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A Comparison of Using Bio-Diesel and the Normal Diesel in Operation of Diesel Engines

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ABSTRACT
In this study, the experiment was conducted using a diesel engine single cylinder four-stroke direct injection, air-cooled. Used in the experiment are four types of fuel: pure diesel, mixture of methanol and diesel by methanol 8% -16% and 24%, three levels of speeds 1500, 2000 and 2500 rpm .we studied in this research The engine performance parameters which included, thermal efficiency, brake specific fuel consumption, noise level ,friction power.

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1. Introduction

Rapid depletion of petroleum reserves and degradation of environment by means of global warming through the pollutant emission by the automotive sector as well as stringent emission norms necessitated the finding of an alternative fuel for internal combustion engine. In the previous few decades, straight vegetable oils and biodiesel make an impact as an alternative fuel for compression ignition engine. However, the above mentioned fuel, being more oxygenative in nature, improves the fuel properties as well as the combustion process. However, alcohols such as ethanol and methanol also received a wide attention from the researchers due to it's oxygenate nature. Alcohols derived from bioresources widely used in compression ignition engine as a supplementary fuel to that of petroleum diesel. However, methanol has an advantage because of its low price and higher oxygen fraction. But as reported by several researchers [1, 2] there is some difficulty to form a homogeneous dieselmethanol mixture, hence the research on this area is very limited.

Methanol or methly alcohol, is composed hydrocarbon ,The chemical compound formula CH_3OH, consisting of oxygen, hydrogen, and carbon is produced industrially or laboratory or extracting, from corn or sugar cane. Is used in electrical power generation and manufacture of paints, plastics and coatings and as an additive for fuel vital because it contains oxygen, it is completing the process of combustion of the mixture in addition to reducing exhaust gas emissions, cases methanol and diesel fuel are blended with an additive Whereas in the fumigation mode, diesel fuel is injected through the injector and methanol is injected with the air intake system into the cylinder [3]. Sayin [4] The low heating value of methanol increased the brake specific fuel consumption also. The same trend was also observed by Sayin and his research group in two different studies also [5, 6]. In addition to these performance behaviors they also observed an increase in brake specific energy consumption. The increment was due to the lower energy content of methanol as reported by them. Gaurav Dwivedi,et al.,2011[7] The reduction of blend methanol in viscosity helps to improve the atomization, fuel vaporization and combustion. The thermal efficiency of blends has improved due to faster burning of methanol in the blend. The reason being the rise in the heat release rate due to rapid combustion of methanol by flame propagation. The thermal efficiency has increased compared to diesel and blends of methanol with diesel.miqdam and Khalil[8] noise decreased in blend diesel methanol because methanol have oxgen and improve combustion.

2. Properties of Methanol

Properties of any fuel depend fully on its chemical compositions which determine the performance and emission characteristics of the engine. diesel fuel is made from petroleum. All petroleum crude oils are composed primarily of hydrocarbons of the paraffinif, naphthenic, and aromatic classes, each class contains a very broad of molecular weights, Diesel fuel must satisfy a wide range of engine types, different operating conditions and duty cycles, as well as variations in fuel system technology, engine temperatures and fuel system pressures, it must also be suitable for a variety of climates, the properties of each grade of diesel fuel must be balanced to provide satisfactory performance over an extremely wide range of circumstances . Methanol is one of the most attractive alternative fuels for compression ignition engine with a chemical formula of CH3OH. It can be readily made from widely available fossil raw materials including coal, natural gas, and bio substances. Methanol is also a clean fuel when judged by regular emission standard. Methanol has many desirable combustion and emission characteristics. It has a lower viscosity compared to diesel fuel, which enhances the atomization process. Higher oxygen content and low sulphur content results a lesser amount of pollutant emission.

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Table 1. Comparison of thermo-physical properties of methanol and diesel.

