# Performance and emission characteristics of castor blends biodiesel in single cylinder diesel engine dynamometer

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**ABSTRACT** – This study presents a preliminary investigation of engine is running on petro-diesel in order to determine the engine's operating characteristics and exhaust emission levels, constituting the base line that is compared with corresponding cases when using second generation biodiesel that used castor biodiesel consists of 5%, 10% and 20% blends. The engine coupled to hydraulic dynamometer through belting connection for load measurement. The same method will be repeated for each fuel blend by keeping the same operating condition. The present studies contribute as an alternative fuel by using biodiesel fuels from non-edible for diesel engines with standard engine parts.

## 1. INTRODUCTION

Recently, crisis about fossil fuel depletion and environmental pollutants already got a people attraction. Air pollution is one of the most dangerous environmental problems all over the globe. Continuously increasing use of oil will intensify local air pollution and accelerate the global warming problems caused by $CO_2$. One of the environmental problems are most widespread in the whole world is air pollution. Production of $CO_2$ gasses accelerates that's global warming and the resulting pollution improving local air from the use of petroleum [1].

Thither is a need to find way by utilizing alternative fuels, which are preferably renewable and also could give off low levels of gaseous and particulate pollutants in internal combustion engine [2].

Nowadays, most researches on biodiesel utilize food based-ingredients as a mixture of the fuel such as palm oil, corn, soy bean and maize, which are also consumed as food. Even though, the effectiveness of those developed biodiesel has been proven to be used as the alternative fuel, it has ignited a conflict between food requirements and fuel necessity. Of this problem, a based non-food ingredient by using Ricinus Communis (Castor) oil is proposed as the blend of the biodiesel. For the purpose of the observation, a direct-injection diesel engine is used to examine the usability and the performance of the proposed biodiesel in term of BSFC, power output, torque and emission produced by the engine[3].

So that, the objectives of this research to studies the direct injection engines performance and emissions of second generation biodiesel of Castor oil and its blends i.e. B5, B10 and B20. As a result the objective this study was to explore the utility of Castor oil as a potential source a biodiesel. Hence, the role of non-edible oils such as Castor would be more sustainable for biodiesel production [4].

## 2. METHODOLOGY

The experimental was conducted using biodiesel and diesel blends on single cylinder engine. The setup is consists of a single cylinder, air-cooled four stroke direct injection diesel engine KIPOR KM 170F that had power of 2.6 kW at 3000 rpm. The exhaust gas analyzer SV-5Q type was used to measure the concentrations of oxygen ($O_2$), carbon monoxide (CO), carbon dioxide ($CO_2$), hydrocarbons (HC) and nitrogen oxides (NOx) of the exhaust gas of engine. Throughout all tests, the engine load was set at 50% load constant while engine speed was varied. Experimental set up was indicated in different blend ratios, these were regular diesel, and then using castor oil blended mixing with diesel at 5% (B5), 10% (B10) and 20% (B20).

Based on values obtained from back pressure, it will allow for obtaining power and torque required. In this case, the engine efficiency was assuming without any losses occurred. Torque and power of engine was determined using equation 1 and equation 2:

Torque of engine:

$$\tau_{th} = \frac{V_D P}{2\pi} \quad (1)$$

where; $\tau_{th}$ = torque (Nm), $V_D$ = pump displacement in cc/rev, and $P$ = pump pressure (bar)

Power of engine:

$$P = \frac{2\pi N \tau_{th}}{60} \quad (2)$$

where; $P$ = pump power (W), $\tau_{th}$ = engine torque (Nm) and $N$ = rotational speed in round per minute or engine speed (RPM).

## 3. RESULTS AND DISCUSSION

Fig. 1 show a comparison between a regular diesel and several biodiesel of B5, B10, and B20 at 50% load condition. As illustrated in Fig.1 that graph shows relationship between brake power and engine speed using different blends of biodiesel castor. As the result, the brake power is increasing steadily for diesel and all biodiesel blends. The maximum power of engine was recorded at 3000 rpm, and it was produce about 2.18 kW, 2.07 kW, 2.18 kW, and 2.29 kW for diesel, B5, B10, and B20, respectively. Clearly that castor blends produced a lower value compared than diesel fuel accordingly to lower calorific values and higher viscosities of biodiesel blends that affected in combustion chamber and cause unusual combustion criteria.

