EFFECT OF EMULSIFIER ON PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE USING PALM BIODIESEL

SUBRAMANYAM. B¹, G. CHANDRA MOHANA REDDY², BRIDJESH. P³
K. DEEPAK⁴ & V. MAHIDAR REDDY⁵

^{1,2}Assistant Professor, Department of Mechanical Engineering, MLR Institute of Technology, Hyderabad, Telangana, India

³Associate Professor, Department of Mechanical Engineering, MLR Institute of Technology, Hyderabad, Telangana, India

⁴Professor, Department of Mechanical Engineering, Vardhaman College of Engineering, Hyderabad, Telangana, India

⁵Assistant Professor, Department of Mechanical Engineering, Institute of Aeronautical Engineering,
Hyderabad, Telangana, India

ABSTRACT

Present study deals to enhance physiochemical properties of palm biodiesel using soy-lecithin as an emulsifier. Performance and emission characteristics using palm biodiesel have been analyzed and compared with diesel and discussed.

KEYWORDS: *Physiochemical Properties of Palm & Palm Biodiesel*

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INTRODUCTION

Diesel engine exhaust gas emissions such as HC, CO, NO_x, and PM have a very significant cause of environmental pollution. Renewable energy, being in the form of biodiesel draws more attention among the research community. Be as it may be, biodiesel is produced from vegetable oils using transesterification process. The properties of biodiesel-diesel blends differ as a function of the composition of both diesel and biodiesel. It is a known fact that the availability of feedstock to produce biodiesel is a prime factor. In this regard, palm oil is one of the vegetable oil that has desired amount feedstock as this is a perennial crop [1].

The research established by [2,3] reveals that a few properties of palm biodiesel are inferior to diesel such as the viscosity of palm biodiesel is higher than diesel, while the calorific value is lower. Various methods were suggested [4] to enhance physiochemical properties of palm biodiesel. Either with neat palm biodiesel or blends of palm biodiesel, the performance of the engine is inferior [5]. Use of appropriate additive is considered appropriate to enhance the physiochemical properties of fuel along with improved performance [6].

Aim of this study is to enhance physiochemical properties of palm biodiesel using soy-lecithin as an additive and also to analyze performance emission characteristics of a diesel engines.

EXPERIMENTAL SETUP AND PROCEDURE

Tests were conducted on a single cylinder diesel engine having rated power of 5.2kW at 1500 rpm. A

detailed description of the setup is presented in [7]. Before starting the engine, lubricating oil level and cooling water supply were checked and ensured. The standard operating procedure of conducting tests as per the manual has been adopted. The engine specifications are presented in Table 1 and setup is shown in Figure. 1. The test fuels used in this study were diesel, palm biodiesel 20% + diesel 80% by vol (PB20) and palm biodiesel 20% + diesel 78% + soy-lecithin 2% (PBS20). Tests were carried out at 25%, 50%, 75% and 100% load to analyze performance, emission characteristics and compare with diesel. Physio-chemical properties of fuels for the test are shown in Table 2.

RESULTS AND DISCUSSIONS

Brake Specific Fuel Consumption (BSFC)

Figure. 2 shows the BSFC for all fuels under test. Average values of BSFC for diesel, PBS20 and PB20 are 0.489, 0.496 and 0.521 kg/kWh respectively. When compared with diesel, PBS20 has shown a marginal increase in BSFC at full load. Also, it is observed that BSFC for PB20 is higher by 8.47% than diesel at full load. This might be more due to the higher viscosity of PB20 than diesel [8].

Brake Thermal Efficiency (BTE)

Figure. 3 shows BTE variations for all test fuels. BTE increases with a load for all test fuels. BTE is greatly influenced by mass flow rate and calorific value of the fuel. Under full load conditions, BTE for diesel, PBS20, and PB20 are found to be 29.68%, 29.12% and 27.1% respectively. With PB20, BTE decreased by 9.5% than diesel. The lower calorific value alongside higher viscosity might have caused for poor vaporization of PB20. It is also observed that BTE for PBS20 is marginally low (1.56%) than diesel. This might be due to soy-lecithin, which lets to have the desired atomization and vaporization of fuel [9].

