IOSR Journal of Applied Chemistry (IOSR-JAC)
ISSN: 2278-5736. Volume 2, Issue 4 (Sep. – Oct. 2012), PP 41-45
www.iosrjournals.org

Eco-friendly Biodiesel as an Alternative Fuel for Diesel-engine

Brajesh Kumar Mishra[1], Rajesh Kumar[2], Dr. Rajat Kumar[3]

[1](Research scholar of Singhania University, jhunjhunu Rajasthan, India)
[2] Department of Chemistry, HBTI Kanpur,India
[3] Department of chemistry DAV PG College Kanpur India,

Abstract: *Depleting reserves of fossil fuel and increasing effects of environment pollution from these fuels demands eco-friendly alternatives. Methyl esters of fatty acids or biodiesel have several outstanding advantages among other non-renewable and clean engine fuel alternatives and can be used in any diesel engine without any modification. It can be made from any biological sources such as vegetable oils and animal fats. Jatropha curcas is a renewable non-edible plant belonging to Euphorbiace family, zero waste perennial plant. Biodiesels offer a very promising alternative to diesel oil since they are renewable and have similar properties with fossil Diesel. The effect of use of biodiesel fuel on engine power, fuel consumption and thermal efficiency are collected and analyzed with that of conventional diesel fuel. In the subsequent section, the engine emissions from biodiesel and diesel fuels are compared, paying special attention to the most significant emissions such as nitric oxides and particulate matter. Fuel-related properties are reviewed and compared with those of conventional diesel fuel.*

Key words: *Biodiesel, diesel engine, emissions. methyl ester and vegetable oil,*

I. Introduction:

Harmful emissions reduction. When biodiesel displaces petroleum. It reduces levels of global warming gases such as CO_2. As plants like Jatroph carcus grow, they take CO_2 from the air during photosynthesis reaction. After the oil is extracted from j.carcus, it is refined into biodiesel and, when burned, produces CO_2 and other emissions, which are returned to the atmosphere. However, this cycle does not add to the CO_2 level in the air because the next j.carcus crop will reuse the CO_2 to grow [1]. Another important environmental factor is that biodiesel reduces tailpipe particulate matter (PM), HC and CO emissions.These benefits occur because biodiesel contains 11% oxygen (O_2) by weight. The presence of O_2 allows the fuel to burn more completely, resulting in fewer emissions from unburned fuel. This same principle also reduces air toxicity, which is associated with the unburned or partially burned HC and PM emissions. Testing has shown that PM, HC and CO reductions are independent of the vegetable oil used to make biodiesel. This has been confirmed by the EPA, which reviewed 80 biodiesel emission tests and concluded that the benefits are real and predictable over a wide range of biodiesel blends [2].

1.1. Human health: It is well-documented that many PM and HC emissions from petroleum diesel fuel combustion are toxic and suspected of causing cancer and other life-threatening diseases. Using biodiesel can eliminate a significant number of these toxic components. Biodiesels' positive impact on air toxicity is supported by numerous studies, including the Bureau of Mines Center for Diesel Research (BMCDR), The Department of Energy (DOE) and Southwest Research Institute (SRI). The National Biodiesel Board (NBD) also conducted Tier I and Tier II health effect studies under "The Clean Air Act" that also support these claims. Recently, the Department of Labor's Mining Safety Health Administration (MSHA) tested and approved using biodiesel in underground mining equipment where workers are exposed to high levels of diesel exhaust.

1.2. Low sulfur content: Currently, the sulfur specification for petroleum-based diesel fuel is less than 500 parts per million (ppm). However, by the end of 2006, all US highway diesel has to contain less than 15-ppm sulfur. Most biodiesel fuels being manufactured today contain less than 15-ppm sulfur and some have levels that are too low to measure.

