International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

Comparative performance analysis of diesel and waste cooking oil (WCO) biodiesel on single cylinder engine

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Abstract – *Biodiesel has become more attractive recently because it is made from renewable resources as well as it achieved desired emission standards. Waste cooking oil (WCO) disposal is also a problem because it cannot reuse for cooking, which causes undesirable affect on human health. The processing cost of biodiesel is the main issue to commercialization of the product. The production of biodiesel from waste vegetable oil offers significant benefits on economic aspect, environmental aspect and waste management of cooking oil. From an economic point of view; the production of biodiesel is very easy and simplified process. The study focuses on comparison performance parameters of diesel and waste vegetable biodiesel on single cylinder engine.*

Key Words: Biodiesel , Waste vegetable cooking oil , Transesterification process.

1. Introduction

Significant rapid growth of population and the change in life style causes high consumption rate of energy sources. This increase of energy demand has been supplied by the use of fossil resources, which caused the crises of the fossil fuel depletion, the increase in its price rate day by day and the serious environmental impacts as global warming, acidification, deforestation, ozone depletion and photochemical smog and many others hazardous impact on environment. As fossil fuels are limited sources of energy, this increasing demand for energy has led to a search for alternative sources of energy that would be economically efficient, socially equitable, and environmentally. Two of the main contributors of this increase of energy demand have been the transportation and the basic industry sectors, being the largest energy consumers. The transport sector is a major consumer of petroleum fuels such as diesel, gasoline, liquefied petroleum gas (LPG) and compressed natural gas (CNG).The demand for transport fuel has been increasing and expectations are that this trend will stay unchanged for the coming decades. Worldwide increasing number of vehicles and a rising demand of emerging economies, demand will probably rise even harder. The expected scarcity of petroleum supplies and the negative environmental consequences of fossil fuels have spurred the search for renewable transportation biofuels.

Biodiesel is environmental friendly fuel compared to diesel fuel which is obtained from petroleum processing. Biodiesel is mono alkyl ester of long chain fatty acid derived from renewable lipid feedstock such as vegetable or animal fats. It is made from nontoxic, biodegradable resources such as new and used vegetable oil and animal fats. Fats and oil are chemically reacted with alcohol to produce chemical compound called fatty acids (Biodiesel).The byproduct glycerol is also important product extensively used in pharmaceutical, soap and cosmetic industry and many others. However the cost of Biodiesel is very important component for its commercialization. The used vegetable oils can be the potential raw materials. Biodiesel can be used directly or mixed with petroleum based diesel. India ranks high among the oil seed producing countries in the world with largest number of commercial varieties like rape seed, soya bean, cotton seed, pomgamia, palm, and jatropha etc. It is non petroleum based fuel that means it is not made with fossil fuels like oil or coal.

The term "waste vegetable oil" (WVO) refers to vegetable oil which has been used in food production and which is no longer viable for its intended use. Waste vegetable oil arises from many different sources, including domestic, commercial and industrial. Waste vegetable oil is a potentially problematic waste stream which requires to be properly managed. The disposal of waste vegetable oil can be problematic when disposed, incorrectly, down kitchen sinks, where it can quickly cause blockages of sewer pipes when the oil solidifies. Properties of degraded used frying oil after it gets into sewage system are conductive to corrosion of metal and concrete elements. It also affects installations in waste water treatment plants. Thus, it adds to the cost of treating effluent or pollutes waterways. Waste vegetable cooking oil cannot be reuse or properly disposal. This waste vegetable oil can be used for biodiesel preparation raw material. This is one of the important energy resources.

