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EXPERIMENTAL INVESTIGATION AND ENGINE PERFORMANCE ON BIO-DIESEL

Patel Nilam.P[1], Prof. Vivek.B.Patel[2]
[1]PG Scholar, [2]Assistant Professor, M.E Thermal Engg., LCIT, Bhandu.

ABSTRACT: In search of a suitable fuel alternative to fast depleting fossil fuel and oil reserves and in serious consideration of the environmental issues associated with the extensive use of fuels based on petrochemicals, research work is in progress worldwide. The three generations of biodiesel feed stocks described in this report are food crops, non-food crops, waste product from industries and microalgae-derived biodiesel. In this report first generation bio fuel (FGBF) are discussed along with its constraints and concerns. In second generation biofuel waste product of vegetable oil industry called as acid oil was selected as a candidate for research. Non edible mahua oil was also used as a SGBF candidate in the present study. The third generation bio fuel (TGBF), microalgae is the only source that can be sustainably developed in the future. Microalgae can be converted directly into energy, such as biodiesel, and therefore appear to be a promising source of renewable energy. Microalgae based biofuels have been discussed in literature review.

I. INTRODUCTION

What is the issue?

The challenge for the 21st century is to sustainably develop and maintain the quality of life for a growing population with higher expectations for well-being. Underlying this challenge is the need for sufficient and sustainable supplies of energy to provide the economic activity underpinning these expectations.

A. Fuel Crises

The world is presently confronted with the crises of fossil fuel depletion. According to the recent World Energy Outlook (IEA, 2007a), if governments around the world continue with current policies, the world's energy needs would be 55 % higher in 2030 than in 2005, with China and India accounting for much of this rising demand. Some 84 % of the increase in primary energy demand will have to come from fossil fuels [1]. Energy production and use, particularly of fossil fuels, have a number of environmental impacts including air pollution, greenhouse gas emissions and adverse impacts on ecosystems. Since the middle of the 19th century, the World Fuel Consumption (WFC) curve exhibits roughly exponential virtually permanent growth at a rate of about 2.3% per year, i.e., roughly doubling every 30 years (Figure 1-l). Total WFC in the middle of 19th century was as low as 550million tons, and by the late 20th century these values increase by a factor of 25. The Global Temperature Anomaly (dT) curve has the age-long linear trend increasing by +0.059°C every 10 years.By the end of 20th century, the global dT increased by 0.6-0.8°C compared to the early 20th century. The WFC and global dT dynamics have two key differences as follows:

1) The age-long increase in WFC is approximated by an exponent, while the age long
Increase in global dT exhibits a linear trend.

2) Unlike monotonously and exponentially increasing WFC, the dynamics of global dT with the background of a linear, age-long trend undergoes quasi-cyclic Fluctuations with a period about 60 years (Figure 1-1).

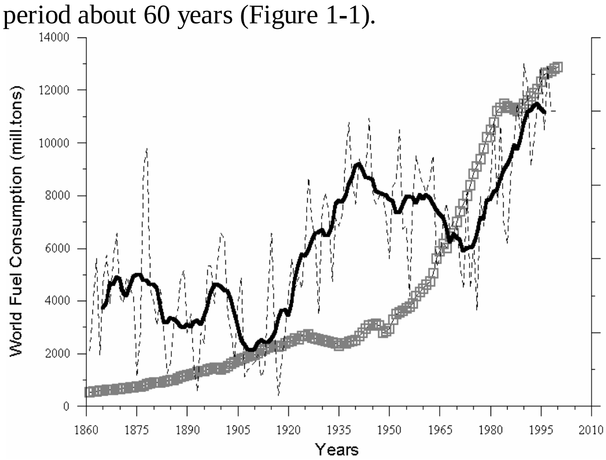

Figure 1-1: Comparative dynamics of the World Fuel Consumption (WFC) and Global Temperature Anomaly (dT) 1861-2000. Thin line - annual dT; Bold line -13-years smoothing; Dashed line - WFC (mill. tons of nominal fuel) [2].

There is, therefore, a demand to develop alternative fuels motivated by the reduction of the dependency on fossil fuel due to the limited resources. Several oxygenated fuels are known to have the potential for use as the alternative gasoline and diesel fuel.

