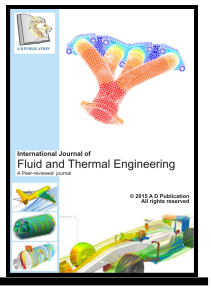
International Journal of
Fluid and Thermal Engineering
A Peer-reviewed journal

IJFTE 06 (2020) 2455-3670



Experimental investigation for performance of single cylinder Diesel Engine by using Diethyl Ether-biodiesel

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A B S T R A C T : The world is presently confronted with the twin crisis of fossil fuel depletion and environmental degradation. Ethanol is another promising alternative fuel, but there are many obstacles in the use of ethanol in CI engines. To overcome these problems, ethanol can be converted easily into DEE through a dehydration process. DEE has several favorable properties for CI engines. It is found that most of the study focuses on the use of diethyl ether in diesel engines as fuel or fuel additive in various diesel engine fuels. It is found that the various researcher used blend of DDE up to 30% with the diesel. The aim of present study is to investigate the effect of higher blending ratio of DEE with diesel on the the performance and emission parameter of the diesel engine. Experiment has been carried out with 5 kW of single cylinder water cooled diesel engine coupled with electric dynamometer. The performance tests of the engine were carried on different load conditions for each blend of biodiesel B20, B40, B60 and then data obtained from the experiments were used to evaluate the performance parameters like Brake thermal efficiency, Brake power, Brake specific fuel consumption and Exhaust gas temperature. The CO, NOx has been measure with the help of gas analyzer for similar blending ratio. It is found that engine performance increases with 40 % blending of DEE, compared to Pure diesel. It also observed lowest CO emission with 40 % blending of DEE. However NOx emission is minimum with 60% blending of DEE as compared to diesel. Current study suggest that up to 40% blending of DEE improve the performance as well as reduced emission, however more than 40% blending lead to adverse effect of performance of the diesel engine.

Keywords: Diesel engine performance, Diethyl Ether, Biodiesel, Emission

1. Introduction

Since the invention of the internal combustion engine over a hundred years ago its impact on the life of human beings has been immense. Diesel engines have become a popular prime mover in transportation and agriculture sector, because of high brake thermal efficiency at which they are capable of operating as compared to gasoline engines. This high thermal efficiency is due to high compression ratios, lean fuel air mixtures and low pumping losses due to the absence of throttle. However rapid depletion, rising prices, uncertain supplies and ever increasing requirement of petroleum and most importantly stricter emission norms have triggered an intensive research for alternative fuel. Hence, fuels which are renewable and which can be produced in a decentralized manner are being investigated as alternative fuels.

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Nomenclature	
BP	Brake power
BTE	Brake thermal efficiency
BSFC	Brake specific fuel consumption
EGT	Exhaust gas temperature
DEE	Diethyl Ether

Ethanol is another promising alternative fuel because it is a renewable bio-based resource and highly oxygenated (34.7% by weight), thereby providing the potential to reduce particulate emissions in CI engines and shows promise as a future fuel for SI engines due to its high octane quality. However, there are many obstacles in the use of ethanol in CI engines such as very low cetane number (8), poor ignition characteristics and limited solubility in diesel fuel. To overcome these problems, ethanol can be converted easily into DEE through a dehydration process. DEE has several favorable properties for CI engines such as high cetane number (>125), low auto ignition temperature, high oxygen content, reasonable energy density for on-board storage, broad flammability limits, high miscibility with diesel fuel and renewable bio-fuel. DEE is a pungent, volatile, highly flammable liquid and widely used as a common solvent.