Lab . Insp.Data	**Gas oil**	**Methanol**	**M8 Gas oil +Methanol**	**M16 Gas oil Methanol+**	**M24 Gas oil +Methanol**
SP. Gravity @ 15.6˚C	0.8236	0.6576	0.8217	0.8208	0.8160
API. Gr. @ 15.6˚C	40.3	21.2	40.7	40.9	41.9
Flash point ˚C	66.2	15	flammable	flammable	flammable
Colour (ASTM)	0.9	0.2			
Pour Point ˚C	-12	-20	Below-21	Below-21	Beloe-21
Vis C.st @ 40 ˚C	2.6	2.0	2.3	2.2	1.7
Carbon Res. Wt %	0.1	0			
Sulfur. W_t %	0.65	0	0.56	0.56	0.55
Cetane Index	57.3	51.2	57.1	56.4	54.9
Density @ 15.0 ˚C	0.8232	0.7921	0.8213	0.8204	0.8156
Calorific value Kcal /Kg	11001	4897	10985	10982	10975

Table 2. Engine Specifications.

Engine Manufacturer	**'Robin' - Fuji DY23D.**
Piston Displacement	230 cm^3.
Stroke	60 mm.
Bore	70 mm.
Nominal Output	3.5 kW at 3600 rev/min.
Maximum Torque	10.5 Nm at 2200 rev/min.

The higher laminar flame propagation speed leads to finish the combustion earlier, thus improves the thermal efficiency of the engine. Lower Calorific value (LCV) of methanol has an average value of 11001 kcal/kg which is much lower than that of diesel, thus increases the fuel consumption of the blended fuel. The high stoichiometric fuel/air ratio, higher oxygen content. The thermo-physical properties of methanol compared to the diesel are listed in Table 1 below.

3. Methodology

In the present work a comparison of using bio-diesel and thenormal diesel in operation of diesel engines (8%, 16% and 24%) on the performance The experiments were conducted using a single cylinder, four-stroke, direct injection, air cooling, robin engine. The parameters, which were calculated in order to find the performance and emission characteristics of the engine were: brake thermal efficiency, brake specific fuel consumption,noise level ,friction power. These parameters were calculated for all the fuels at constant engine speeds of 1500,2000,2500 rpm. The engine used in this work has the specification shown in Table 2.

4. Results and Discussion

4.1 Brake thermal efficiency BTE

The ratio of the brake power output and the energy released due to complete combustion of fuel is called brake thermal efficiency. It also indicates the ability of the combustion system. Figure 1 ,2 indicates the variation of brake thermal efficiency of the engine with diesel and other blends of methanol (M8, M16 and M24) with diesel at different speeds 1500,2000,2500. From the results, it is observed that with decrease of speeds, the brake thermal efficiency for each fuel (pure or blended fuel) increases and the maximum thermal efficiency is obtained at speed 1500rpm 5**3.4**% for M24 . It can be observed from the same figure that pure diesel and diesel-methanol blends follow similar trend, but brake thermal efficiencies increase with the increase of methanol percentage in the blend. The reason behind is that methanol contains more oxygen by mass (50%) than pure diesel which results in better combustion and hence the efficiency increases. The oxygen content of methanol blended fuels enhances the combustion efficiency and decreases the heat losses in the cylinder due to lower flame temperature. In addition to that, the vaporization of the fuel continues in the compression stroke as the latent heat of vaporization is more with methanol blended fuel. As the fuel absorbs heat from the cylinder during the vaporization, the work required for compressing the air–fuel mixture decreases and this situation increases the thermal efficiency.

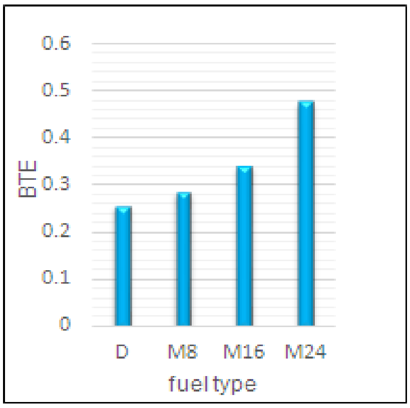

Figure 1. Brake thermal efficiency vs. fuels type for diesel and diesel-methanol blends.

