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A Study of DI Diesel Engine using Mahua Biodiesel and Petro-Diesel

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Abstract: - The engine emission characteristics of Mahua biodiesel (Mahua oil Methyl Ester) and petro-diesel are presented. The thermo-physical properties of all the fuel blends have been measured and presented. The engine tests are conducted on a 4Stroke Tangentially Vertical (TV) single cylinder kirloskar 1500 rpm water cooled direct injection diesel engine with eddy current dynamometer at different static injection timings of 22°, 23° (standard) and 24°bTDC under standard nozzle opening pressure of 240 bar maintained as constant throughout the experiment under steady state conditions at full load condition of the engine. From the test results, it could be observed that the lower static injection timing (22° bTDC) for B0 fuel and B100 fuel give lower Carbon Monoxide, Smoke Density and Oxides of Nitrogen in the case of emissions.

Keywords: - *Petro-Diesel; Biodiesel; Static Injection Timings; Engine Emissions*

I. INTRODUCTION

The diesel engine sector forms a vital part of transportation systems in all the developed and developing countries of the world. However, diesel engine exhaust emissions are a major contributor to environment pollution. The conventional fossil fuel (diesel) used in diesel engines contains higher amounts of aromatics and sulphur, which cause environment pollution. As an example, higher amount of particulate matter (PM), unburned hydrocarbon (HC), oxides of nitrogen (NO_x), carbon dioxide (CO_2) and oxides of sulphur (SO_x) are produced from fossil-fuelled diesel engine exhaust emissions. Moreover, NO_x and CO_2 are the green house gases and SO_x causes acid rain. Bio-fuel contains less aromatic content and is practically sulphur-free, and produces complete combustion due to its oxygen content in comparison with conventional diesel fuel. Secondly, the environmental benefit is another motivation factor due to a lesser green house effect, less local air pollution, less contamination for water and soil and a reduced health risk. There are different types of Biodiesels are available such as Cottonseed, Soybean, Sunflower, Soyabean, Mahua, Linseed, Pongamia, Jatropha, etc., From the previous studies, it could be observed that most of the studies are mainly related to the emission characteristics of diesel engine using biodiesel as fuel. In this paper an analysis of 4S TV 1 DI with static injection timings of 22°, 23° (standard) and 24° bTDC and with a constant nozzle opening pressure of 240 bar at full load condition of the diesel engine with eddy current dynamometer using B0 and B100 as fuel is presented.

II. EXPERIMENTAL SETUP AND PROCEDURE

Experiments have been conducted on a 4 stroke, kirloskar, TV 1 direct injection diesel engine developing power output of 5.2 kW at 1500 rpm connected with water cooled eddy current dynamometer. The schematic diagram of the engine setup is shown in Fig. 1. The static injection timings of 22°, 23° (standard) and 24° bTDC and the standard nozzle opening pressure of 240 bar are used for the entire experiments at full load condition of the engine. AVL 444 di-gas analyzer is used for the measurement of exhaust emission of CO, CO_2, NO_x. Smoke level is measured using standard AVL 437 smoke meter. All the experimental readings have been taken under steady state conditions of the engine.

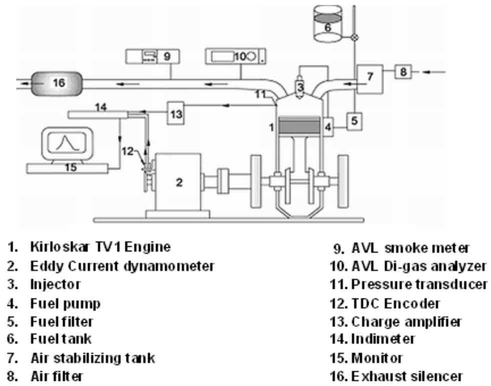

Figure 1: Schematic Diagram of the Engine Setup

Table 1: Properties of Mahua Biodiesel and Petro-Diesel

S. No	Name of the Properties	B0	B100
1	Kinematic Viscosity at 40ºC in cSt	2.6	6.04
2	Gross Calorific Value in kJ/kg	45, 596	41, 819
3	Flash Point in ºC	65	170
4	Fire Point in ºC	70	183
7	Specific Gravity	0.82	0.88

From Tab. 1, it is clear that specific gravity, kinematic viscosity, flash point and fire point increases as the biodiesel content in the biodiesel-diesel blends increases. Especially, the significant increase in the fire point shows that the volatility of the mixture having increased, biodiesel content will decrease. It is also observed that the flash point and fire point of biodiesel increase. Therefore B100 is very easy to store and safe for transportation as compared with B0 (pure diesel). The gross calorific value decreases as the biodiesel in the mixture increases.