All cars that uses conventional petroleum diesel can be Biodiesel cars. It doesn't matter what the capacity of engine is or how old the car is, if it run on petrol diesel it will have no problem running on Biodiesel. It works great in pick-up trucks, big rig trucks, buses as well as diesel electric hybrids. Some vehicle manufacturers approve the use of B100 but most only approve B5 up to the B20. If crude oil doesn't run out soon it might still take a couple of years for all vehicles approve the use of 100% Biodiesel. One of the Advantages of biodiesel is that it cleans fuel tank and engine. Biodiesel has solvent like properties that will breakdown and remove all the carbon build up inside your engine. This build up is formed by using conventional petroleum diesel. We use waste vegetable oil as feedstock for making Biodiesel.

Lapuerta, Magun shows that the biodiesel is a powerful tool for reducing CO_2 emissions from transportation, which is considered responsible for 23% of greenhouse emissions. 1937 was a landmark year in the history of Biodiesel. In this year a Patent was granted to *G. Chavanne* from the University of Brussels for the: "Procedure for the transformation of vegetable oils for their uses as fuels". The patent describes the process of alcoholysis (also called transesterification) of vegetable oils using ethanol in order to separate the fatty acids from the glycerol [1].

N.N.A.N. Yusuf, et al. found that vegetable oil can be mixed with diesel fuel and used directly for running an engine. The successful experimental blending of vegetable oil with diesel fuel has been done by various researchers. A diesel fleet was powered with a blend of 95% filtered used cooking oil and 5% diesel in 1982. In 1980, Caterpillar Brazil Company used Pre-combustion chamber engines with a mixture of 10% vegetable oil to maintain total power without any medications to the engine. A blend of 20% oil and 80% diesel was found to be successful. The direct use of vegetable oils and/or the use of oil blends have generally been considered to be unsatisfactory and impractical for both direct and indirect diesel engines. The high viscosity, acid composition, free fatty acid content, gum formation due to oxidation, polymerization during storage and combustion, carbon deposits and lubricating-oil thickening are the obvious problems. The use of 100% vegetable oil is also possible with some minor medication to the fuel system [2].

2. BIODIESEL PREPAARATION FROM WCO

The feedstock coming from waste vegetable oils or commonly known as waste cooking oils is one of the alternative sources among other oils. Waste cooking oil is easy to collect from other industries such as domestic usage and restaurant and also cheaper than other oils. Hence, by using these oils as the raw material, we can reduce the cost in biodiesel production. The advantages of using waste cooking oils to produce biodiesel are the low cost and prevention of environment pollution. These oils, need to be treat before dispose to the environment to prevent pollution. Due to the high cost of disposal, many individuals dispose waste cooking oils directly to the environment especially in rural area. Use of waste cooking oils is an effective way to reduce the cost of biodiesel production.

There are normally four methods for production of biodiesel which converts free fatty acids of vegetable oil (triglycerides) into biodiesel. The problems with substituting triglycerides for diesel fuels are mostly associated with their (i)high viscosity; (ii) low stability against oxidation (and the subsequent polymerization reactions); and (iii) low volatility, which influences the formation of a relatively high amount of ash due to incomplete combustion. Here for preparation of biodiesel transesterification process is used.

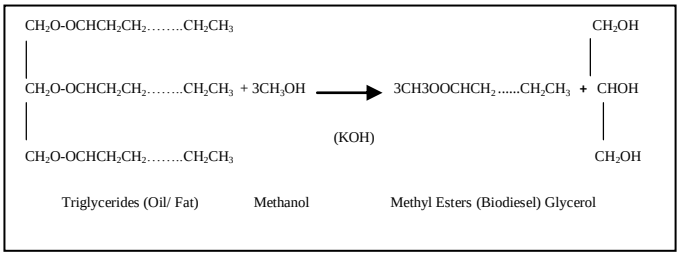


Fig -1 Chemical Reaction for transesterfication process

Biodiesel is made through transesterification between triglyceride and alcohol

Table -1: Comparisons between Biodiesel from WCO and SVO

Sr. No.	Properties	Biodiesel From WCO	Biodiesel From SVO
1.	Flash Point (°C)	144	212
2.	Fire Point (°C)	157	221
3.	pH	6.41	3-4
4.	Cloud Point (°C)	-2	3
5.	Pour Point (°C)	Below -5	11
6.	Density (gm/cc)	0.8832	0.9
7.	Cetane Number	46	49
8.	Calorific Value (Kcal/kg)	8949	
9.	Viscosity (cSt)	7.9	36.4