B. Engine Emission

In the same IEA reference scenario, if no further action is taken to reduce the energy demand, energy-related CO2emissions will increase by 49 % by 2030 compared to 2005 levels and all regions will face higher energy pricesin the medium- to long-term.

In all over the world human being are using gasoline and diesel fuel in an automobile.Diesel exhaust include gaseous and particulate phase component. The gaseous phase consists of CO2, CO, NOx, unburned and partially hydrocarbon (HC), excess air and many other constituent. NOxemissions are of particular concern for diesel engine due to their relatively high contributions to emission inventories. NOxformation in the diesel engine where, due to high temperature and pressure occurring in the diesel engine cylinder, atmospheric nitrogen can be fixed at to yield NO as a major product. CO and THC emission from diesel engine stem from incomplete combustion [3]. The particulates phases consist of element carbon, organic carbon, trace metals and other inorganic components. Particulate matter is formed in the cylinder of the engine during the combustion process. Carbonaceous soot or element carbon is formed in the centre of the fuel spray where the air- fuel ratio is low.

C. Biodiesel processing from microalgae

Figure 1-3 shows a schematic of the production of biodiesel from microalgae. The first step is the selection of an appropriate species with the relevant properties for the specific culture conditions and products. The culture conditions, including light, temperature, pH, air (carbon dioxide) and nutrient concentration, must be considered. Microalgae can be harvested using microscreens, sedimentation, centrifugation, flocculation or membrane filtration. The harvested biomass is then dried under vacuum to release water until it reaches a constant weight. The dried biomass is pulverized with a mortar and pestle before the oil is extracted. After extraction, the oil is converted into biodiesel.

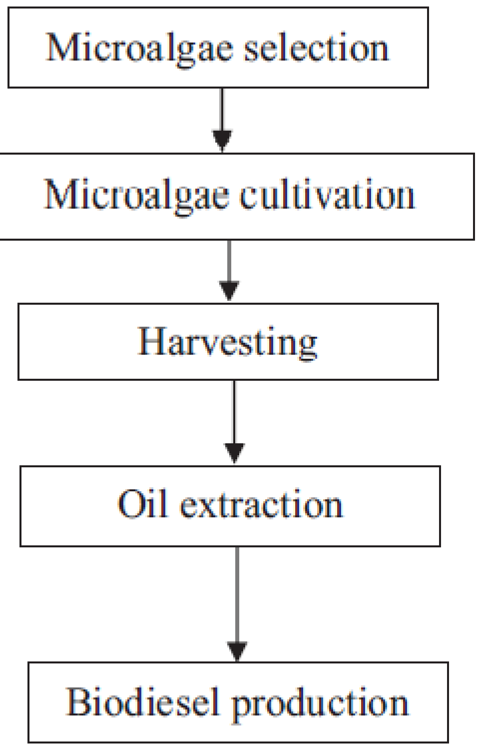

Figure 1-3: Production of Biodiesel from Microalgae

D. Advantage and Disadvantage of micro algae

Advantage of biodiesel from algae oil

- Enhanced efficiencies or reduction in cost. The costs associated with the harvesting and transportation of microalgae are relatively low compared to those of other biomass materials such as trees and crops. In addition, they do not directly affect the human food supply chain, eliminating the food versus fuel dispute.
- Microalgae do not compete for land with crops used for food production, fodder and other products. As above study, the cultivation of microalgae does not require a large area of land compared to other plant sources.
- Microalgae can be grown in a number of environments that are unsuitable for growing other crops, such as fresh, brackish or salt water or non-arable lands that are unsuitable for conventional agriculture. In addition, they can be grown on farms or in bioreactors. Because of this non selective growth, microalgae produce a superior yield per hectare with improved ecological performance.
- The most common microalgae have oil levels in the range of 20 to 50% by weight of dry biomass, but higher productivities can be reached. Microalgae commonly double their biomass within 24 h, but exponential growth rates can result in a doubling of their biomass in periods as short as 3.5 hour.
- Microalgae produce valuable co-products or by-products such as biopolymers, proteins, carbohydrates and residual biomass, which may be used as feed or fertilizer. In addition, cultivation of microalgae does not require herbicides or pesticides.
- Micro algae are considered to be an efficient biological system for harvesting solar energy to use in the production of organic compounds, and because of their small size, they can be easily chemically treated.
- Microalgae are capable of fixing carbon dioxide in the atmosphere, facilitating the reduction of atmospheric carbon dioxide levels, which are now considered a global problem. In addition, microalgae biomass production can affect the bio fixation of waste carbon dioxide, reducing emissions of a major greenhouse gas (1 kg of dry algal biomass requires about 1.8 kg of CO_2).
- Microalgae lipids are mostly neutral lipids due to their high degree of saturation, and their accumulation in the micro algae cell at different stages of growth (depending on the strain) makes micro algae lipids a potential diesel fuel substitute.

