International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 6 (2018) pp. 295-298

Bio-Diesel- An alternate source of future

Ashok Kumar
[1]*Department of Mechanical Engineering, KIET Group of Institutions, Ghaziabad, India*

Ajay Tyagi
Department of Mechanical Engineering, KIET Group of Institutions, Ghaziabad, India

Vineet Kumar Vashishtha
Department of Mechanical Engineering, KIET Group of Institutions, Ghaziabad, India

Abstract

The world consumption of fossil fuels is increasing rapidly and it affects the environment by green house gases causing health hazards. Biodiesel is emerging as an important promising alternative energy resource which can be used to reduce or even replace the usage of petroleum. Since is mainly derived from vegetable oil or animal fats can be produce for large scale by local farmers offering a great choice. However the extensive utilization of the bio-fuels can lead to shortages in the food chain. This paper analyzed the sunflower methyl ester (SFME) and its blends as an alternate source of fuel for diesel engines.

Biodiesel was prepared from sunflower oil in laboratory in a by base transesterification. A 4 cylinde**r** Kirloskar TV1 diesel engine was used to perform the tests on various blends of sunflower biodiesel. The emissions of CO, HC were lower than diesel fuel for all blends tested. The NOx emissions were higher due to the high volatility and high viscosity of biodiesel.

***Keywords*:** NOx emission, VCR, Sunflower Bio-diesel, vegetable oil, animal fats.

1. INTRODUCTION

In the past the use of petroleum has led to atmospheric pollution and the global warming. The increase in human population worldwide and industrialization led to depletion of fossil fuel. Gasoline and diesel-driven automobiles are the principal sources of greenhouse gas (GHG) emissions today. Replacing the fossil fuels with bio-fuels seems to be a viable option because of the scarcity of petroleum reserves and continuously increasing stronger emission regulations. However the fossil fuel cannot be replace in totality especially in transport and power generation because these represent the backbone for the economic growth in a country. Biodiesel can be produced from various feedstock's (vegetable oils: soyabean, sunflower oil, rapeseed/canola, palm, cottonseed, coconut,peanut, pongamia, karanja, neem; animal fats: usually tallow; or waste oil such as frying oils from food industry). Due to their high viscosity and density these oils cannot be used in the engines until the glycerol component is removed by a reaction of transesterification . The thermo-physical properties considered important to bio-fuels are density, viscosity, calorific value, cetane number, flash points, cloud and pour points. Also in several researches has been reported the properties of bio-fuels depends even by the chemical composition and fatty acid contents.

1.1 Bio-Fuels

The biofuels are produced from biomass. The biofuels may be in solid (vegetables wastes, and a fraction of the urban and industrial wastes) liquid (bioalcohols and biodiesel) or gaseous (biogas and hydrogen) form.

The first generation biofuels are produced from cereal crops (e.g. wheat, maize), oil crops (e.g. rape, palm oil) and sugar crops. Biodiesel is a first generation biofuel. Other first generation biofuels are bioethanol, biogas and straight vegetable oils.

Second generation biofuels are produced from lignocellulosic materials. The syngas produced by gasification of biomass is used as precursor of second generation biofuels like Biomass to liquid (BTL), Bio Dimethylether / Methanol, Bio_Synthetic Natural Gas and biohydrogen. Bio- oil, produced by pyrolysis of biomass, and cellulosic ethanol are also second generation biofuels.

1.2 Biodiesel

Biodiesel is an alternative fuel for diesel engines produced by chemically reacting a vegetable oil or animal fat with an alcohol. Alcohols are the most frequently used acyl acceptors, particularly methanol and, to a lesser extent, ethanol. Other alcohols can also be used, e.g., propanol, butanol, isopropanol, tert-butanol, branched alcohols and octanol but the cost is much higher. Regarding the choice between methanol and ethanol, the former is cheaper, more reactive and the fatty-acid methyl esters (FAME) produced are more volatile than fatty-acid ethyl esters (FAEE). However, ethanol is less toxic and is considered more renewable because it can be easily produced from renewable sources by fermentation. In contrast, methanol is currently mainly produced from non-renewable fossil sources, such as natural gas. Regarding their characteristics as fuels, FAME and FAEE show slight differences; for example, FAEE have slightly higher viscosities and slightly lower cloud and pour points than the corresponding FAME.6 The reaction requires a catalyst, usually a strong base, such as sodium or potassium hydroxide, and produces new chemical compounds called methyl esters. It is these esters that have come to be known as biodiesel.