After preparation of biodiesel it is mixed with diesel fuel with some proportion. We cannot use 100% biodiesel in an engine because of some problem, one of them is viscosity. From table it is seen that the viscosity of

biodiesel from waste cooking oil is 7.9 cSt which is greater than petroleum diesel. It affect on fuel injection system of diesel engine. So that biodiesel is mixed with diesel with definite proportion and proper homogenous mixture is prepared. This prepared mixture is called blending of biodiesel

Table -2: Properties of blends

Blend	Specific Gravity	Calorific Value (KJ/Kg)	Flash Point (° C)	Viscosity (mm^2/s)	Cetane No	Cloud Point (° C)
B5	0.8645	42590	60	4.19	44	-15
B10	0.8655	42580	45	4.21	41	-12
B20	0.8665	42192	40	4.28	39	-15
B50	0.8675	39953	40	4.42	36	-18

From above table it is seen that specific gravity of blends increases with percentage of biodiesel increases. Also by observing calorific value is a decrease with percentage of biodiesel increases. As percentage of biodiesel increases in blends viscosity of blend is increases

2. PERFOMANCE ANALYSIS

For measuring performance of WCO biodiesel and diesel trial conducted on single cylinder engine. The specification details of an engine are below.

Table -3: Engine Specification

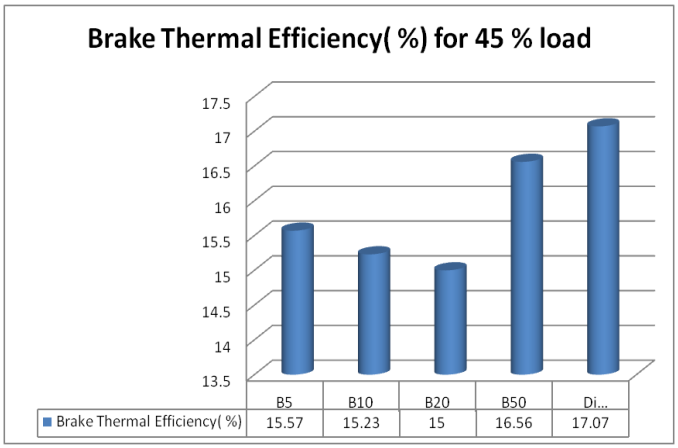
Type	Single Cylinder Water Cooled Four Stroke Diesel Engine
Bore	85mm
Stroke	110mm
Power And Speed	3.75KW,850 rpm
Cubic Capacity	1432 CC
Compression Ratio	25:1
Fuel	Diesel

Engine performance is an indication of the degree of success of the engine performs its Assigned task, i.e. the conversion of the chemical energy contained in the fuel into the Useful mechanical work. The performance of an engine is evaluated on the basis of the Following.

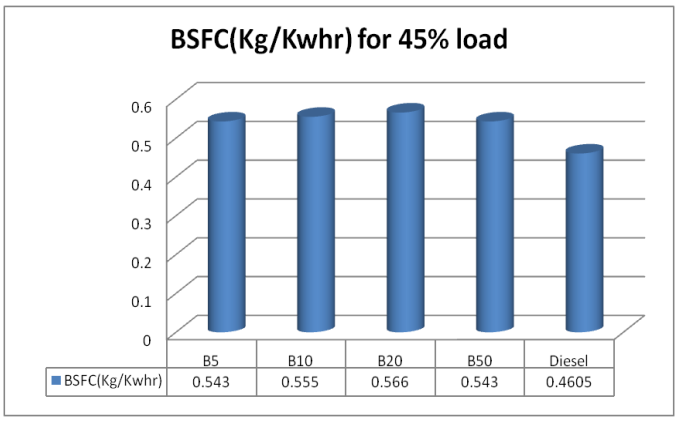
1. Fuel consumption
2. Heat supplied
3. Brake power
4. Brake thermal efficiency
5. Brake specific fuel consumption
6. Heat balance sheet

These are the performance parameter used for comparison of WCO biodiesel and diesel.