Disadvantage of micro algae

- Most of algal lipids have lower calorific value than diesel fuel.
- The cost of cultivation is higher compared to common crop oils currently.
- The concentration of bio mass is low.
- Algae based bio fuel cannot be transported by pipelines since it cannot flow well in low temperature.
- Precious work is required for harvesting and oil extraction from algae.

II. PREPARATION AND CHARACTERISATION

2.1 Preparation of Second generation biodiesel (SGBD):

"Biodiesel is defined as mono-alkyl ester of long chain fatty acid derived from vegetable oil or animal fats." In this report, Non edible Mahua oil and acid oil (waste product) from ground nut oil industry is used as a second generation bio fuel.

2.1.1 Esterification Process:

Esterification is the chemical process for making esters, which are compounds of the chemical structure R-COOR', where R and R' are either alkyl or aryl groups. The most common method for preparing esters is to heat a carboxylic acid, R-CO-OH, with an alcohol, R'-OH, while removing the water that is formed. A mineral acid catalyst is usually needed to make the reaction occuring at a useful rate.

$$\underset{FFA}{R\text{–}COOH} + \underset{Alcohol}{R'OH} \xleftrightarrow{Catalyst} \underset{Water}{H_2O} + \underset{Ester}{R\text{–}COO\text{–}R'}$$

2.1.2 Transesterification process

Biodiesel will be prepared from raw non edible oil mahua and acid oil for the present study. The general transesterification process was followed for bio diesel preparation discussed below. Biodiesel is generally produced by transesterification of triglyceride; a triglyceride reacts with an alcohol in the presence of a strong acid or base, producing a mixture of fatty acids alkyl esters and glycerol. The overall process is a sequence of three consecutive and reversible reactions, in which diandmonoglycerides are formed as intermediates. Thestoichiometric reaction requires 1 mol of a triglyceride and3 mol of the alcohol. However, an excess of the alcohol is used to increase the yields of the alkyl esters and to allow its phase separation from the glycerol formed. Reactions could be summarized as follows:

$$\underset{Triglycerides}{\begin{matrix} CH_2\text{-}OOC\text{-}R_1 \\ | \\ CH\text{-}OOC\text{-}R_2 \\ | \\ CH_2\text{-}OOC\text{-}R_3 \end{matrix}} + \underset{Alcohol}{3R'OH} \xleftrightarrow{Catalyst} \underset{Esters}{\begin{matrix} R_1\text{-}COO\text{-}R' \\ \\ R_2\text{-}COO\text{-}R' \\ \\ R_3\text{-}COO\text{-}R' \end{matrix}} + \underset{Glycerin}{\begin{matrix} CH_2\text{-}OH \\ | \\ CH\text{-}OH \\ | \\ CH_2\text{-}OH \end{matrix}}$$

2.2 Preparation of bio diesel from Mahua oil

Mahua oil was obtained from Agrawal oil mills near Udaipur, Rajasthan, India. Before preparation of bio diesel the property of oil likes chemical composition of oil, acid value, iodine value and FFA etc should be known for establishing procedure for bio diesel. Mahua biodiesel was prepared using two step processes, in which initial step is acid esterification process and second one is transesterification process. Experiments were conducted in a laboratory-scale setup. All chemicalsincluding methanol (99.5%) and sulfuric acid (99% pure)were of analytical reagent (AR) grade. The KOH inpellet form was used as a base catalyst for transesterificationreaction.Crude unrefined mahua oil was brownish yellow in colour. This oil had an initial acid value of 20.34 mg KOH/gm of oil corresponding to a FFA level of 10.17%.

