Available online at www.sciencedirect.com

SciVerse ScienceDirect

Energy Procedia 14 (2012) 1624 – 1629

Energy Procedia

2011 2nd International Conference on Advances in Energy Engineering (ICAEE 2011)

Effect of Additive on Performance of C.I. Engine Fuelled with Bio Diesel.

M.Shahabuddin[a],H.H.Masjuki,M.A. Kalam,M. Mofijur,M.A.Hazrat, A.M.Liaquat.

Centre for Energy Science, Department of Mechanical Engineering
University of Malaya, 50603 Kuala Lumpur,Malaysia.
Email: shahabuddin.suzan@yahoo.com

Abstract

Among the alternative fuels the Bio diesel is one the most common and familiar to all. It's biodegradable, environment friendly as well as suitable source, to meet the future energy crises. The main concern of this experimental analysis is to reach a tentative goal, how this fuel can be utilised with maximum effective way. To find this ,an experiment data analysis of different parameter such as break power, break specific fuel consumption, emission characteristic(NOx, HC,CO. etc) and exhaust temperature, is done through bio diesel fuel and also compared with ordinary diesel which is also known as petro diesel. This investigation is carried out through eddy current dynamometer and load cell arrangement which is controlled by a computer in case of finding the break power and BSFC respectively. And the emission characteristics are observed using Bosch and Bacharach exhaust analyzers. And finally the result is compared with diesel engine which is run by ordinary diesel. The final result implied that the bio diesel with some additives (B20+1%) shows best performance and reduce the exhaust emission including NO_x.Thus the decision may be taken,20% blended bio diesel with 1% additive as a best alternative fuel considering all the view aspects and alternatives.

Keywords: Additive;Biodiesel;Emissions;Brake Power and;SFC.

1. Introduction

[a] * Corresponding author. Tel. +60162418438; fax: +603 7967 4448.
E-mail address: shahabuddin.suzan@yahoo.com

doi:10.1016/j.egypro.2011.12.1143

The considerable amount of energy is expense in transportation sector and vital demand is meeting through Diesel engine in all over the world due to their higher performance as compared to other conventional fuels. However the total crude oil reserve in the world is unknown and it diminishing day by day therefore most of the researchers worried about the future energy resource. Thus concentration should be directed on the alternative fuel. As an alternative fuel Pure bio diesel is formulated from animal fat and vegetable, which are more bio degradable and non toxic [**1**] as well as environment friendly except NOx emission and more reliable source. In environmental aspect the bio diesel is more acceptable compare to conventional diesel fuel. Its forms low carbon and smoke which is responsible for global warming **[2**]. In Malaysia palm oil is used as a bio diesel which is known as Palm Oil Methyl Ester (POME). To use this fuel (blended and adding some additives) in diesel engine no need to change the design and exhibit more or less same performance.B20+1% (20% blended bio diesel with 1% additive) and a catalytic converter will cut air pollution. Particulate matter is reduced 31 percent, carbon monoxide by 21 percent and total hydrocarbons by 47 percent which will also reduce sulfur emissions and aromatics [**3**]. To increase the performance (about 30%) of diesel engine turbocharger with intercooler is being used now a day and plays a significant role on diesel engine performance however the use of turbocharger in bio diesel fuelled engine is not suitable but catalytic converter can be used to increase emission behaviour. Moreover, several factors are responsible for the exhaust emission of diesel engine i.e., fuels, lubricant, engine operating condition, emission reduction technique etc. [**4**,**5]**.This paper presents the experimental data analysis of different parameter of an Turbocharged (IDI) Diesel engine exhaust emissions while running with POME blended anti-corrosion additive as fuels. This investigation focused on the significant effects of additive on POME-Diesel blended fuels especially for B20+1%. Several form of bio diesel is used to do this experiment namely, B100 (pure bio lubricant), B20, B20+1%, B20+2%.And compared with ordinary diesel which shows hopeful result to use bio diesel.

2. Experimental set-up and apparatus

Tests were carried out with conventional diesel fuel powered natural aspirated engine as the baseline study. The similar engine was coupled with turbocharger for the next test stage. At this stage, 20% biodiesel blended diesel fuels as well as conventional diesel fuel were used to obtain the comparison results.