V. Edwin Geo et al.[1] (2010) evaluated the performance of vegetable oils can be improved by injecting a small quantity of diethyl ether (DEE) along with air injection at different flow rates of 100, 150 and 200 g/h. Results indicate that the BTE of the engine improves from 26.5%. Obed M. Ali et al.[2] (2013) studied an oxygenated additive diethyl ether (DEE) was blended with palm oil biodiesel (POME) in the ratios of 2%, 4%, 6% and 8% and tested for their properties improvement. Palm biodiesel with diethyl ether additive exhibited slightly superior low temperature performance, acid value, viscosity and density with slight energy continent in comparison to POME. K.R. Patil et al.[3] (2014) carried out experimental investigation blending 2%, 5%, 8%, 10%, 15%, 20% and 25% DEE (by volume) with diesel. The experimental test results showed that the DEE–kerosene–diesel blends have low brake thermal efficiency, high brake specific fuel consumption, high smoke at full load, low smoke at part load, overall low NO, almost similar CO, high HC at full load and low HC at part load. Sandip S. Jawre et al.[4] (2014) study presents effect of diethyl ether as additive (5%,10%and 15%) to biodiesel of kusum (schliechera oleosa) methyl ester on the performance and emission of diesel engine at different load and constant speed and two different injection pressure (170 and 190 bar). Because of high oxygen contents of DEE. It also reduced at 190 bar injection pressure. Higher cetane rating of DEE and oxygen content are also advantageous for obtaining lower smoke emission. Amr Ibrahim et al [5] (2018) carried out an experiment by adding 5,10 and 15% of DEE with diesel in CI engine. It was found that using diesel-biodiesel blend increased the minimum brake specific fuel consumption (BSFC) and reduced the maximum thermal efficiency by 8.1% and 6.8%, respectively, compared to diesel fuel. However, employing 5% DEE in the diesel-biodiesel mixture improved engine performance considerably for most engine loads in comparison with all fuels.

2. Experimental Test-facility

2.1. Biodiesel blends:

Biodiesel blend contains both Diethyl Ether and diesel. B20 refers to a fuel which contains 20% of DEE and 80% of diesel. Similarly with increment in percentage of biodiesel refers to B40 and B60. Pure diesel is

designated as B00. The selected fuels were blended on volume basis (v/v). First the known volume of diesel was taken in the measuring beaker and required quantity of biodiesel was added and stirred manually for 10 to 15 min. The nomenclatures given for blends are presented in Table-1.

Table-1: Details nomenclature of Biodiesel blends with petro Diesel prepared

Sr. no	Fuel type	Nomenclature
1	0% DEE Biodiesel + 100% Diesel	B00
2	20% DEE Biodiesel + 80% Diesel	B20
3	40% DEE Biodiesel + 60% Diesel	B40
4	60% DEE Biodiesel + 40% Diesel	B60

2.2 Experimental setup

Experimental set up consist of four main integrated systems: (1) a single cylinder four stroke diesel engine (fig.2a), (2) an engine loading system (fig.2b) and (3) various measuring instrument (4) digital display (fig.2c) (4) multiple gas analyzer (fig.2d). All integrated systems attached to engine, is shown in line diagram figure 1. This test is conducted on a single cylinder four stroke diesel engine of 95mm bore and 115mm stroke. Diesel engine is coupled with electrical generator of 5kW and Engine output is measured by using ammeter and voltmeter. Exhaust gas temperature is measured by thermocouple. Multiple gas analyzer is connected with exhaust pipe of engine. Engine is also loaded by variable resistance load panel. Burette is mounted on the fuel tank which uses to measure the rate of fuel consumption. Engine specification is mentioned below Table-2:

Table-2: Engine specification

Sr. no	Engine	Specification
1	Model	Swaraj PV-4
2	Type	4- Stroke water cooled
3	Fuel	Diesel
4	Cylinder	1
5	Displacement volume	780cm3
6	Bore	95mm
7	Stroke	110mm
8	Compression ratio	15.5:1
9	Rated output	5.9kW

