in Compression Ignition engine without modification. The biodiesel combustion is better not only for people but also for earth's environment. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend [3]. Generally the blend of biodiesel diesel mix is denoted by capital alphabet B followed by percentage of biodiesel in a mixture so if 20% biodiesel and 80% diesel is in a mixture on a volume basis then it is denoted as B20.in other word Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics. [4]

1.1 Need of biodiesel

Petroleum resources are not infinite so search for alternative is continuing all over the world. The demand of energy is fulfilled by the conventional energy resources like coal, petroleum and natural gas. Petroleum-based fuels are fewer reserves concentrated in some areas of the world. The scarcity of known petroleum reserves will make renewable energy resources like biodiesel more attractive [5].

- Biodiesel is Energy Independence
- Biodiesel has Smaller Trade Deficit
- Biodiesel important for Economic Growth
- Biodiesel is need for Cleaner Air
- Biodiesel is use to reduce Global Warming
- Due to High price of crude oil biodiesel is less costly

1.2 Transesterification

[1] Corresponding Author, Department of Mechanical Engineering,Thaper University Patiala, Punjab, India
[2] Assistant professor, Department of Mechanical Engineering, Punjabi University Patiala, Punjab, India

The majority of the methyl esters are produced using the base catalysed reaction because it is the most economic for several reasons [6]

1. low temperature and pressure
2. high yields and short reaction times
3. direct conversion process
4. simple in operation and environmentally eco-friendly

Transesterification can be defined as the process of reacting a triglyceride (oil) with 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 oil into methyl or ethyl esters. Glycerin, also known as glycerol, is the by-product of this reaction. The process is similar to hydrolysis, except than alcohol is used instead of water.

Critical quality parameters in the process are:

• Complete reaction
• Removal of glycerol
• Removal of catalyst
• Removal of alcohol
• Absence of free fatty acids
• Low sulphur content

Methanol is used as the alcohol for producing biodiesel because it is the least expensive alcohol, although other alcohols. Such as ethanol may yield a biodiesel fuel with better fuel properties but it is expensive. Often the resulting products are also called fatty acid methyl esters (FAME) instead of biodiesel. The amount of alcohol used can be reduced by conducting the reaction in steps, where part of the alcohol and catalyst are added at the start of each step, and the glycerol is removed at the end of each step. Free fatty acids in the oils or fats can be converted to alkyl esters with an acid catalyst also. This can be followed by a standard alkali-catalysed transesterification to convert the triglycerides. Acid catalysts can be used for the transesterification of oils to alkyl esters, but they are much slower than alkali catalysts. [7]

1.3 Use of Catalyst in Transesterification

These are broadly divided into two types:

(a) Base catalyst
It is basically used for vegetable containing free fatty acid not more than 2%. KOH and NaOH are preferred as base catalyst. due to less cost.

(b) Acid catalyst
It is basically used for vegetable containing free fatty acid more than 2%. Sulfuric acid is preferred as acid catalyst. This procedure is carried out if the free fatty acid of the substrate is high. The conversion of free fatty acid to alcohol esters is relatively fast. Acid catalyst process needs excess alcohol and large amount of catalyst. Commonly used acid catalysts are Sulfuric acid and Phosphoric acid. Soap formed during this process is removed and the remaining oil is ready for base catalysis. Some oil is lost during this process. Acid catalyst can be used for direct esterification. Reaction is carried out for one and a half hour and allowed to settle for 24 hr.

1.4 Dual fuel diesel Engine

Conventional internal combustion engines operate on a mono fuel either liquid or gaseous. However, biogas run dual fuel diesel engines operate on both liquid and gaseous fuel simultaneously. Because the temperature attained at the end of the compression stroke inside the combustion chamber of CI engines is around 553 K. However, the auto ignition temperature of biogas is around 1087 K [8]. Therefore, simply compressing the biogas air mixture will not ignite the charge. Hence, a small amount of liquid fuel must be supplied which initially ignites and acts as an ignition source for biogas. The liquid fuel used is called the Pilot fuel. The gaseous fuel i.e. biogas. It is seen that in a dual fuel engine, the combustion starts in the same fashion to that of a CI engine. However, in the later part of combustion, the flame propagates in a manner similar to that of an SI engine. It is possible to achieve a substitution of diesel up to 85% by using biogas [9][11][14][18].