The tests were conducted at the Heat Engines Laboratory of Mechanical Engineering Department, University of Malaya based on the SAE Recommended Practice. The Isuzu 4FBIfour-cylinder diesel engine which is controlled by CP CADET 10 Data Acquisition System was used in this experiment. The engine specification and the details of instrumentation have been fully described by Masjuki *et.al* [**6**]. The engine is operated between 1000 to 4000 rpm. The exhaust emissions were measured by using a HORIBA MEXA 9100-D Gas Analyzer. Meanwhile, the fuel blends were prepared at the laboratory by blending conventional diesel with biodiesel by using a homogenizer dispersion system to achieve a homogeneous fuel blend between diesel fuel and biodiesel. The characteristics of fuels were also obtained using several instruments in accordance with ASTM methods. Table 1 shows some obtained important characteristics

Table 1. Fuel Characteristics of biodiesel blended fuel and Conventional diesel (OD)

Properties	OD	B20	B100
Calorific value MJ/kg	45.8	44.74	39.21
Kinematic viscosity (cSt) at 40 ^{o}C	3.6	4.05	5.85
Cetane index ASTM D976	53	52	37
Conradson carbon residue ASTM D198%wt	0.14	0.01	-
Sulfur content %wt	0.1	0.03	-

Additive: The additive used in this experiment is IRGANOR NPA (Product name) as a corrosion inhibitor for fuels.

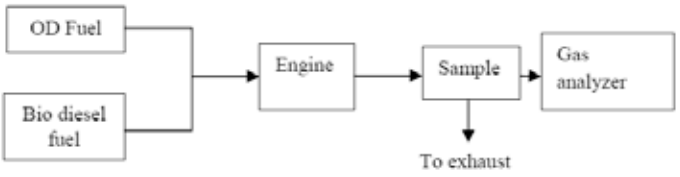

Figure 1 Schematic diagram of experimental set-up

3. Results and Discussions

The parameter of diesel engine for different fuel through experiment is done in the Tribology Laboratory, Department of Mechanical Engineering, and University of Malaya. And various parameters are compared with one another, including petro diesel.

3.1 *Brake power output*

The results of brake power output from turbocharged diesel engine for every fuel test including 1% and 2% percent of additive added biodiesel fuels are shown in Fig.2. Which illustrate that fuel "B20+1%" produces higher brake power over the entire speed range in comparison to other fuels. It is found that fuel "B20+1%" produces an average of 11.50 kW brake power over the entire speed range which is 1.68% higher than fuel B20. Thus the result implies that the addition of some additive is more effective than additive less fuel and it's also shows that 1% of additive is exhibit higher performance than 2%.because of good combustion quality and reliable fuel viscosity .and another important observation is, the fuel B20+1% results better performance comparing with ordinary diesel (OD). Overall results of different fuel regarding brake power are accumulated in Fig.2.

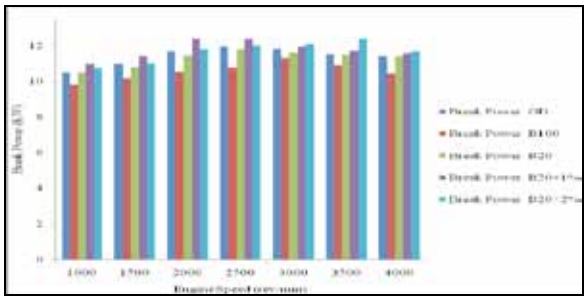

Figure 2: Brake Power Output vs. Engine Speed

3.1 *Specific fuel consumption*

Fig. 3 illustrates break specific fuel consumption (BSFC) for all the fuels. It is seen that the fuel consumption in pure bio diesel (B100) is maximum and the bio diesel B20+1 %(20% blended bio diesel with 1% additive) is minimum. It is found that B100 consumes an average of 711 g/kW.h and for fuel B20+1% the average consumption is 405 g/kW.h and fuel B20 consumes an average of 536 g/kW.h ,it clear that the addition of some additives are more effective than B20. This is due to good combustion ability, reliable viscosity and good wear properties. The fuel B20+2% result higher BSFC than B20+1% thus the addition of 1% additive is optimum. All this data is compared with ordinary diesel and found that B20+1% has the lower SFC even OD fuel.