III. CHARACTERIZATION OF SECOND GENERATION BIO DIESEL

3.1 Acid value

A value indicating the amount of free acid present in a substance, equal to the number of milligrams of potassium hydroxide needed to neutralize the free fatty acids present in one gram of fat or oil also called acid number. Figure 3-1 shows acid value of different Oils and biodiesel.

AV = (v - b) x N x 56.1 / w

Where, v is the titration volume in ml b is the blank in ml N is the normality of the KOH solution w is the weight of sample in gm

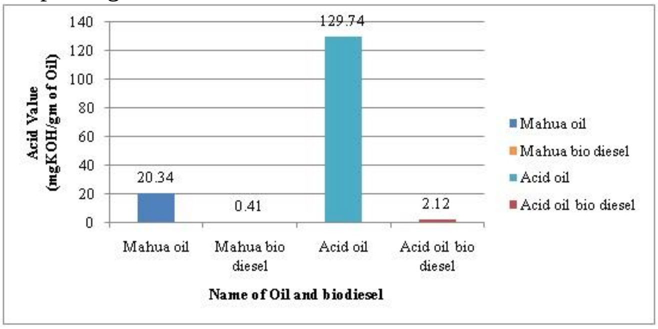

Figure 3.1 Acid Value of different Oils and biodiesel

3.2 Free fatty acid (FFA)

Figure 3.2 FFA of different Oils and biodiesel. FFA% is the weight to weight ratio of FFA found in an oil sample. The weight of an oil sample divided into the weight of the FFA in that sample. To calculate FFA% from an acid value the formula is:

AV = 1.99 FFA%

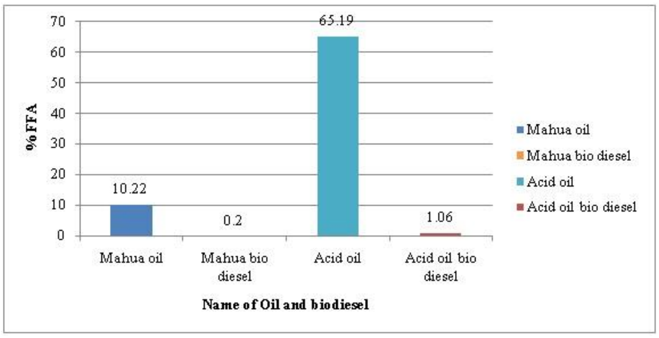

Figure 3.2 FFA of different Oils and biodiesels

IV. CONCLUSION

Characterization of Mahua biodiesel and Acid Oil biodiesel was carried out in-house and also at some accredited laboratories from Gujarat. It was observed that acid oil biodiesel has the similar calorific value as that of diesel and its viscosity also matches well with that of diesel. Somewhat lower calorific value of mahua biodiesel was obtained as compared to that of diesel and its viscosity was a bit higher than that of diesel. Results obtained for these biodiesel fuels in terms of FFA values, acid values, Calorific value, pour point, cloud point, flash and fire point and viscosity values were matching well with that of diesel.

