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Biodiesel effect on performance of diesel engine

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Abstract
Fossil products are being used as a fuel source for IC engines. The increase price of fossil fuel, and the benefits of biodiesel fuel to the environment these reasons made the researchers working on enhance the performance of engines are running on biodiesel. This work presents biodiesel that produce from palm oil by transesterification. this paper also studied biodiesel fuel properties such as, density, calorific value, cetane number, kinematic viscosity and flash point. Parameters such as BTE, BSFC, brake power and speed of engine were measured at different loads for biodiesel and diesel fuels using TD202 small diesel engine. The results show the BTE less by 12 % for B100 compare to diesel. the BSFC for B100 more by 30 % than it for diesel, BP of B100 less than BP of fossil diesel by average 7.2 %, while volumetric efficiency decrease by 40 % for biodiesel fuel compare with diesel. and the highest exhaust gas temperature was 155 ºC.

Keywords: Biodiesel, diesel engine, engine performance, transesterification, brake power

Introduction
Biodiesel is alternative fuel, that produced from renewable resources [1]. Biodiesel can be blended with fossil diesel to make a biodiesel blend [2]. Biodiesel made at a chemical process "transesterification" this process produce biodiesel and glycerin these products can be separated by separation funnel [3]. Biodiesel formed from renewable resource so it's has less content of emission and more useful for the environment from fossil diesel [4].

S. Bari *et al*. are a measure of the thermal efficiency of fuel combustion. The researchers used single-cylinder engine where he found that the brake thermal efficiency of biodiesel is less than that of diesel, as the highest percentage of biodiesel was 20% while the diesel was 21% and fuel consumption decreased by 10% Biodiesel over diesel This means that combustion in biodiesel is better than diesel [5]**.** S. Chattopadhyay *et al*. the average values of fuel consumption were calculated for B10 and B20, and they were 0.415 and 0.418 kg kW h-1, respectively, compared to fossil diesel 0.407 kg kW h-1. Where the researcher noticed that the value of fuel consumption does not change much for B10 and B20 mixtures. The reason for this is the low calorific value, high density, and high viscosity [6]**.** J. Jayaprabakar *et al*. showed the volumetric efficiency of an engine indicates how well it can breathe. This feature is influenced by the surrounding environment as well as the engine's operating circumstances. Because of the increased cylinder temperature, the volumetric efficiency of the rice bran methyl ester mixes and algal methyl ester blends is nearer to pure diesel. The cylinder temperature rises and the volumetric efficiency of all fuel types rises when the injection timing is advanced [7]. R. Stalin *et al***.** showed that as the load increases, brake power increases to a maximum at 70% load and subsequently falls. When the brake power generated by the engine at various loads for various dual fuel combinations is compared, it is discovered that the braking power grows until B40 and then drops. So when brake power at various loads for diesel and various dual fuel mixtures is evaluated, the brake power for the dual fuel mixtures from B5 to B30 is higher than diesel. The brake power of the B40 is similar to that of a diesel engine. The brake power of dual fuel mixtures B50 to B100 is lower than that of diesel [8]. Sanjay Mohite *et al*. used single cylinder, water cooled, four stroke, direct injection engine EGTs of B20 found to be lower than fossil fuels. VE for B30 was highest for all other fuel blends [9]. Suleyman Simsek used A naturally aspirated, single cylinder, air-cooled, four stroke, direct injection diesel engine. exhaust gas temperatures for biodiesel were lower than that for diesel fuel [10].

the main goal of this study is to produce biodiesel fuel with to steps and, to compare between diesel and biodiesel in parameters BTE, BSFC, exhaust gas temperature, volumetric efficiency, and brake power at engine speed 1500 rpm.

Experimental work
A. Materials and Methods
6 moles of methanol react with 1 mole of palm oil, yielding 6 moles of biodiesel and 1 mole of glycerol. These principles are based on personal experience and research. Etihad food industries co. LTD. provided palm oil. A local laboratory in Najaf governorate provided methanol, sodium hydroxide, and sulfuric acid. In each operation, 50 g were used. Methanol with a purity of 100 % was used. As well as sodium hydroxide. Sulfuric acid with a purity of 95 % was used as a catalyst in the treatment process. Baker, magnetic stirrer, thermometer, and separation funnel are some of the other important components.