III. RESULTS AND DISCUSSION

3.1 Carbon di-oxide

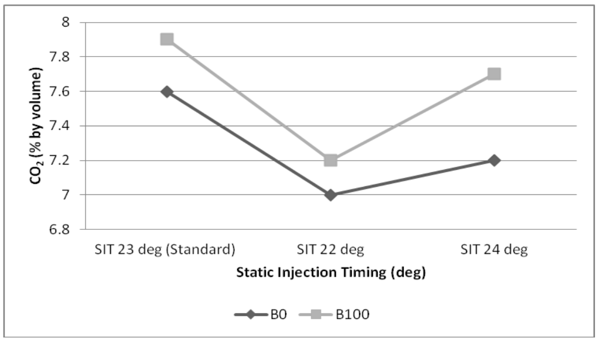

Figure 2: Carbon-di-oxide vs SIT

Figure 2 shows variation of Carbon di-oxide with respect to static injection timings of 22°, 23° (standard) and 24° bTDC. From the test results, it could be stated that the 22° bTDC of static injection timing gives lowest CO_2 (% by volume) as compared to all other static injection timings. The percentage reduction of CO_2 for injection timing of 22° for B0 and B100 is 7.82 and 8.76 respectively as compared with standard injection timing of 23° bTDC. Among fuels, the B100 gives highest CO_2 of 8.86 in terms of percentage reduction of CO_2 at full load condition. This may be due to oxygen (% by volume) of B100 is comparatively lower than that of all other blends. Therefore, there may be a possibility of getting better combustion with lower emissions.

3.2 Carbon monoxide

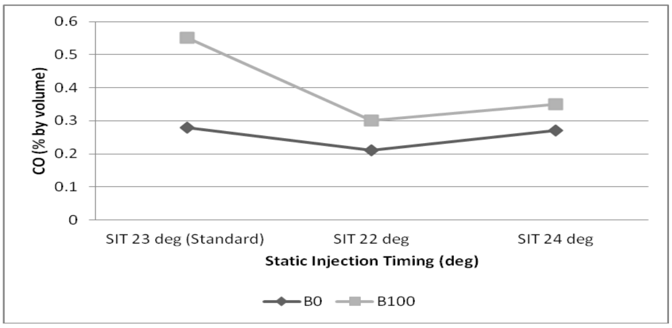

Figure 3: Carbon monoxide vs SIT

The variation of Carbon monoxide with respect to static injection timings of 22°, 23° (standard) and 24° bTDC is shown in figure 3. From the graph results, it could be observed that the 22° bTDC of static injection timing gives lowest CO as compared to all other static injection timings for all blends of fuel. The percentage reduction in CO (% by volume) for static injection timing of 22° bTDC for B0 and B100 is 25.05 and 44.78 respectively as compared with standard static injection timing of 23° bTDC. Among the blends, the B100 gives highest percentage of reduction in CO of 44.78 at full load condition of the engine.

3.3 Smoke Density

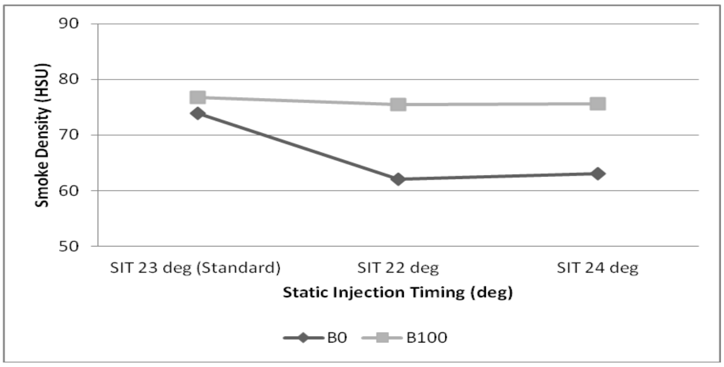

Figure 4: Smoke Density vs SIT

Figure 4 shows variation of Smoke Density with respect to static injection timings of 22°, 23° (standard), and 24° bTDC. From the test results, it could be observed that the 22° bTDC of static injection timing gives lowest Smoke Density (HSU) as compared to all other static injection timings. The percentage reduction in Smoke Density for static injection timing of 22° bTDC for B0 and B100 is 15.67 and 1.56 respectively as compared with standard static injection timing of 23° bTDC. Among the blends, the B0 gives highest Smoke Density of 15.67 in terms of percentage reduction in Smoke Density at full load condition of the engine.

3.4 Hydrocarbon

The variation of Hydrocarbon with respect to static injection timings of 22°, 23° (standard), and 24° bTDC is shown in figure 5. From the test results, it could be stated that the 22° bTDC of static injection timing gives lowest hydrocarbon as compared to all other timings for both fuels.