1.3 Use of vegetable oils

The interest in the use of renewable fuel started with the direct use of vegetable oils as a substitute for diesel. Vegetable oils have become more attractive recently because of their environmental benefits and the fact that they are made from renewable resources. More than 100 years ago, Rudolph Diesel tested vegetable oil as the fuel for his engine.9 Vegetable oils have the potential to replace a fraction of the petroleum distillates and petroleum-based petrochemicals in the near future. However, their direct use in compression engines was restricted due to high viscosity which resulted in poor fuel atomization, incomplete combustion and carbon deposition on the injector and the valve seats causing serious engine fouling. Chemically speaking, vegetable oils and animal fats are triglyceride molecules in which three fatty acid groups are esters attached to one glycerol molecule.12 Fats and oils are primarily water-insoluble, hydrophobic substances in the plant and animal kingdoms that are made up of 1 mol of glycerol and three moles of fatty acids and are commonly referred to as triglycerides. More than 350 oil-bearing crops have been identified, of which only soybean, palm, sunflower, safflower, cottonseed, rapeseed, and peanut oils are considered potential alternative fuels for diesel engines.14,15 Dwivediet.al.12 reviewed Impact analysis of biodiesel on engine performance and concluded Bio-diesel scores very well as an alternate fuel of choice as it helps in decreasing dependence on fossil – fuels and also as it has almost no sulphur. Higher cetane of biodiesel as compared to petro diesel implies its much improved combustion profile in an internal combustion engine.

1.4 Sunflower oil

Botanical Name: Helianthus annuss.

Aroma: Sour in Taste, Agreeable Nutty Odour and Pale yellow In Colour.

Properties: Edible, used as cooking oil

The physical properties of sunflower seeds (Helianthus annus L.) were determined as a function of moisture content in the range of 10.06-27.06% dry basis. Composition of Regular Sunflower oil Sunflower oil contains predominantly linoleic (48– 7%), oleic (14–40%), palmitic (4– 9%) and stearitic (1–7%). There are several types of sunflower oils produced,such as high linoleic, high oleic and mid oleic. High linoleic sunflower oil typically has at least 69% linoleic acid.High oleic sunflower oil has atleast 82% oleic acid. The variation in the unsaturated fatty acids profile is strongly influenced by both genetics and climate. In the last decade, high stearic lines of sunflower oil have been developed in Spain to avoid the use of hydrogenated vegetable oils in the food industry. The conventional sunflower oil (highlinoleic) is used for home cooking oil and margarine and for industrial use (paint,etc). The high oleic sunflower oil is used for cosmetics, gasoline blend and other purposes. Sunflower oil also contains lecithin, tocopherols, carotenoids and waxes. Sunflower oil's properties are typical of vegetable triglyceride oil. It is lighting taste and appearance and has high vitamin E content. There fined oil is clear and slightly amber-coloured with a slightly fatty odour.

Table 1.1 Sunflower prices [USDA and Census Bureau,2010].

YEAR	SUNFLOWER SEED ($/cwt) (1cwt = 100 lb ≈ 45,36 kg)	SUNFLOWER OIL (cents/lb) (1lb≈0,4536 kg)
1990/91	10.80	23.67
1991/92	8.69	21.63
1992/93	9.74	25.37
1993/94	12.90	31.08
1994/95	10.70	28.10
1995/96	11.50	25.40
1996/97	11.70	22.64
1997/98	11.60	27.00
1998/99	10.60	20.10
1999/00	7.53	16.68
2000/01	6.89	15.89
2001/02	9.62	23.25
2002/03	12.10	33.11
2003/04	12.10	33.41
2004/05	13.70	43.71
2005/06	12.10	40.64
2006/07	14.50	58.03
2007/08	21.70	61.15
2008/09	21.80	50.24

2. PREPARATION OF BIODIESEL

Considerable efforts have been made to develop vegetable oil derivatives that approximate the properties and performance of hydrocarbon-based diesel fuels. 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.16 These can be changed in at least four ways, as follows. DIRECT USE AND BLENDING 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 modification to the engine. A blend of 20% oil and 80% diesel was found to be successful17. Pramanik18 found that a 50% blend of Jatropha oil can be used in diesel engines without any major operational difficulties but further study is required to determine the long-term durability of the engine. The direct use of vegetable oils and/or the use of oil blends have generally been considered to be unsatisfactory and impractical for

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 6 (2018) pp. 295-298

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.