The relationship between engine torque against engine speed can be illustrates from Fig. 2. It can be seen that biodiesel blends of B5, B10, and B20 have a similar trends compared to diesel fuel. The diesel produced about 7.29 Nm at 3000 rpm, B5 about 6.95 Nm, B10 about 5.95 Nm and B20 about 5.95 Nm. Biodiesel produced less value of torque because it related to higher calorific value and higher cetane number of blends.

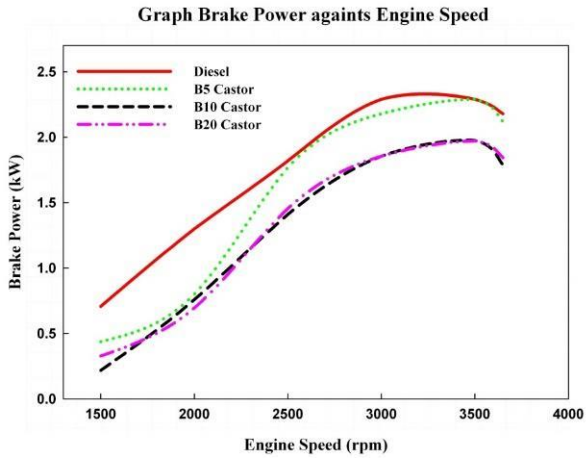


Fig. 1 Variation of Brake Power respect with engine speed

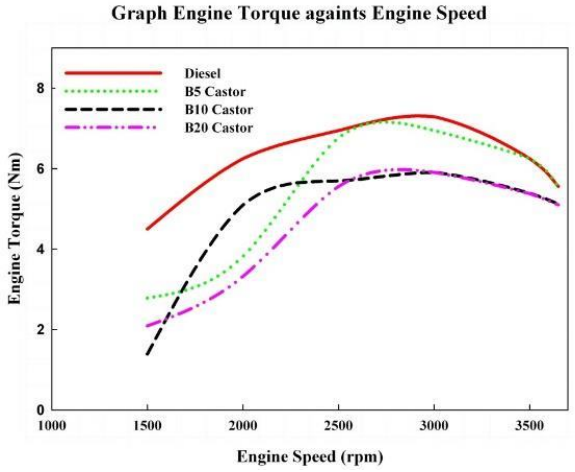


Fig. 2 Variation of Torque of Engine against engine speed

## 4. CONCLUSIONS

From the experimental works, it can be concluded that biodiesel fuel gives brake power and engine torque, lower than regular diesel fuel due to higher volume flow rate of fuel. Biodiesel castor oil is suitable alternative fuel for diesel engine without major adjustment of engine parts. It suggests that biodiesel from non-edible oil like castor oil could be a full replacement for diesel engine and can play a vital part in the near future particularly for meeting energy requirement in agriculture, industrial and shipping sectors. With comparable engine performance and reduction of Hydrocarbon, CO and with penalty of increased NOx emissions in comparison to regular diesel fuel, it can be concluded that biodiesel derived from castor oil and its blends could be applied in a formal diesel engine without any alteration. Nevertheless, the optimization of suitable blend can be subjected to future work with regard to engine parameters.

## 5. ACKNOWLEDGEMENT

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## 6. REFERENCES

[1] G. Corro, N. Tellez, E. Ayala, and A. Marinez-Ayala, “Two-step biodiesel production from Jatropha curcas crude oil using SiO 2•HF solid catalyst for FFA esterification step,” Fuel, vol. 89, pp. 2815–2821, 2010.

[2] K. K. Radha, A. A. Kumari, S. N. Sarada, E. L. Nagesh, and K. Rajagopal, “Alternative Fuels for a Single Cylinder Direct Injection Diesel Engine,” 2008 First Int. Conf. Emerg. Trends Eng. Technol., 2008.

[3] M. Kousoulidou, G. Fontaras, L. Ntziachristos, and Z. Samaras, “Biodiesel blend effects on common-rail diesel combustion and emissions,” Fuel, vol. 89, pp. 3442–3449, 2010.

[4] B. S. Chauhan, N. Kumar, H. M. Cho, and H. C. Lim, “A study on the performance and emission of a diesel engine fueled with Karanja biodiesel and its blends,” Energy, vol. 56, pp. 1–7, 2013.