B. Acid-Catalyzed Esterification
In the esterification reaction, the molar ratio of methanol to oil, reaction time, acid catalyst number, and temperature are all important factors. Sulfuric acid was applied to the catalyst after 50 g of oil was poured in, followed by methanol. The molar ratio of methanol to oil was 3:1. A magnetic stirrer was used to heat the mixture to 60°Cand stir it for 60 minutes at 250 rpm. H_2SO_4 concentration was 0.25 %wt. After the reaction was finished, the mixture was

heated to 65 ºC for 25 minutes to evaporate the methanol and dispose of it. Following these measures, the percentage of free fatty acids in the body could have decreased by around 5%.

C. Transesterification Process

To make sodium methoxide, 11 g of methanol were combined with 0.375 g of sodium hydroxide in a beaker and stirred continuously for 10 minutes. 50 g palm oil, heated to 60°C, sodium methoxide poured over palm oil, and stirred continuously at 300 rpm for 2 hours with a magnetic stirrer, resulting in a molar ratio of methanol to palm oil of 6:1. When the reaction is complete, the mixture is allowed to separate into two layers for 8-12 hours, the biodiesel upper layer and the glycerol is lower layer. Two materials of different densities can be separated using a separating funnel. After separation, the biodiesel process is completed by dumping water at 70 ºC to remove methanol and the catalyst.

D. Experimental procedure

In this study the researchers used single cylinder, four stroke, overhead valves - one for inlet, one for exhaust, direct fuel injection, pressurized oil lubrication TD200 small diesel engine. Experiments with diesel and pure biodiesel were conducted at different engine loads (0, 25, 50, 75, and 100 %) at 1500 rpm engine speed. The engine warmed up with fossil diesel fuel. During the tests, the engine was first loaded at the zero load, then constantly increased. In order to obtain accurate results, the experimental measurements were recorded in 10-minute intervals at each constant speed and torque.

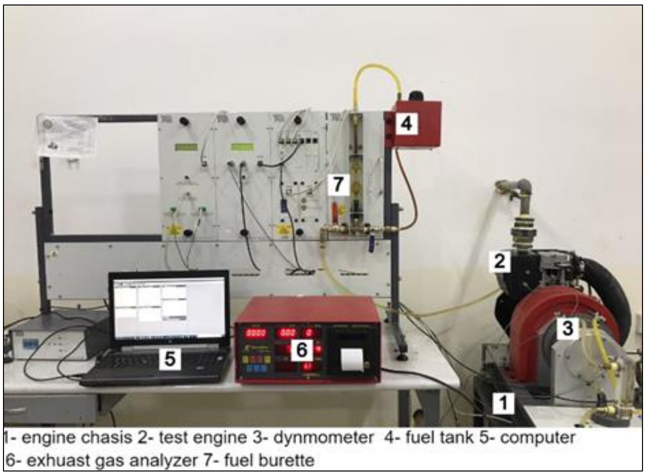

Fig 1: The actual scheme of experiment

Table 1: Physical and chemical specifications of biodiesel and diesel fuel according to EN14214 [11, 12]

No.	Name of test	Unite	Biodiesel	Standard values for biodiesel EN 14214	Diesel
1	Density @25 ºC	g/ml	0.8748	0.86-0.90	0.84
2	Kinematic viscosity @40 ºC	cSt	4.681	3.5-5	2.8
3	Flashpoint	ºC	181	≥ 120	78
4	Cetane number	-	53	> 51	45
5	calorific heating value	kJ/kg	37000	-	39500