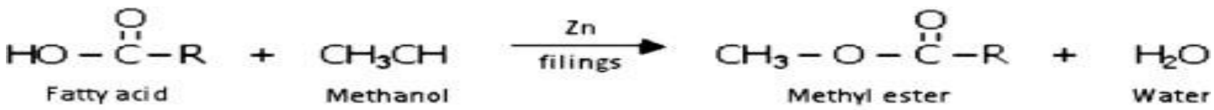
1.3. Improved lubricity: Engine manufacturers depend on good lubrication to keep moving parts, such as fuel pumps, from wearing prematurely. Biodiesel is approximately twice as viscous as petroleum diesel and therefore has better lubricating properties. This is an extremely important property when biodiesel is blended with ultra-low-sulfur diesel, which is known to be a poor lubricant. Even the lubrication properties of dry fuels such as kerosene can be improved by using 2% biodiesel.

II. Material and Method:

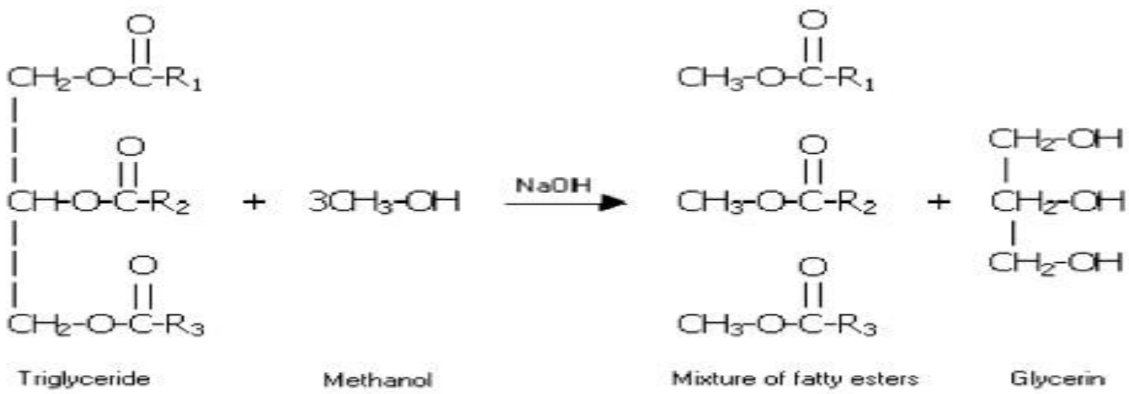
Vegetable oils are chemically complex esters of fatty acids. These are the fats naturally present in oil seeds, and known as triglycerides of fatty acids. The molecular weight of these triglycerides would be of order of 800 kg/m^3or more. Because of their high molecular weights these fats have high viscosity causing major problems in their use as fuels in CI engines. These molecules have to be split into simpler molecules so that they have viscosity and other properties comparable to standard diesel oils. Modifying the vegetable oils (to make them lighter) can be achieved in many ways, including; Pyrolysis, Micro emulsification, Dilution and Transesterification. Among these, transesterification is the most commonly used commercial process to produce clean and environmentally friendly light vegetable oil fuel i.e. biodiesel.

2.1 Transesterification

The fatty acid triglycerides themselves are esters of fatty acids and the chemical splitting up of the heavy molecules, giving rise to simpler esters, is known as Transesterification. The triglycerides are reacted with a suitable alcohol (Methyl, Ethyl, or others) in the presence of a catalyst under a controlled temperature for a given length of time. The final products are Alkyl esters and Glycerin. The Alkyl esters, having favorable properties as fuels for use in CI engines, are the main product and the Glycerin, is a by-product. The chemical reaction of the triglyceride with Methyl alcohol is shown below. With higher alcohols the chemical equation would change correspondingly [3-4]



(Reaction 1)



(Reaction 2)

Biodiesel (fatty acid methyl esters) production by: FFA esterification catalyzed by metallic Zn filings (Reaction 1); triglycerides (TGs) transesterification catalyzed by NaOH (Reaction 2).

Free fatty acid present in curcas oil firstly converted in methyl ester with methanol in the presence of Zn metal as a catalyst.

It can be seen from the above reaction that one mole of the heavy tri-glyceride and three moles of methyl alcohol yields one mole of Glycerol and three moles of lighter fatty methyl esters. Without the use of a catalyst the reactions would be very slow and also incomplete. A temperature of 60°C to 70°C would be needed for the reactions to become effective [5]. Also a vigorous agitation of the reactants would be needed and so a mechanized stirrer in the reaction vessel becomes necessary. Various catalysts can be used. The most common are the acid catalysts, like H2SO4 and the Alkalies, like NaOH or KOH. For trans-esterification any alcohol can be used. The most popular is Methyl Alcohol. Most of investigators and those who produce vegetable oil esters in bulk use only Methyl Alcohol.