Oxides of Nitrogen

Figure. 4 shows the NO_x variations of all test fuels with the load. It is clear from the figure that NO_x emission increases as load increases. NO_x emission for PB20 is higher than other fuels. The average values of NO_x for diesel, PBS20, and PB20 are 0.9086, 0.924 and 1.1352 g/kWh respectively. Under full load conditions, the peak combustion temperature is higher in PB20 than other fuels. As such, NO_x emission recorded is higher for PB20 than other fuels. It is found that NO_x emission increased by 23.25% with PB20 than diesel. On the other hand, NO_x emission for PBS20 is higher by 2.63% than diesel. Also the additional oxygen present in biodiesel assists in combustion and in turn rise in temperature [10].

Hydrocarbon (HC)

Figure. 5 shows HC variations with the load. The parameters that influence for the formation of HC are fuel properties, spray characteristics and engine operating conditions. Average HC emissions for diesel, PBS20 and PB20 are 0.045, 0.041 and 0.051 respectively. There is a 6.2 % decrease in HC emission with PBS20 than diesel. The oxygen content in palm biodiesel and emulsification action of soy-lecithin might have provided an additional advantage which enhanced the oxidation unburned HC [11].

Carbon monoxide

Fig. 6 shows the variations of CO. Formation of CO is influenced by the amount of air available and mixing of fuel with air. Average values of CO for diesel, PBS20 and PB20 are 0.6725%, 0.47% and 0.505% respectively. it is also

observed that CO emission with PBS20 is lower than diesel by 35%. Lower CO emission for PBS20 than other fuels may be attributed to the combined effect of emulsification of soy-lecithin and higher certain number of fuel [6, 12].

Smoke

Figure. 7 shows the smoke emission variations. Average smoke emission for diesel, PBS20, and PB20 are 2.70, 2.37 and 2.97 FSN respectively. With PBS20, smoke emission reduced by 15.56% than diesel. This reduction in smoke might be due to the additive [12].

Exhaust Gas Temperature (EGT)

Figure.8 shows the EGT variations. EGT is an important parameter that reveals the combustion phenomenon. EGT is higher for PB20 than other fuels. This might be due to the delayed combustion with PB20. The poor atomization due to the higher viscosity of PB20 might also have influenced for higher EGT [13].

CONCLUSIONS

The following conclusions are drawn based on the experimental results:

- The physio-chemical properties of PBS20 and PB20 are suitable to be used as fuels on the engine.
- The additive, soy-lecithin is found to be a good emulsifier which can be used with palm biodiesel.
- PBS20 produced better stabilization as compared with PB20.
- BTE with PBS20 is marginally lower than diesel.

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Figure 1: Experimental Setup

Table 1: Engine Specifications

Make and model	Kirloskar, TV1
Number of cylinders	1
Bore, mm	87.5
Stroke, mm	110
Combustion chamber	Hemispherical
Piston bowl	Shallow bowl
Compression ratio	17.5:1
Rated power, kW	5.2
Rated speed, rpm	1500
Fuel injection type	Direct injection
Number of nozzle holes	3
Fuel injection pressure, MPa	22
Fuel injection timing, °CA bTDC	23
Dynamometer	Eddy current, 7.5 kW, 1500-3000 rpm, air cooled with loading unit
Load measurement	Direct coupling, Strain gauge

Table 2: Properties of Blending Stocks

Property	Diesel	PBS20	PB20	ASTM Method
Density @ 15°C (kgm ⁻³)	0.835	0.826	0.838	D4052
Calorific value (MJkg ⁻¹)	45.4	43.9	43.9	D240
Kinematic viscosity (cSt)	2.15	3.52	4.05	D445

Figure 2: Brake Specific Fuel Consumption Variation with Load

Figure 3: Brake Thermal Efficiency Variations with Load

Figure 4: NO_x Variations with Load

Figure 5: Hydro Carbon Emission Variations with Load

Figure 6: CO Emission Variations with Load

Figure 7: Smoke Emission Variations with Load

Figure 8: Exhaust Gas Temperature Variations with Load