Results and discussion

A. Physical and Chemical Specifications of Biodiesel

Table 1 shows the inferred fuel results. Kinematic viscosity is a measure of the friction of the internal fluid or flow resistance of oil that appears to oppose any dynamic change in the motion of the fluid. Kinematic viscosity is the key explanation of why biodiesel transesterifies fats and oils. Biodiesel's viscosity is about an order of magnitude smaller than that of the starting oil or fat. As the Kinematic viscosity of palm oil 35 cSt, and after the transesterification decreased to 4,681 cSt, biodiesel showed an increase in the Kinematic viscosity compare to fossil diesel that has 2.8 cSt [13]. Biodiesel showed a higher density than fossil diesel fuel, as biodiesel at 25 °C had a density of 0.8748 g/ml compared to fossil diesel fuel with a density of 0.84 g/ml at the same temperature [14]. The flashpoint is the temperature at which fuel can ignite when exposed to a heat source. It is important from the standpoint of safe handling, storage, and transportation. It is the amount of heating energy that a unit value of fuel releases through combustion. With increasing chain length, calorific value increases and with increasing unsaturation decreases, and it is important to estimate the fuel consumption, the lower fuel consumption, the higher the calorific value Palm oil has a calorific value of 36 MJ/kg, and after the transesterification increased to 37 MJ/kg less compared to fossil diesel fuel of 44,5 MJ/kg. The high flash point is known to ensure more safety in handling and storage. palm has a value of 341 ºC and after transesterification, it is 181 ºC and it is higher than diesel (103 ºC) and therefore it is safe to store, compared to that of fossil diesel fuel, which has 78 °C [12]. These values are also verified according to International standards for biodiesel including ASTM D6751 (US), EN 14214 (Europe), and BIS (India) as well as other plant-oil-based biodiesel. These results showed clear agreement.

B. Brake Thermal Efficiency (BTE)

Fuel quality, cetane number, fuel optimization, fuel evaporation rate, combustion chamber design, injection timing, compression ratio, and pressure are all factors that affect diesel engine combustion. By optimizing these factors, combustion can be improved, and thus the amount of fuel used and the rate of emissions generated by combustion can be reduced. One of the essential factors that affect diesel engine output and emissions is combustion efficiency and cetane number. Fig. 2. show that The thermal efficiency of B10, B20, B50, B70, and B100 fuel blends at 1500 rpm decreased by values of 0.89%, 1.53%, 2.23%, 2.84%, and 4.19%, respectively compared to fossil diesel fuels. respectively, compared to fossil diesel fuels. In reality, biodiesel has a lower calorific value than diesel fuel; however, because of its higher cetane number and oxygen content, biodiesel facilitates better combustion. Furthermore, whenever the masses pumped are compared, Biodiesel has a higher viscosity and is pumped in a bigger volume from a fuel pump of the same volumetric capability.

C. rake Specific Fuel Consumption (BSFC)

Fig. 3 shows the BSFC chart for biodiesel and diesel fuel blends depending on engine load BSFC of B10, B20, B50, B70, and B100 fuel at 1500 rpm increased by 0.013 kg/kW-h, 0.065 kg/kW-h, 0.099 kg/kW-h, 0.0.115 kg/kW-h, and 0.139 kg/kW-h, respectively, based on engine loads. The viscosity, density, and decreased calorific value of the injected diesel have an impact on the fuel consumption factor. Because biodiesel has a lower calorific value than diesel, more fuel must be pushed from the fuel pump to obtain the same power output as diesel, resulting in higher specific fuel consumption.

D. Brake power (BP)

At higher engine loads, the engine's braking power is comparatively high since the increased combustion temperature contributes to more full combustion during the higher load. Fig. 4. show brake power of B10, B20, B50, B70, and B100 fuel blends at 1500 rpm decreased by 0.014 kW, 0.017 kW, 0.025 kW, 0.023 kW, and 0.031 kW, respectively, based on engine loads. Apart from that, at different loads, pure diesel controlled the output brake power. The viscosity and density of fuels play a key role in the atomization process and can slow down the fuel-air mixing rate, resulting in poor fuel combustion and reduced brake power.

E. Volumetric efficiency (VE)

The volumetric efficiency of a compressor cylinder refers to how well it compresses the gas. It's the ratio of the amount of gas supplied to the piston displacement, adjusted for suction temperature and pressure. By far the most significant impact on volumetric performance is re-expansion. The engine's inlet temperature and pressure have a direct impact on volumetric performance. The differences in volumetric efficiency for various tested fuels under various loading conditions are shown in Fig. 5. the tested fuels had similar inlet conditions, and all of the tested fuels had marginal volumetric efficiency decreases as compared to diesel. Fig. 3. show Volumetric efficiency of B10, B20, B50, B70, and B100 fuel blends at 1500 rpm decreased by 0.76 %, 1.41 %, 3.08 %, 4.64 %, and 6 %, respectively, compare to diesel based on engine loads..