Effect of biodiesel on emissions: Biodiesel mainly emits unburned hydrocarbons, carbon monoxide, oxides of nitrogen, sulphur oxides and particulates. A brief review has made of these pollutants emitted from biodiesel-fuelled engines.

2.2. Unburned hydrocarbon (UBHC)

Most researchers' results show a sharp decrease in unburned hydrocarbon emissions when substituting conventional diesel fuel with biodiesel fuels [6-8]. The US Environmental Protection Agency (EPA) review [9] shows a 70% mean reduction with pure biodiesel with respect to conventional diesel as shown in Fig.1.
Most of the authors have attributed this to better combustion in biodiesel fuelled engines. Since biodiesel is an oxygenated fuel, it promotes combustion and results in the reduction of UBHC emissions. However, a few studies show no significant differences [10-11] or increases [12] in UBHC emissions when fuelling diesel engines with biodiesel instead of conventional diesel.

2.3. Carbon monoxide (CO)

Some researchers [8-9], found a decrease in CO emissions when substituting diesel fuel with biodiesel shown in Fig.2. Most of the authors have explained this to better combustion in biodiesel fuelled engine. Since biodiesel is an oxygenated fuel, it promotes combustion and results in reduction in CO emissions. Nevertheless, other authors found no differences between diesel and biodiesel [11], and even noticeable increases when using biodiesel [12].

2.4. Nitrogen oxides (NOx)

NOx is formed by chain reactions involving Nitrogen and Oxygen in the air. These reactions are highly temperature dependent. Since diesel engines always operate with excess air, NOx emissions are mainly a function of gas temperature and residence time. Most of the earlier investigations show that NOx emissions from biodiesel engines are generally higher than that in conventional diesel fueled engines. Also earlier investigations revealed that NOx emissions increase with an increase in the biodiesel content of diesel as shown in Fig. 3. They say this is due to higher combustion temperatures and longer combustion duration [9].
The investigation of Schumacher et al. [13] and Marshall et al. [14] report an increase in the biodiesel engine NOx emissions and concluded that diffusion burning was the controlling factor for the production of NOx. An almost equal number of investigations report a declining trend in the level of emissions of NOx e.g. Hamasaki et al. [12].

2.5. Smoke and particulates (PM)

It might be expected that biodiesel engines would produce less smoke and particulates than standard engines for reasons such as high gas temperatures and high temperatures of the combustion chamber wall. Although some authors have occasionally reported some increases in PM emissions when substituting diesel fuel with biodiesel [15-16], a noticeable decrease in PM emissions with the biodiesel content can be considered as an almost unanimous trend [6-7]. Earlier investigations show that PM emissions decreases with increases in biodiesel content in diesel as shown in Fig. 4. This may be due to more complete combustion and the presence of oxygen in the biodiesel and its blends.

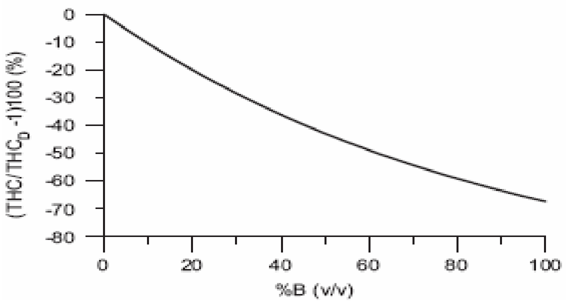


Figure 1. Mean reduction in Total Hydro Carbon (THC) emissions as the biodiesel content increases (trend obtained from Ref. [9] for heavy-duty engines with no EGR).

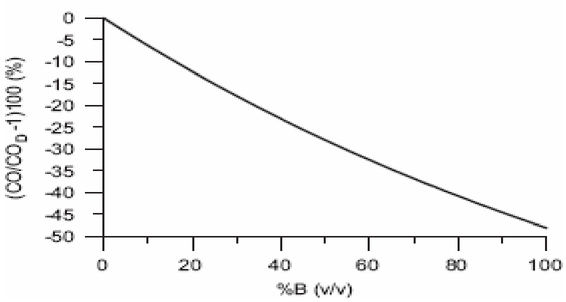


Figure 2. Mean reduction in CO emissions as the biodiesel content increases (trend obtained from Ref. [9] for heavy-duty engines with no EGR).