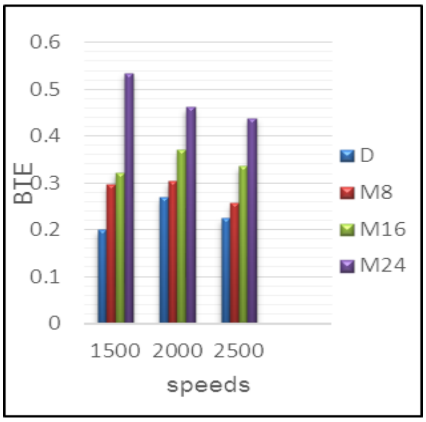

Figure 2. Brake thermal efficiency vs. speeds,fuels type for diesel and diesel-methanol blends.

4.2 Brake specific fuel consumption BSFC

Brake specific fuel consumption (BSFC) is defined as the fuel consumption rate to produce unit brake power. Generally, the specific fuel consumption of the blended fuel is more because of the lower heating value of methanol than gasoline. The heating value of methanol is lesser than diesel due to 50% oxygen content in the fuel which does not contribute to heat generation during combustion inside the cylinder and it normally increases fuel consumption for methanol and its blends. However, the consumption rate is also dependent on the engine operating conditions like load condition and speed.Figure 3 represents the variation of the brake specific fuel consumption of diesel and blends of methanol (M8, M16 and M24) with diesel.

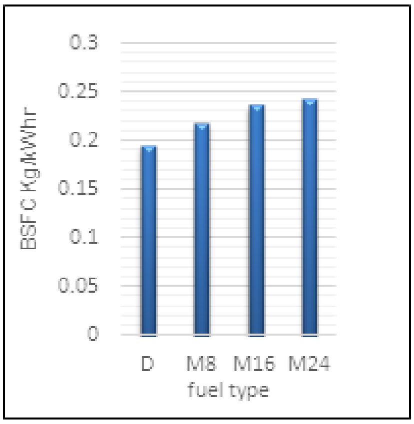

Figure 3. BSFC vs. fuels type for diesel and diesel-methanol blends

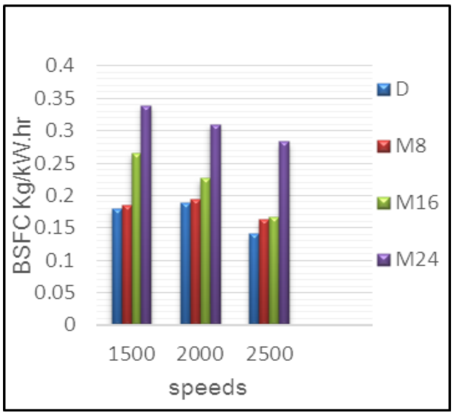

Figure 4. BSFC vs. speeds,fuels type for diesel and diesel-methanol blends

From the figure 4, it is observed that the brake specific fuel consumption of pure diesel as well as the blends of diesel and methanol increase with decrease in speed. It can be clearly seen from the figure that, with the addition of methanol in the blended fuel, brake specific fuel consumption increases. Thisbehavior is due to the lower energy content of methanol, for that, producing same amount of speed consumption is more . Also the low density and viscosity as well as the low cetane number can be responsible for this kind of behavior.

4.3 noise level dB

The engine is a complex source of noise whose power is made up of the acoustic energy fluxes emanating from different individual sources. The most important component of internal combustion engine noise is: acoustics of aerodynamic nature, noise generated by vibrating surfaces and acoustic energy released in the atmosphere by the engine vibration on its elastic suspension. noise level decreased in increasing persantage of methanol compares with diesel because methanol improve combustion.increasing engine speeds gives hard combustion and higher noise. Whereas increasing methanol percentage improved the combustion characters without mentioning the reduction in resulted brake power. This helped in reducing engine noise. Increasing methanol portion in the blends may not improve engine performance or resulted emissions but it definitely reduced engine noise. Increasing speed increased the mechanical vibrating parts but the aerodynamics of engine combustion became smoother, so the measured noise level was the resultent of these two parameters. It is obvious now that adding methanol makes the combustion smoother and reduces the combustion noise.