F. Exhaust Gas Tempreature (EGT)

The temperature of the exhaust gas offers information about the combustion process's efficiency. For all of the fuels tested, EGT increased as the engine load increased. The EGT of diesel fuel was found to be higher than that of other fuels. This will result in continuous fuel combustion until the combustion process is completed, releasing an increasing amount of heat. Fig. 6 at 1500 rpm, the EGTs and at full load were recorded to be about 161 °C, 160 °C, 159 °C, 158 °C, °C, and 156 °C, respectively for diesel, B10, B20, B50, and B70 compared to that of 154°C for mineral biodiesel.

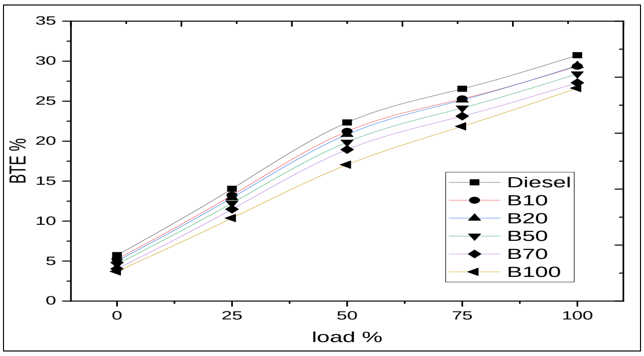

Fig 2: BTE graphic according to engine load

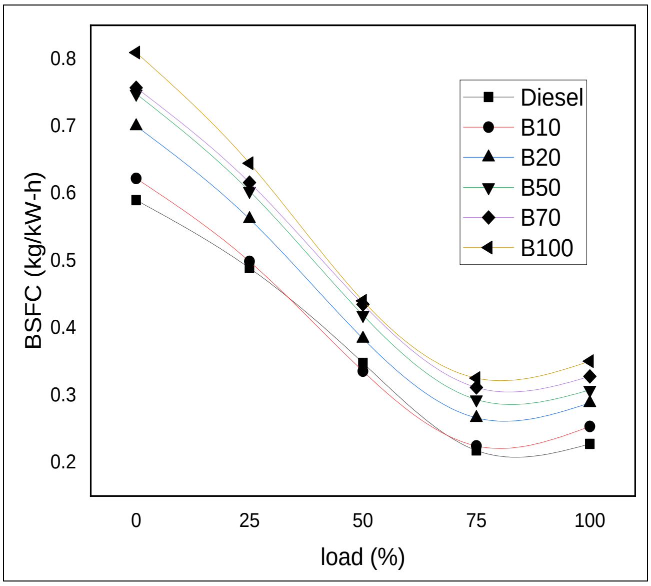

Fig. 3: BSFC graphic according to engine load

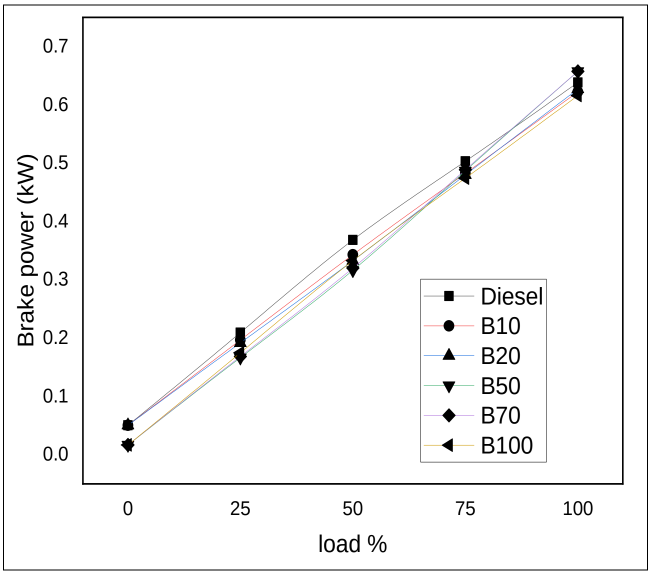

Fig 4: Brake power graphic according to engine load

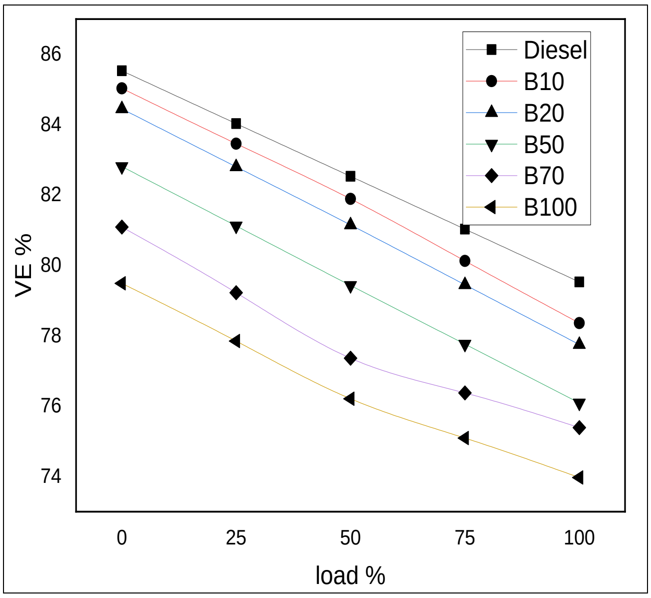

Fig 5: Volumetric efficiency graphic according to engine load

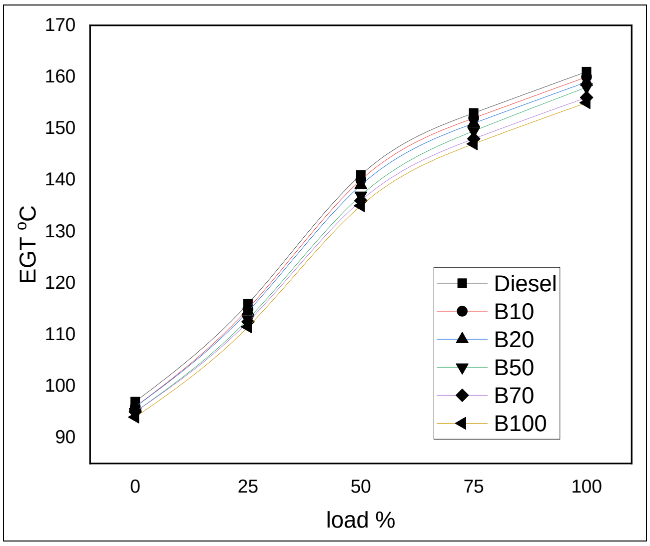

Fig 6: BSFC graphic according to engine load

Conclusion