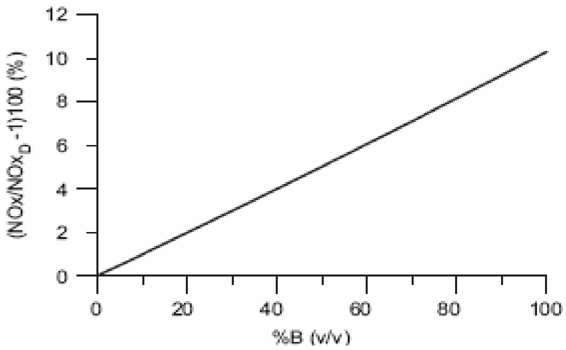


Figure 3. Mean reduction in NOx emissions as the biodiesel content increases (trend obtained from Ref. [9] for heavy-duty engines with no EGR).

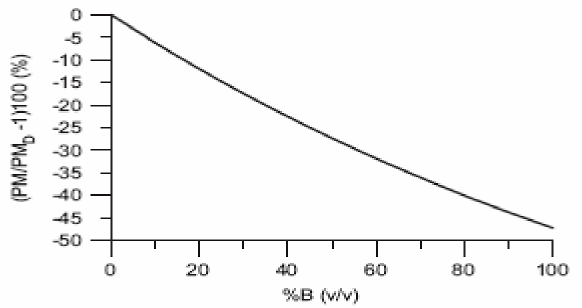


Figure 4. Mean reduction in particulate matter (PM) emissions as the biodiesel content increases (trend obtained from Ref. [9] for heavy-duty engines with no EGR).

III. Result and discussion:

Biodiesel, derived from vegetable oil or animal fats, is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is a renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable.The use of biodiesel has grown dramatically during the last few years. Feedstock costs account for a large percent of the direct biodiesel production costs, including capital cost and return. The amount of FFA was reduced from 93 wt % to less than2 wt % at the end of the esterification process. The FAME was pureed by neutralization with 0.1 M sodium hydroxide in water solution at a reaction temperature of 62 °C. Condition parameters for esterification process for methanolysis of rapeseed oil were 1.8 % H_2SO_4 as catalyst, MeOH/oil of molar ratio 2: 0.1 and reaction temperature 62°C, for a period of 3h. The yield of methyl ester was > 90 % in1 h. Biodiesel has a viscosity much closer to diesel fuel than vegetable oil.The cost of biodiesel is higher than diesel fuel.

Biodiesel increase the emission of NOx which can be controlled by using suitable additives like DTBP. Anti-oxidants such as butylated hydroxy toluene have also been shown to reduce NOx Emissions [17].Use of biodiesel will reduse emission of GHG and SOx which responsible for global warming and acid rain.

Biodiesel have low contents of aromatics and and high cetane number which decrease the burning period and burning retention so it prevent more particle producing.

In general as discussed, biodiesel has some benefits such as:

- Cheaper fuel for consumers,
- More energy security & diversified sources,
- Higher farm incomes & rural employment,
- Significant carbon emission reduction,
- Lower Imports & energy prices.

IV. Conclusion:

The problems with substituting vegetable oil for diesel fuels are mostly associated with their high viscosities, and low volatilities. The viscosity of vegetable oils can be reduced by transesterification. Transesterification is the most common method and leads to mono alkyl esters of vegetable oils and fats, known as bio-diesel. The production of biodiesel from vegetable oil is very simple. In the production of biodiesel it is observed that the base catalyst performs better than acid catalysts and enzymes. The biodiesel and their blends have similar fuel properties as that of diesel. It is also observed that biodiesel has similar combustion characteristics as diesel. Biodiesel engines offer acceptable engine performance compared to conventional diesel fueled engines.