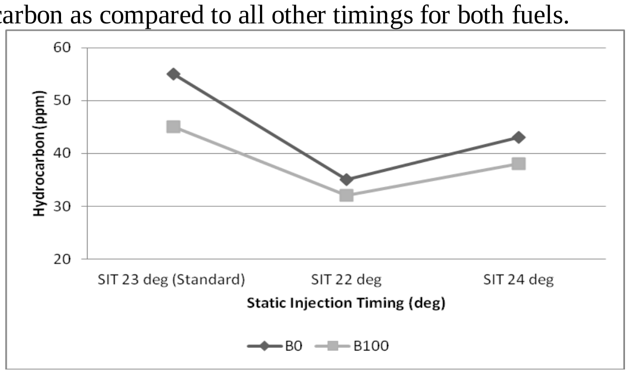

Figure 5: Hydrocarbon vs SIT

The percentage of reduction in hydrocarbon (ppm) for static injection timing of 22° for B0 and B100 is 35.56 and 26.78 respectively as compared with static injection timing of 23° bTDC. Among the blends, the B0 gives highest hydrocarbon of 35.56 in terms of percentage of reduction in hydrocarbon at full load condition. This variation may be due to presence of oxygen in the fuel, which promotes the combustion process.

3.5 Oxides of Nitrogen

Figure 6 shows variation of Oxides of Nitrogen (NO_x) with respect to static injection timings of 22°, 23° (standard) and 24° bTDC. From the test results, it could be seen that the 22° bTDC of static injection timing gives lowest NO_x (ppm) as compared to all other SITs for both fuels. The percentage reduction in NO_x for static injection timing of 22° bTDC for B0 and B100 is 22.45 and 14.45 respectively as compared with standard static injection timing of 23° bTDC. Among the fuels, the B0 gives highest NO_x of 22.45 in terms of percentage reduction in NO_x at full load condition. There are two parameters which influence the engine NO_x emission, stoichiometric air fuel ratio and the flame temperature.

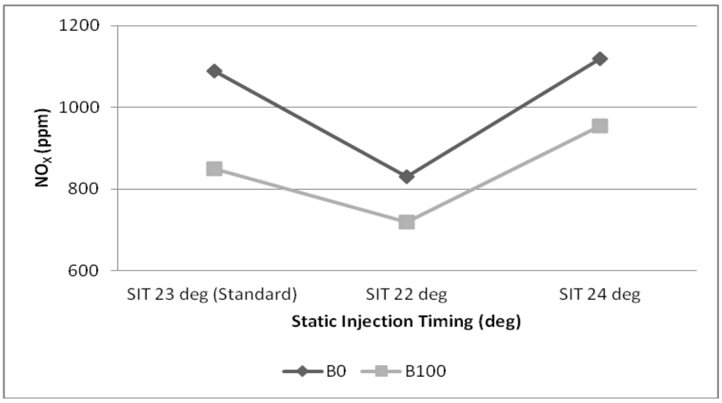

Figure 6: Oxides of Nitrogen vs SIT

IV. CONCLUSIONS

From these readings, it could be concluded that the B100 safely used as an alternative fuel for operating four stroke tangentially vertical single cylinder kirloskar direct injection water cooled constant speed diesel engine with static injection timing of 22° bTDC and nozzle opening pressure of 240 bar.

REFERENCES

[1] A S Ramadhas, S. Jayaraj and C. Muraleedharan, *Use of vegetable oils as IC engine fuels: A review, Renewable Energy, 29, 2003,* 27-742.

[2] P Srinivasa Rao and K.V Goplalakrishna. Esterified oils as fuels in diesel engine, *11th National Conference on IC Engines, IIT Madras, 1983,* India.

[3] Canakci and Vam Geroen, 2003, A pilot plant to produce biodiesel form high free fatty acid feedstock, *American society of agricultural engineers, 46 (4),* 2003, 945-954.

[4] M A Fangrui and A. Milford, *Hanna biodiesel production: a review, Bioresource Technology, 70, 1993,* 1-15.

[5] Suresh Kumar, A.K. Gupta and S.N. Naik, *Conversion of non-edible oil into biodiesel, Journal of Scientific and Industrial Research, 62, 2003,* 124-132.

[6] M Martin and D. Prithviraj, *Performance of Pre-heated Cottonseed Oil and Diesel Fuel Blends in a Compression Ignition Engine, Jordan Journal of Mechanical & Industrial Engineering, 5 (3), 2011,* 235 – 240.

[7] H Raheman and S.V. Ghadge, *Performance of compression ignition engine with Mahua (Madhuca Indica) biodiesel, Fuel, 86, 2007,* 2568-2573.

[8] J B Heywood, *Internal Combustion Engine Fundamentals, McGraw Hill, New York, 1988,* USA.