1.5 Primary fuel and its importance

The gaseous fuel that is use in dual fuel engine is called primary fuel. Biogas is called the primary fuel on which the engine mainly runs. Biogas run dual fuel diesel engines can be a panacea to the problem of acute power shortage particularly in rural areas in India. As is known to all, conventional diesel engine owns the benefit of much higher thermal efficiency than SI engine at the expense of high NOx and soot emissions. Hence, the utilization of biomass fuel in CI engines will improve the emissions and maintain high efficiency, which will promote the application of biomass fuel [10]. Moreover, gaseous fuels are considered good for internal combustion engines, because of their good mixing characteristics with air. The high self-ignition temperature enables them to operate with lean mixtures and higher compression ratios, resulting in an improvement in the thermal efficiency and reduction in emissions. Biogas is a good renewable gaseous fuel, and is produced by the anaerobic digestion of cow dung, non-edible seed cakes, animal waste, food waste, agricultural waste, municipal waste, sewage sludge etc[13].

1.6 Pilot fuel and its importance

The liquid fuel use in dual fuel engine is called pilot fuel. The blend of biodiesel- diesel –ethanol is called pilot fuel for dual fuel engine. The pilot fuel has a tremendous influence on the dual fuel combustion as it elicits the combustion process.[19] The combustion process of a biogas run dual fuel diesel engine is more complex than single fuel combustion. Prior to ignition of pilot fuel, the biogas air mixture undergoes pre-ignition chemical reaction during the relatively longer compression stroke.[15] The pre-ignition reaction results in the formation of active radicals and partial combustion products that are believed to affect the ignition of the injected pilot fuel. cottonseed oil is the under-utilized non edible vegetable oil which is available in large quantity in rice cultivating countries and very little research has been done to utilize this oil as a replacement for mineral diesel. The direct injection of cotton seed oil cannot be done because of their high viscosity. So there is to reduce the viscosity of the cotton seed oil the transesterification is to be needed. First of all FFA content is calculated to know that which type of the catalyst is used either alkali or acid. After that optimum molar ratio methanol to oil is to be calculated [16].

1.7 Advantages of dual fuel engine

- No major modification of engine needed.
- Operation on diesel fuel alone is possible when biogas is not available.
- Any contribution of biogas from 0% to 85% can substitute a corresponding part of diesel fuel while performance remains as in 100% diesel fuel operation.

Because of existence of a governor at most diesel engines automatic control of speed/power can be done by changing the amount of diesel fuel injection while the biogas flow remains uncontrolled. Diesel fuel substitutions by biogas are less substantial in this case [17].

2. MATERIALS AND METHODS

2.1. Materials

Following materials are used:

1. Refined soya bean oil
2. Methanol (methyl alcohol)
3. Sodium hydroxide (NaOH) as catalyst
4. Ethanol (oxygenated fuel)

Refined soya bean oil purchase from local general store in Patiala. Methanol sodium hydroxide (NaOH) and ethanol were purchase from pooja science lab, Patiala, Punjab. The commercial diesel fuel was purchased from the nearer petrol pump.

2.2 Methodology to be adopted

1. Production of biodiesel.
2. Making the D80-B10-E10 and D60-B20-E20 blends.
3. Compare the properties of pure biodiesel and the blended biodiesel with pure diesel

2.3 Apparatus for Biodiesel properties

Properties	Apparatus used
Density(kg/Lt)	Weighing balance
Kinematic viscosity(mm^2/sec)	Redwood viscometer
Flash point and fire point(^oC)	closed cup flash and fire point apparatus
Ash content (%)	Muffle furnace
Cloud point and pour point(^oC)	Cloud and pour point apparatus
Carbon residue (%)	Carbon residue apparatus
Calorific value(kJ/kg or MJ/kg)	Bomb calorimeter

2.4 Density

Bio-diesel is slightly heavier than conventional diesel fuel and ethanol (specific gravity 0.88 compared to 0.84 for diesel fuel). This allows use of splash blending by adding bio-diesel on top of diesel fuel and ethanol for making bio-diesel blends.