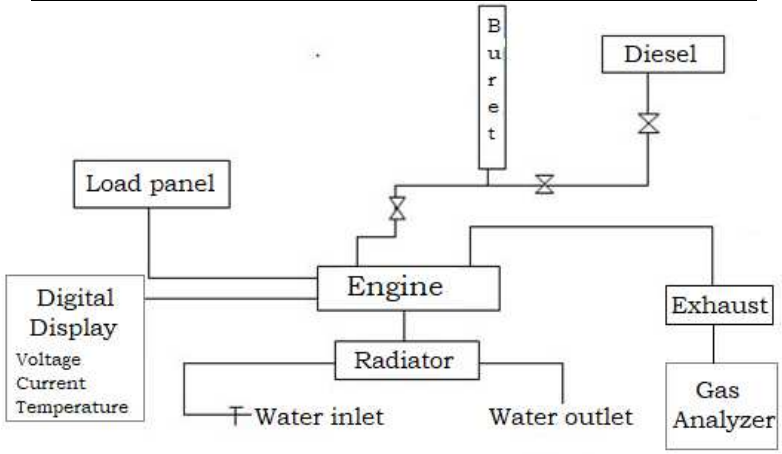

Figure 1: Schematic diagram of Experimental setup

Figure 2(a) Single cylinder four stroke diesel engine

Figure 2(b) Engine loading system

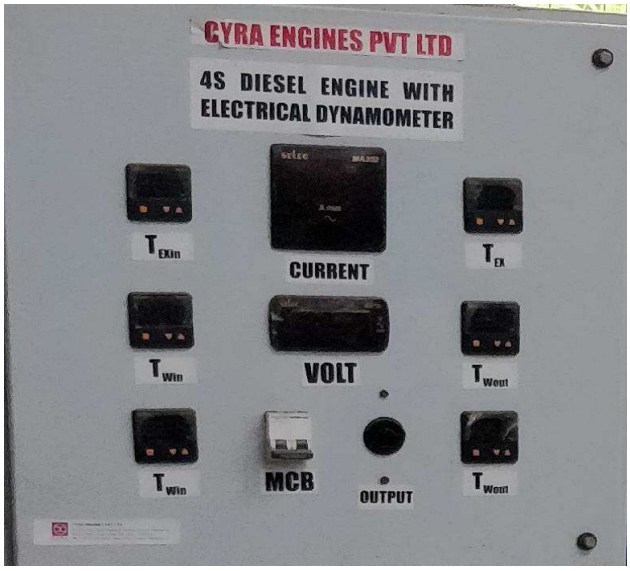

Figure 2(c) Measurement panel

Figure 2(d): multiple gas analyzer

Figure 2 Diesel Engine test-setup

2.3 Experimental procedure

Experiment was carried out on four stroke water cooled diesel engine. The engine was run at no load and at different load conditions and the various observations were evaluated in terms of BP, BSFC,BTE and emission of exhaust gas were measured at different loads for different blends of biodiesel. The digital exhaust gas analyzer detected the following parameters of the exhaust gas; CO, NO, NO_2 Exhaust gas temperature. Various observations were evaluated by measuring of time taken for 20ml fuel consumption, exhaust gas temperature, Current and voltage.

3. Result and discussion:

3.1 Performance analysis

3.1.1. Brake power:

The power developed by the engine at the output shaft is called break power. BP increases with increase in load. B40 at various load condition brake power increase rapidly than all other blend. . Highest brake power for full load condition is 3.33kW for B00 blend. Lowest brake power is for B20 DEE which is 2.48kW. Effect with load on BP is shown in figure 3