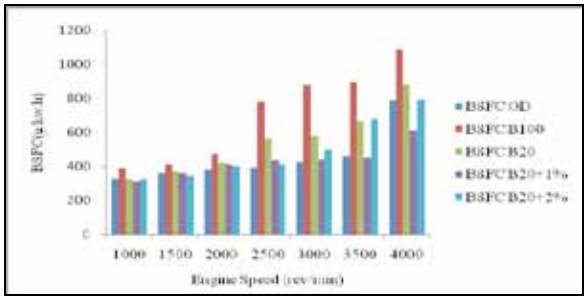

Figure 3: Break Specific Fuel Consumption vs. Engine Speed

3.2 Emission characteristics: Following comparison with petro diesel shows the emission behaviour of B100 and B20 fuel.

Table 2: Average Biodiesel Emissions Compared to Conventional Diesel, According to EPA.

Emission Component	B100	B20
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NOx	+10%	+2%
Sulfates	-100%	-20%
PAH	-80%	-13%

3.3.1 *Oxides of Nitrogen (NOx) emission*

The effect of biodiesel blended additive on Nitrogen Oxide (NOx) concentration is shown in Fig. 4. It is found that the NOx concentration decreases with additive blended fuel. The result shows, NOx is reduced especially while engine is running on B20+1% fuel with. This phenomenon shows that B20+1% fuel is the optimum composition in order to achieve better fuel quality with less NOx formation. In addition, with the presence of additive, the combustion temperature could be reduced which cause to control the NOx , Moreover the flame temperature also reduced dramatically which cause complete fuel combustion. Another fact is, the blended fuel with additive reduces friction between the cylinder wall and piston thus the heat loose is controlled in the cylinder and result in considerable reduction in NOx. This condition was also observed by several researchers who conducted some studies in terms of flame and combustion stability of oxygenated and renewable fuels. (**7,8**). Over the entire speed range, B20+1% fuel produces an average of 95 ppm and fuel B20 produces 123 ppm. Hence the 28 ppm reduction is due to the effect of 1% additive in B20 fuel.

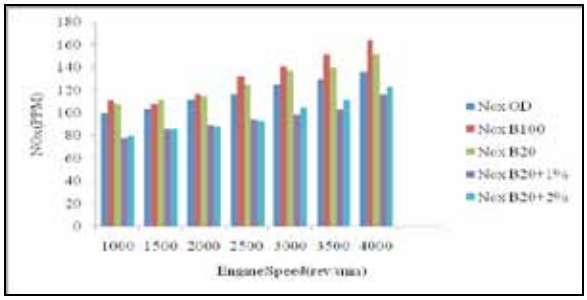

Figure 4: NOX concentration vs. Engine Speed

3.2.2 *Carbon Monoxide (CO) emission*

The CO is produced due to incomplete combustion of fuel. Most CO is produced when air-to-fuel ratios are too low in the engine during vehicle starting, when cars are not tuned properly, and at higher altitudes, where thin air reduces the amount of oxygen available for combustion. Two-thirds of the carbon monoxide emissions come from transportation sources, with the largest contribution coming from cars. In urban areas, the passenger vehicle contribution to carbon monoxide pollution can exceed 90%. [**9**]. However, since the operating conditions are exclusively lean, the CO concentration value for all the fuels is less than 1% as shown in Fig.5. It is found that among all the fuels, fuel B20+1% produce lowest level of CO emissions which is on average of 0.141 %, B20 is 0.213% and OD is 0.296% . The difference between B20+1% and B20 shows the effect of additive in Biodiesel fuel especially with B20 fuel. The details results for all the fuels are shown in Fig.5.

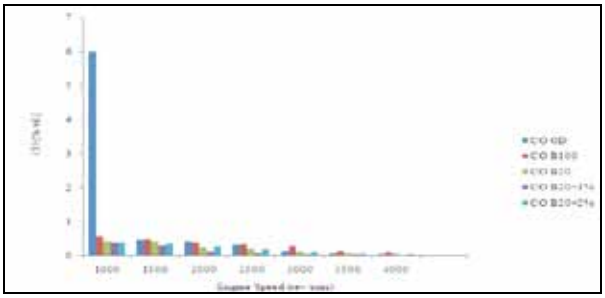

Figure 5: CO concentration vs. Engine Speed

3.3.3 *Hydrocarbon (HC) Emission*

Fig.6 shows HC emissions for all the fuels. It is found that fuel B20+1% produces lower level of HC emission followed by B20+2%, B100, B20 and OD fuels respectively. The maximum level of HC was produced by OD fuel. It can be seen that additive added biodiesel fuel produces comparatively lower level of HC as compared to OD fuel. This is mainly due to complete combustion in the combustion process.