REFERENCES

[1] Anca Diana Barbu, Ricardo Fernandez, Ann Gardiner, AylaUslu and James Greenleaf., Energy and environment report 2008, EEA Report No 6, 2008.
[2] L.B. Klyashtorin& A.A. Lyubushin., 'On the Coherence between Dynamics of the World Fuel Consumption and Global Temperature Anomaly', Energy & Environment, volume 14, No.06, 2003.
[3] Sandip D. Shah., 'A Study of the Physical and Chemical Properties of Exhaust Emissions from Heavy- Duty Diesel Engines', Ph.D. Thesis, Dept. of Chemical and Environment Engineering, University of California, Dec 2004
[4] Agarwal A.K., 'Bio fuels (alcohols and biodiesel) applications as fuels for internal combustion engines' Progress in Energy and Combustion Science, 33, 233-71, 2007.
[5] Poonam Singh Nigam, Anoop Singh., 'Production of liquid bio-fuels from renewable resources: A review' Progress in Energy and Combustion Science, 37, 52-68, 2011
[6] S.N. Naik, Vaibhav V. Goud, Prasant K. Rout, Ajay K. Dalai., 'Production of first and second generation bio fuels: A comprehensive review' Renewable and Sustainable Energy Reviews, 14, 578–597, 2010
[7] International Energy Agency (IEA), From First to Second-Generation Bio fuel Technologies. http://www.iea.org/publications/free/new/Desc. pdf; 2008.
[8] Larson ED., Biofuel production technologies: status, prospects and implications for trade and development, Report No. UNCTAD/DITC/TED/2007/10.
[9] Stevens DJ, Worgetten M, Saddler J., Biofuels for transportation: an examination of policy and technical issues, IEA Bioenergy Task 39, Liquid Biofuels Final Report 2001-2003.
[10] Srivastava, A., Prasad R., 'Triglycerides-based diesel fuels', Renew. Sustain. Energy Rev., 4, 111–133, 2000.
[11] B M Kulkarni, B G Pujar& S Shanmukhappa, 'Investigation of acid oil as a source of biodiesel', Indian Journal of Chemical Technology, Vol. 15, pp. 467-471, September 2008.
[12] VishwanathPatil, Khanh-Quang Tran, Hans RagnarGiselrod, 'Towards Sustainable Production of Biofuels from Microalgae', International Journal of Molecular Sciences, 9, 1188-1195, 2008.
[13] A.L. Ahmad, N.H. Mat Yasin, C.J.C. Derek, J.K. Lim., 'Microalgae as a sustainable energy source for biodiesel production: A review' Renewable and Sustainable Energy Reviews, 15, 584–593, 2011.
[14] Shashikant Vilas Ghadge, HifjurRaheman., 'Process optimization for biodiesel production from mahua (Madhucaindica) oil using response surface methodology' Bio resource Technology, 97, 379–384, 2006.
[15] Angelo C. Pinto, Lilian L. N. Guarieiro, Michelle J. C. Rezende, Núbia M. Ribeiro, Ednildo A. Torresb, Wilson A. Lopes, Pedro A. de P. Pereirac and Jailson B. de Andrade., 'Biodiesel: An Overview', J. Braz. Chem. Soc., Vol. 16, No. 6B, 1313-1330, 2005.
[16] D.Y.C. Leung ,Y. Guo., 'Transesterification of neat and used frying oil: ptimization for biodiesel production', Fuel Processing Technology , 87, 883–890, 2006.
[17] Rafael Guzatto, Diego Defferrari, Quelen Bülow Reiznautt, Ígor Renz Cadore, Dimitrios Samios., 'Transesterification double step process modification for ethyl ester biodiesel production from vegetable and waste oils', Fuel, 92, 197–203, 2012.
[18] D. Samios, F. Pedrotti, A. Nicolau, Q.B. Reiznautt, D.D. Martini, F.M. Dalcin.' 'A Transesterification Double Step Process - TDSP for biodiesel preparation from fatty acids triglycerides', Fuel Processing Technology, 90, 599–605, 2009.
[19] Michael J. Haas, Paul J. Michalski, Stan Runyon, Alberto Nunez, and Karen M. Scott., 'Production of FAME from Acid Oil, a By-product of Vegetable Oil Refining', JAOCS, Vol. 80, no. 1, 2003.
[20] M. Canakci • H. Sanli., 'Biodiesel production from various feedstocks and their effects on the fuel properties', J Ind Microbiol Biotechnol, 35, 431–441, 2008.
[21] Ali Y, Hanna MA, Cuppett SL., 'Fuel properties of tallow and soybean oil esters', J Am Oil ChemSoc, 72, 1557–1564, 1995.
[22] Lee I, Johnson LA, Hammond EG., 'Use of branched-chain esters to reduce the crystallization temperature of biodiesel', J Am Oil ChemSoc, 72, 1155–1160, 1995.