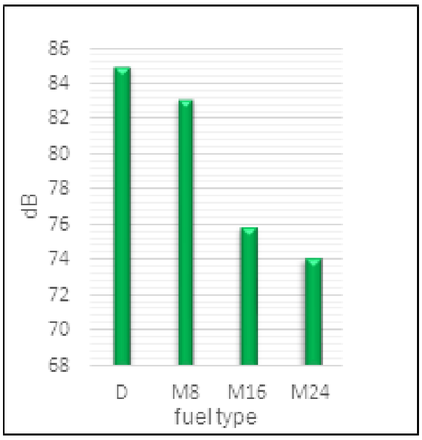

Figure 5. dB vs.,fuels type fordiesel and diesel-methanol blends.

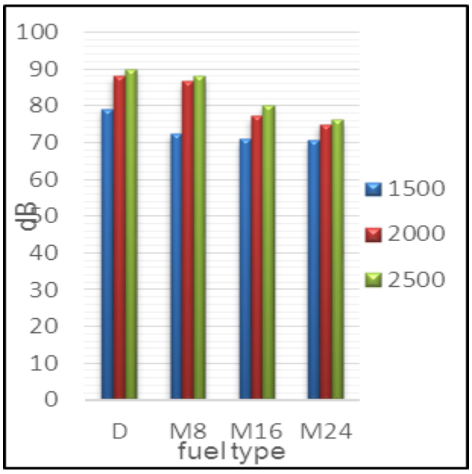

Figure 6. dB vs. speeds,fuels type for diesel and diesel-methanol blends.

4.4 Friction power FP

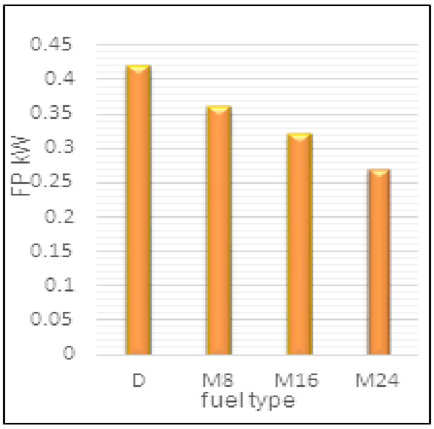

Figure 7. fp vs.,fuels type fordiesel and diesel-methanol blends.

Fig 7 showes the variation of friction power with fuels type for diesel and diesel-methanol blends.friction power increasing with diesel compared diesel-methanol.the main reason methanol have more evaporation and cooling cylinder lead to increasing oil viscosity more than diesel. Fig8 showes the variation of friction power with speed,the friction power increasing in speed .the main reason no more time to cooling engine.

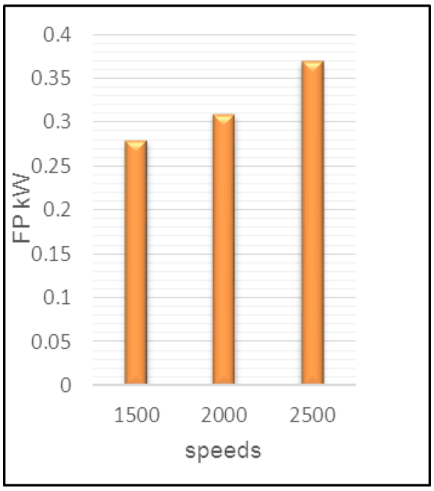

Figure 8. fp vs. speeds,fuels type for diesel and diesel-methanol blends.

5. Conclusion

From the above study it can be concluded that, methanol can be a suitable supplementary fuel of CI engine. A marginal improvement in brake thermal efficiency and BSEC is observed. This is due to more complete combustion in the fuel-rich zone. This enhances the combustion efficiency and decreases heat losses in the cylinder due to lower flame temperature of methanol-blended fuels. However, BSFC increase to some extent with methanol addition to diesel due to lower energy content of methanol. On the other hand brake thermal efficiency increasing in methanol blends,noise level decreasing in methanol blends and friction.

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