Experimental investigations achieve on four-stroke, single-cylinder TD202 diesel engine at different type fuel fossil diesel, B10, B20, B30, B50, B70, and B100. The result of this study show:

- The best molar ratio of acid-catalyzed esterification is 3:1 methanol to oil and 0.25 wt% H_2SO_4 as a catalyst.
- The break thermal efficiency of B10, B20, B50, B70, and B100 fuel blends decreased by values of 0.76%, 1.53%, 2.56%, 3% and 3.66%, respectively, compared to fossil diesel fuels
- The specific fuel consumption increased by 0.087 kg/kW-h, 0.15 kg/kW-h, 0.212 kg/kW-h, 0.286 kg/kW-h,, and 0.344 kg/kW-h, respectively, compared to fossil diesel fuels.
- Brake power for biodiesel and its blends decrease by 0.9%, 1.7%, 3.7%, 5.6% and 7.2% for biodiesel blends B10, B20, B50, B70, and biodiesel compare with fossil diesel
- Volumetric efficiency decreases as compared to diesel.
- For biodiesel EGT decreases compared to diesel.
  Diesel engine shouldn't be modified to run with biodiesel fuel and biodiesel/diesel blends the main reason of this conclusion the Physical and chemical specifications of biodiesel and diesel fuel according to EN14214, where the specification of produced biodiesel within range of EN14214 show table 1.

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