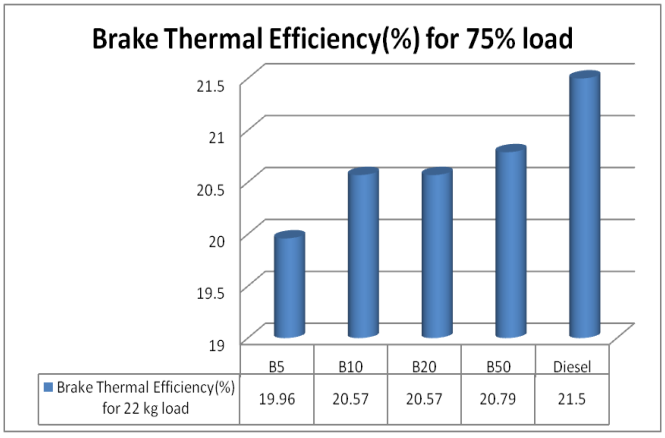
Trial is conducted for variable load and constant speed condition for different blends. Variable load changed from no load condition to 75% of rated load of an engine. With the help of graphs we can compare the performance of biodiesel. Some important parameters only used for analysis purpose.



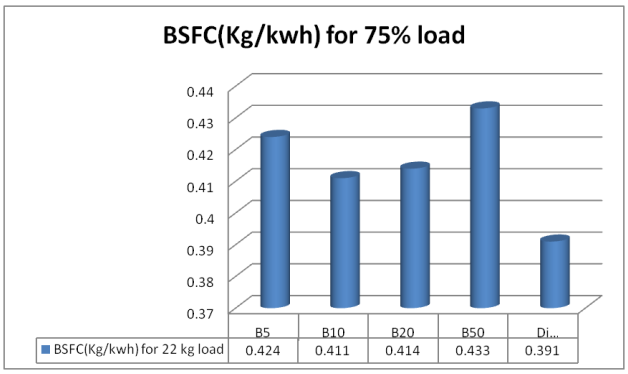
Graph -1 Break thermal efficiency for 45% rated load



Graph -2 BSFC (Kg/Kw hr) for 45% rated load



Graph- 3 Break thermal efficiency (%) for 75% load
Graph- 4 BSFC (Kg/Kw hr) for 75% load



3. CONCLUSIONS

As biodiesels have similar properties at some extent with petroleum diesel, we can produce biodiesel from various conventional and non conventional feeds stocks to reduce the deficiency of petroleum diesel. Import of petroleum diesel can be reduced. If proper attention is given to the production of biodiesel then biodiesel will be made available to people in very cheap price than petroleum diesel. We can reduce the pollution with using biodiesel in vehicles and also industrial purpose. The biodiesel fuels have not been widely accepted in the market because they are more expensive than petroleum fuels. Biodiesel is an important new alternative transportation fuel. Biodiesel refers to the fuel produced from renewable sources that meets ASTM International D6751, the standard for biodiesel. By observing the result and graphs we can make some comments as follows:

1. B100 or higher blend levels such as B50 require special handling and may require equipment modifications. It can be produced from many vegetable oil or animal fat feed stocks.
2. There was increasing thermal efficiency of waste cotton seed oil biodiesel as compared to pure diesel because of complete combustion.
3. Brake power of B20 is nearly equal to diesel. Fuel consumption of B20 is nearly equal to diesel. Properties of the B20 are nearer to the diesel fuel.
4. Thus the above integration suggests that B20 is optimum blend which can produce better values with pure diesel for diesel engine as far as performances were considered.

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BIOGRAPHIES

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