The main advantage in biodiesel usage is attributed to lesser exhaust emissions in terms of carbon monoxide, hydrocarbons and particulate matter. Biodiesel is said to be carbon neutral as more carbon dioxide is absorbed by the biodiesel yielding plants than what is added to the atmosphere when [burnt] used as fuel. Even though biodiesel engines emits more NOx, these emissions can be controlled by adopting certain strategies such as the addition of cetane improvers, retardation of injection timing, exhaust gas recirculation, etc.

According to estimates by the World Resource Institute, the transport sectorcontributes about 14% to total global GHG emissions. Within this sector, road transport comprises about 72%, air transport 11%, and marine transport 8% (WRI,2005). In view of this, it is especially important to concentrate on road travel.fuel economy and reduced emissions using biodiesel in CI engines are attainable, but more investigations under proper operating constraints with improved engine design are required to explore the full potential of biodiesel engines.

References:

[1] Ramadhas AS, Jayaraj S, Muraleedharan C, Use of vegetable oils as I.C. Engine fuel- A review, *Renewable Energy* 29 (2004) 727-742.

[2] Bari S, Yu CW, Lim TH, Performance deterioration and durability issues while running a diesel engine with crude palm oil, *Proc. Instn. Mech. Engrs Part-D, J. Automobile Engineering* 216 (2002) 785-792.

[3] L.C. mehar,V. S. S .Dharmagga,Optimimization of alkali catalized transesterification for production of biodiesel,vol 97 pp.1392-1397,2003

[4] Y.M .Choo and A.N. Ma, Production technology of methyl ester from rapeseed pp 165-68, 1996

[5] R.Brand , Greeting of policy integration and interlinkage network in renewable energy in ermany conference ,2004.

[6] Monyem A, Van Gerpen JH, The effect of biodiesel oxidation on engine performance and emissions, *Biomass Bioenergy* 20 (2001) 317-325.

[7] Staat F, Gateau P, The effects of rapeseed oil methyl ester on diesel engine performance, exhaust emissions and long term behaviour-a summary of three years of experimentation, *SAE paper* (1995) 950053.

[8] Pinto AC, Guarieiro LLN, Rezende MJC, Ribeiro NM, Torres EA, Lopes WA, de P Pereira PA , de Andrade JB, Biodiesel: an overview, *J Braz Chem Soc* 16/6B (2005) 1313–1330.

[9] Assessment and Standards Division (Office of Transportation and Air Quality of the US Environmental Protection Agency), *A comprehensive analysis of biodiesel impacts on exhaust emissions* (2002) EPA420-P-02-001.

[10] Labeckas G, Slavinskas S, The effect of rapeseed oil methyl ester on direct injection diesel engine performance and exhaust emissions. Energy Convers Manage 47 (2006) 1954–1967.

[11] Serdari A, Fragioudakis K, Teas C, Zannikos F, Stournas S, Lois E, Effect of biodiesel addition to diesel fuel on engine performance and emissions, *J Propul Power* 15/2 (1999) 224–231.

[12] Hamasaki K, Kinoshita E, Tajima H, Takasaki K, Morita D, Combustion characteristics of diesel engines with waste vegetable oil methyl ester, *In: The 5th international symposium on diagnostics and modeling of combustion in internal combustion engines* (2001) (COMODIA 2001).

[13] Schumacher LG, Borgelt SC, Hires WG, Fosseen D, Goetz W, *Fueling diesel engines with blends of methyl ester soybean oil and diesel fuel* (1994).

[14] Marshall W, Schumacher LG, Howell S, Engine exhaust emissions evaluation of a cummins L10E when fuelled with a biodiesel blend, *SAE paper* (1995) 952363.

[15] Munack A, Schroder O, Krahl J, Bunger J, Comparison of relevant gas emissions from biodiesel and fossil diesel fuel, *Agricultural Engineering International: the CIGR Journal of Scientific Research and Development* 3 (2001) manuscript EE 01 001.

[16] Alfuso S, Auriemma M, Police G, Prati MV, The effect of methyl ester of rapeseed oil on combustion and emissions of DI engines, *SAE paper* (1993) 932801.

[17] M.A. Hess, M. J. Haas, T. A. Foglia, W. N. Marmer, “Effect of anti-oxidant addition on NOx emissions from biodiesel”, Energy and Fuels, 19 (4), 1749 (2005)