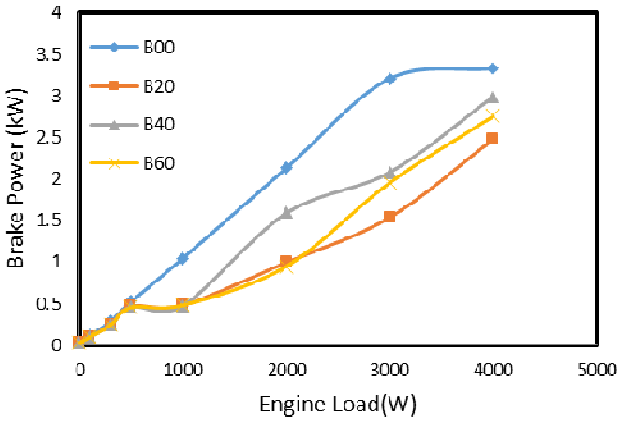

Figure 3: Brake power vs Engine load

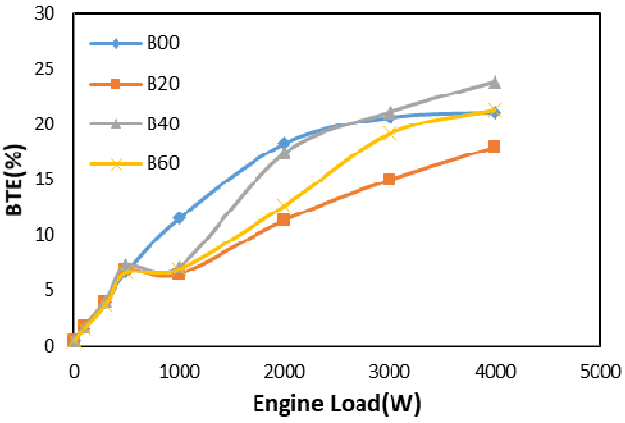

Figure 4: Brake thermal efficiency vs Engine load

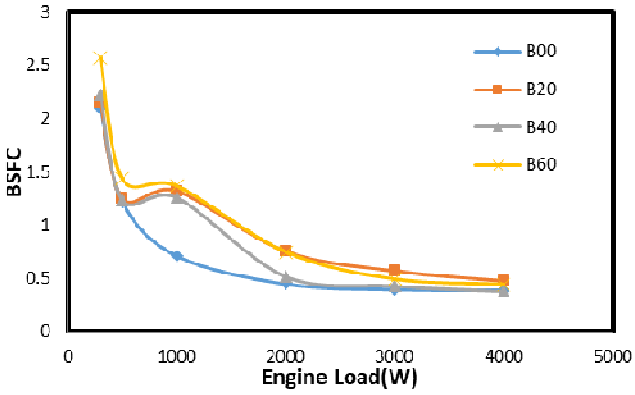

Figure 5: BSFC vs Engine Load

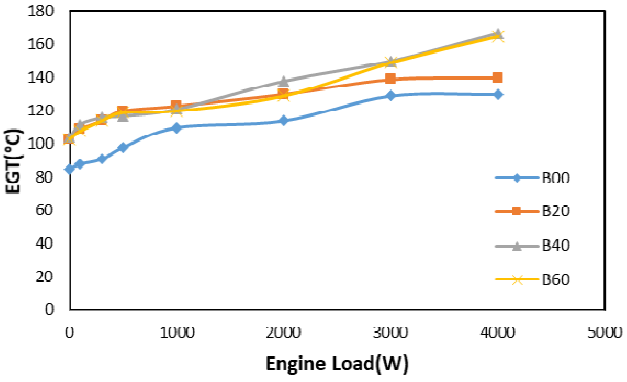

Figure 6: Exhaust gas temperature vs Engine Load

3.1.2. Brake thermal efficiency:

It is the ratio of power developed by the engine and the energy release per unit time due to complete combustion of fuel. The brake thermal efficiency of 40% DEE diesel blend is higher than all other blends. However as blend percentage increase the BTE is decrease. Highest brake thermal efficiency is 23.86% obtain

when 40% of DEE is blend with diesel at full load. It can be seen that efficiency for B40 is 2.79% more than B00 (Diesel) for full load. BTE with variable load is shown in figure 4.