Table- Density of diesel, biodiesel and Blends

Pure oil and Blends	Density (kg/Lt)
Diesel	815
Biodiesel	816

D60-B20-E20	820
D80-B10-E10	822

2.5 Viscosity of Biodiesel

It is an important property of a diesel. Improper viscosity leads to poor combustion, which results in loss of power and excessive exhaust smoke.
Diesel fuels with extremely low viscosities may not provide sufficient lubrication for the closely fit pumps and Injector plungers.
Limits and method: kinematic viscosity is measured according to ASTM D-445 where it is limited to 1.9-6.0 mm^2s^{-1}
Table- viscosity of diesel, biodiesel and Blends

Pure oil and Blends	Viscosity (mm^2sec^{-1})
Diesel	5.16
Biodiesel	2.5
D60-B20-E20	3.3
D80-B10-E10	3.26

2.6 Cloud and pour point
Cloud point is defined as the temperature at which a cloud or haze of wax crystal appears at the bottom of a test jar when chilled under prescribed conditions.
Pour point is defined as the temperature at which the fuel ceases to flow. Both properties may indicate the tendency towards flow problems in the fuel line.

Table- cloud and pour point of diesel, biodiesel and Blends

Pure oil and Blends	Cloud point (^0C)	Pour point (^0C)
diesel	3	2
Biodiesel	6	1
D60-B20-E20	5.5	0.5
D80-B10-E10	5.1	0.1

2.7 Flash and fire point
Flash point is defined as the lowest temperature at which the fuel gives off sufficient vapours and ignites for a moment. Fire point is an extension of flash point in a way that it reflects the condition at which vapour burns continuously for five seconds. Fire point is always higher than flash point by 5 to 8^0C.
Table-Flash and Fire point of diesel, biodiesel and Blends

Pure oil and Blends	Flash point(^oC)	Fire point(^oC)
diesel	65	70
Biodiesel	155	160
D60-B20-E20	82	87
D80-B10-E10	73	78

2.8 Calorific Value
Calorific value of a fuel is an important measure since it is the heat produced by the fuel within the engine that enables the engine to do the useful work.
Table- calorific value of diesel, biodiesel and Blends

Pure oil and Blends	**DIESEL**	**Biodiesel**	**D60-B20-E20**	**D80-B10-E10**

Calorific value (MJ/kg)	42.85MJ/Kg	39MJ/Kg	39.45MJ/Kg	41.15MJ/Kg

3. CONCLUSION

- The results indicated that the blend of cotton seed biodiesel D60-B20-E20 had less calorific value than D80-B10-E10 and blend D80-B10-E10 had the calorific value 4.13% less than calorific value of diesel.
- The cloud point ,flash point pour point and fire point temperature of blend D60-B20-E20 were more than the blend of D80-B10-E10
- The viscosity of D80-B10-E10 was 58.28% less than diesel but more than blend D60-B20-E20.

In the end of study it was found that Blend D80-B10-E10 was best blend as compare to blend D60-B20-E20 for compression ignition engine at the place of pure diesel.

4. REFERENCE

[1] Liu Yao, Effects of diesel injection pressure on the performance and emissions of a HD common-rail diesel engine fueled with diesel/methanol dual fuel, 2015, Fuel 140, pp 192-200.

[2] Chandra, R, Vijay V.K, Subbarao P.M.V, Khura T.K, Production of methane from anaerobic digestion of Jatropha and Pongamia oil cakes,2012, Apply, Energy 93, pp 148-159.

[3] Amandeep Singh, Dr. Gurpreet Singh Sidhu, Dr. S.K. Mahla Study of Combustion Performance and Emission Characteristics of C.I Diesel Engine Fueled With Biogas and Rice Bran Oil Biodiesel in Dual Fuel Mode, December 2016.