3. FUEL BLEND PREPARATION

(1) D95 WCO5%: In this mixture of biodiesel and diesel we mix 5 percent of waste sunflower oil with 95 percent of diesel. The blended fuel is then used for carrying out further tests and analysis.

(2) D90 WCO10%: In this mixture of biodiesel and diesel we mix 10 percent of waste sunflower oil with 90 percent of diesel. The blended fuel is then used for carrying out further tests and analysis.

(3) D85 WCO15%: In this mixture of biodiesel and diesel we mix 15 percent of waste sunflower oil with 85 percent of diesel. The blended fuel is then used for carrying out further tests and analysis.

(4) D100: This refers to 100 percent diesel.

CR 14

B.P.(Brake Power)

LOAD	DIESEL	B5	B10	B15
0	0.03	0.04	0.04	0.04
3	1.06	0.84	0.86	0.84
6	1.72	1.65	1.74	1.65

I.P.(Indicated Power)

LOAD	DIESEL	B5	B10	B15
0	3.3	4.85	4.65	4.22
3	3.24	5.07	5.24	4.45
6	3.66	5.52	5.67	4.63

SFC (Specific fuel consumption)

LOAD	DIESEL	B5	B10	B15
0	11.85	7.16	6.77	7.3
3	0.48	0.54	0.47	0.55
6	0.35	0.34	0.32	0.37

B.T.E.(Brake Thermal Efficiency)

LOAD	DIESEL	B5	B10	B15
0	0.74	1.22	1.29	1.2
3	18.29	16.05	18.61	15.99
6	24.76	25.79	27.33	23.62

I.T.E.(Indicated Thermal Efficiency)

LOAD	DIESEL	B5	B10	B15
0	71.17	139.22	133.65	121.31
3	55.83	96.98	112.87	85.15
6	52.59	86.52	88.82	66.48

CR 16

B.P.(Brake Power)

LOAD	DIESEL	B5	B10	B15
0	0.03	0.04	0.04	0.04
3	1.06	0.84	0.86	0.84
6	1.72	1.68	1.74	1.65

I.P.(Indicated Power)

LOAD	DIESEL	B5	B10	B15
0	3.3	5.08	4.65	4.22
3	3.24	5.5	5.24	4.45
6	3.66	6.06	5.67	4.63

SFC (Specific fuel consumption)

LOAD	DIESEL	B5	B10	B15
0	11.85	58	.77	.3
3	0.48	54	.47	55
6	0.35	33	.32	37

B.T.E.(Brake Thermal Efficiency)

LOAD	DIESEL	B5	B10	B15
0	0.74	1.15	1.29	1.2
3	18.29	16.05	18.61	15.99
6	24.76	26.32	27.33	23.62

I.T.E.(Indicated Thermal Efficiency)

LOAD	DIESEL	B5	B10	B15
0	71.17	145.74	133.65	121.31
3	55.83	105.37	112.87	85.15
6	52.59	94.87	88.82	66.48

4. RESULTS AND DISCUSSIONS

1) Compared to diesel fuel, a little amount of power loss happened with vegetable oil fuel operations.
2) Particulate emissions of vegetable oil fuels were higher than that of diesel fuel, but on the other hand, NO_X emissions were less.

3) Vegetable oil methyl esters gave performance and emission characteristics closer to the diesel fuel. So, they seem to be more acceptable substitutes for diesel fuel.
4) Raw vegetable oils can be used as fuel in diesel engines with some modifications.
5) Before starting wide application, there are some improvements that should be done, such as Fuel systems should be optimized for vegetable oil operation.

5. CONCLUSION

The 4 cylinder diesel engine runs successfully during tests on biodiesel of sunflower oil and its blends. The blends were characterized for their various physical chemical properties. The EGT was found highest for pure biodiesel. The availability of extra oxygen enhanced the temperature of combustion resulting in higher temperature for all the blends tested. CO and HC emissions are highest for the diesel fuel and lower for the blends of SFME. The NO_X were found highest for pure SFME and its blends because of high volatility, low heat content and high viscosity compared with diesel fuel.

The experiments demonstrate that the methanol/oil ratio influences on the biodiesel production. The yield of biodiesel increases with the ethanol/oil ratio.

Regarding the influence of the amount of catalyst on biodiesel production in the studied conditions is not possible to achieve a definitive conclusion.

6. ACKNOWLEDGMENT

We thank our colleagues from KIET who provided insight and expertise that greatly assisted there search.

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