3.1.3. Brake specific fuel consumption:

BSFC is the rate of fuel consumption divided by the power produced. Variation of BSFC with load is shown in figure 5. From the experiment is noticed that Brake Specific Fuel Consumption for the B40 is lowest among all blend. In case of B40 the BSFC is around 2.65% less than diesel fuel. It is also seen that as blend percentage increase the BSFC is in increase than diesel at full load. For other load condition B00 has less BSFC.

3.2. Emission analysis

3.2.1 Exhaust gas temperature:

The exhaust gas temperature increases with the increase of load. With the increase of load more fuel is burned inside the cylinder and more temperature is generated and so the exhaust temperature increases. The exhaust gas temperature also increases with the increase of bio-fuel blends.

3.2.2 NOx emission:

NOx emission can be calculated with the help of NO and NO_2. Figure 7 describes variation of NOx with different blend at different load. It is observed that NOx emission increases with increase in load. B20 produces more emission compared to other blending. . It is observed that B60 has lowest emission than others at full load.

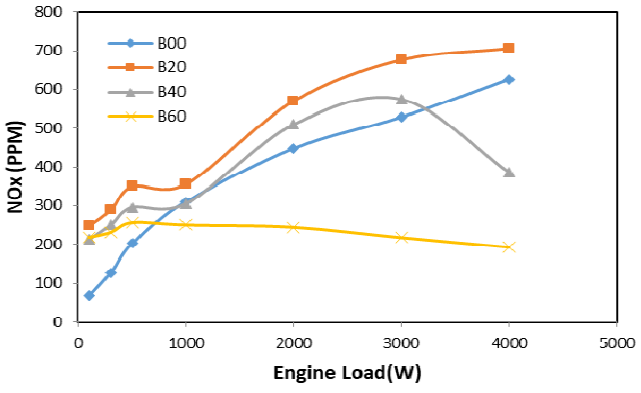

Figure 7: NO_x vs Engine Load

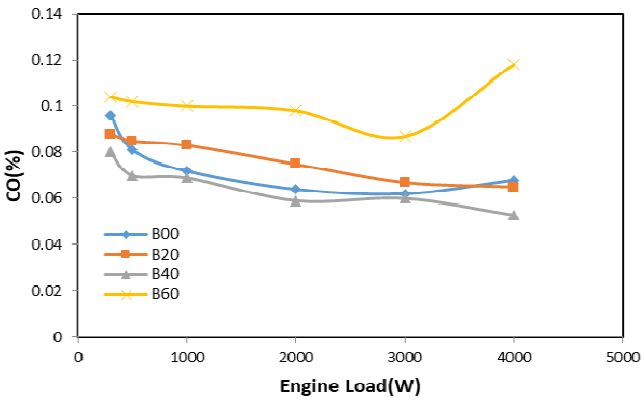

Figure 8 : CO vs Engine Load

3.2.3 CO emission

Carbon monoxide emission is observed minimum for B40 than all other blends. The load increased, CO emission decreased initially and further it increased as the load increased. Variation in CO emission with different blends of biodiesel at varying load is shown in figure 8.

4. Conclusions

In the present work, the performance and emission evaluation of single cylinder four stroke diesel engine using neat diesel and Diethyl Ether biodiesel for different blends and variable loading are carried out. Highest brake power for full load condition is 3.33kW for B00 blend. Lowest brake power is for B20 DEE which is 2.48kW. Maximum variation in BTE is observed at 80% of load which is 2.79% higher than diesel. Brake specific fuel consumption for the B40 is lowest among all blend. In case of B40 the BSFC is around 2.65% less than diesel fuel at full load. Exhaust gas temperature is increases with increasing load on engine. There is 26.92% increase in temperature compared to diesel at full load. Carbon monoxide emission is observed minimum for B40 than all other blends. Minimum emission is observed at 80% of load on engine. Nitrogen oxide emission increases with increasing load on engine. It is observed that B60 has lowest emission than others at full load. The optimum condition for performance of engine using biodiesel is blend of 40% biodiesel and 80% load on engine. Whereas desiring lowest emission, optimum condition is to use B40 blend.

5. References

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