[4] Amandeep Singh, Dr. Gurpreet Singh Sidhu, Dr. S.K. Mahla Study of Combustion Performance and Emission Characteristics of C.I Diesel Engine Fueled With Biogas and Rice Bran Oil Biodiesel in Dual Fuel Mode, December 2016.

[5] Chen, C.H, Cheung, C.S, Chan, T.L. Lee, S.C. Yao, C.D. Tsang, K.S, Comparison of emissions of a direct injection diesel engine operating on biodiesel with emulsified and fumigated methanol.2008, Fuel 87, pp 1870–1879.

[6] Ajav, E.A. Singh, Bhattacharya, T.K. Experimental study of some performance parameters of a constant speed stationary diesel engine using ethanol-diesel blends as fuel, 1999, Biomass Bioenergy 17, pp 357–365.

[7] Knothe, van Gerpen and Krahl, The Biodiesel Handbook, National Center for Agricultural Utilization Research Agricultural Research Service U.S. Department of Agriculture Peoria, Illinois, U.S.A , Department of Mechanical Engineering Iowa State University Ames, Iowa, U.S.A , University of Applied Sciences Coburg, Germany 2005.

[8] Mustafi, N.N, Raine, R.R. Verhelst, Combustion and emissions characteristics of a dual fuel engine operated on alternative gaseous fuels, 2013, pp 669-678.

[9] Lu, X.C, Yang, J.G, Zhang, W.G.; Huang, Z.: Effect of cetane number improver on heat release rate and emissions of high speed diesel engine fueled with ethanol–diesel blend fuel, 2004, Fuel 83, pp 2013-2020.

[10] Agarwal, A.K. Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines. J. Prog. Energy. Combus, 2007, Sci 33, pp 233–271.

[11] G.K. Prashant , D.B. Lata , P.C. Joshi, Investigations on the effect of methanol blend on the combustion parameters of dual fuel diesel engine, Applied Thermal Engineering 103, 2016, pp 187–194.

[12] Ying Wang, Hong Liu, Zhiyong Huang, Zhensheng Liu, stated on combustion and emission of a dimethyl ether-diesel dual fuel premixed charge compression ignition combustion engine with LPG (liquefied petroleum gas) as ignition inhibitor, Energy 96, 2016, pp 278-285

[13] Wang Pan, Chunde Yao, Guopeng Han, Hongyuan Wei, Quangang Wang, The impact of intake air temperature on performance and exhaust Emissions of a diesel methanol dual fuel engine, Fuel 162 , 2015, pp 101–110.

[14] Bhaskor J. Bora, Ujjwal K. Saha, Comparative assessment of a biogas run dual fuel diesel engine with rice bran oil methyl ester, pongamia oil methyl ester and palm oil methyl ester as pilot fuels, Renewable Energy 81, 2015, pp 490-498.

[15] B.J. Bora, U.K. Saha, Comparative assessment of a biogas run dual fuel diesel engine with rice bran oil methyl ester, pongamia oil methyl ester and palm oil methyl ester as pilot fuels, Renewable Energy 81, 2015, pp 490-498.

[16] Jindal M, Rosha P, Mahla S.K, Dhir A, Experimental investigation of performance and emissions characteristics of waste cooking oil biodiesel and ethanol blends in a compression ignition engine, 2015, pp 33863-33868.

[17] Debabrata Barik, S. Murugan, Investigation on combustion performance and emission characteristics of a DI (direct injection) diesel engine fuelled with biogas and diesel in dual fuel mode, Energy 72, 2014, pp 760-771.

[18] V. Gnanamoorthi, G. Devaradjane, Effect of compression ratio on the performance, combustion and emission of DI diesel engine fuelled with ethanol Diesel blend, Journal of the Energy Institute, 2014, pp 1-8.

[19] Hariram Venkatesan, Harshavardhann, Performance and Emission analysis of Compression Ignition engine in Dual fuel mode using Rice bran biodiesel and LPG, Volume-03, Issue-02,2014, pp-184-190.