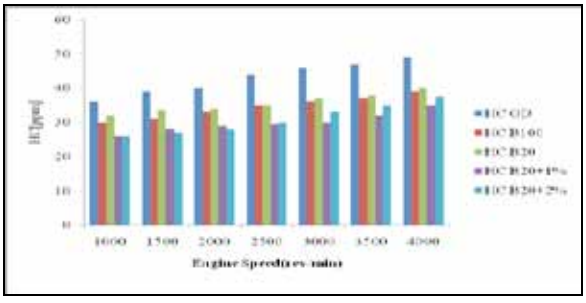

Figure 6: HC concentration vs. Engine Speed

3.3 *Exhaust Temperature*

Fig. 7 Illustrate the effect on exhaust temperature fuelled with blended, without blended, blended with additive in different percentage and ordinary diesel, which implies more or less same exhaust temperature thus it may concluded from the graph, the effect of those fuels on exhaust temperature has a little effect on exhaust temperature moreover the exhaust temperature of ordinary fuel is maximum and blended fuel with 2% additive is minimum.

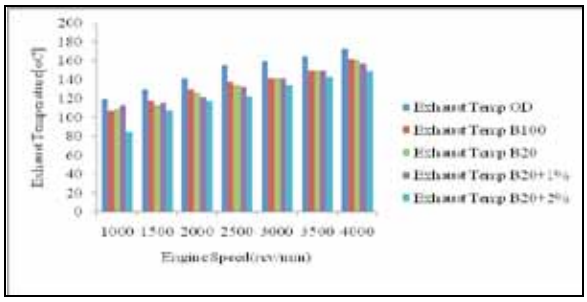

Figure 7: Exhaust Temperature vs. Engine Speed

4. Conclusions

The following conclusions may be drawn from the present investigation:

- Fuel "B20+1%" produces 1.73% and 9% higher brake power as compared to fuel B20 and OD respectively.
- Fuel "B20+1%" consumes 26% and 6% lower SFC as compared to fuel B20 and OD respectively.
- Fuel "B20+1%" reduces CO, NOx and CO_2 emissions as compared to other fuels.

Hence, it is found that there is a benefit in addition of additive in biodiesel in terms of better Brake power, SFC and emissions performance.

Acknowledgements

The authors would like to thank Department of Mechanical engineering, University of Malaya and Ministry of Higher Education (MOHE) of Malaysia for HIR Grant No. UM.C/HIR/MOHE/ENG/07 which made this study possible and Mr. Sulaiman Arifin (laboratory assistant) for his extensive technical support during the work presented in this paper.

Reference

[1].Zhang X, Peterson CL, Reece D, Haws R, Moller G. Biodegradability of biodiesel in the aquatic environment. ASAE 1998;41(5):1423-0.

[2].Murayama T, et al. Low carbon flower buildup, low smoke, and efficient diesel operation with vegetable oils by conversion to mono-esters and blending with diesel oil or alcohols, SAE 841161; 1984. p.292–302.

[3]. Kado, N.Y., R.A. Okamoto and P.A. Kuzmicky, Chemical and bioassay analyses of diesel and Biodiesel Particulate matter: pilot study, Final Report Dept. of Environmental Toxiology University California Davis – California for the Montana State Dept of Enviro. Quality and United States-Dept of Energy,(1996).

[4]. Handa,T., Yamamura, T., Kato, Y., Saito, S. Ishi, Factor analysis and derivation of an experimental equation on polynuclear aromatic hydrocarbon emissions from automobiles, Environ. Science. Technology, No.13, pp. 1079-1081 (1979).

[5]. Andrew, G.E., Abdelhalim, S., Abbase, M.K., Asadi-Aghdam, H.R., Williams, P.T., Bartle, K.D., The role of exhaust pipe and in cylinder deposits on diesel particulate composition, SAE Paper 92164. New York, (1992).

[6]. Masjuki. H.H, M.Z. Abdulmuin, H.S. Sii, Indirect Injection Diesel Engine Operation on Palm OilMethyl Esters and its Emulsions, Proceeding I.MechE Vol. 211, (1997).

[7].Yasufumi, Yoshimoto and Hiroya Tamaki, Reduction of NOx and smoke emissions in a dieselengine fueled by biodiesel emulsions combined with EGR, SAE Paper 2001-01-0649, (2001).

[8]. Zeller, H.W., Fuel additive and engine operation effects on diesel soot emission, U.S. Department of the interior 9238, Supplement of Report Document No. I 28.27:9238, (1992).

[9]. http://www.nutramed.com/environment/carsepa.htm