International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Experimental Investigation of Methanol-Diesel Blends as Alternate Fuels for Compression Ignition Engines

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Accepted 31 May 2016, Available online 06 June 2016, **Vol.6, No.3 (June 2016)**

Abstract

The rapid industrialization and the rise in the population of the world as led to a sharp increase in the demand for conventional sources of energy. The use of fossil fuels has led to rapid environmental degradation due to excessive pollutant emissions. Fossil fuel resources are getting depleted at a rapid rate. Hence importance has to be given towards the research of alternate fuels. Methanol and various other alcohols can behave as suitable alternate fuels. Methanol can be widely manufactured from feedstock sources which makes it advantageous. In the present work methanol-diesel blends are proposed as alternate fuels. The blends chosen are M10 (10% methanol+90% diesel), M20 (20% methanol+80% diesel) and M30 (30% methanol+70%diesel).The creation of methanol-diesel emulsion is carried out by means of a mechanical stirrer. The performance and emission characteristics of methanol-diesel blends are tested on a four stroke, single cylinder, water cooled diesel engine and the results are analyzed.

Keywords: *Alternate fuels, Diesel, Alcohol, Methanol, Blends, Performance, Emissions.*

1. Introduction

In the current scenario rapid industrialization of the world is taking place. With the ever increasing population of the world the need for energy resources is continuously rising at a sharp rate. The use of fossil fuels like petrol and conventional diesel there is causing a rapid deterioration of the environment. Various pollutant emissions are highly harmful and pose a serious threat to the environment. Fossil fuels are also non-renewable, the will become scarce in the coming years. Therefore we need to turn our attention towards other alternative fuels in order to sustain our energy needs and also to reduce the level of pollutant emission. Several alternate fuels like hydrogen, biodiesels and alcohols are available. A vast amount of research activity is being carried out in the field of alternate fuels.

In the experimental investigation of methanol-biodiesel blends using blends containing 5%, 10% and 15% of methanol along with diesel it was concluded that there was a marginal increase in brake thermal efficiency and the specific fuel consumption. It was also noted that the NOx emissions were reduced by 15.96%(C. Mishra, *et al*, 2013).During research of effect of load and methanol percentage in blended fuels on a four stroke compression ignition engine it was concluded that for a constant value brake power there was an increase in the value of friction power and also there was an increase in the fuel consumption as the proportion of methanol was raised in the blends. It was concluded that a blend of diesel and methanol containing 12% of methanol gave the best performance (T. Singha, *et al*, 2014).

In the experimental investigation of the effect of usage of biodiesels on compression ignition engines it was concluded on an overall basis that by the use of biodiesels there is an increase in the emission of nitrous oxide, but there is a reduction in the emission of CO, HC and particulate matter. It was also concluded that a higher value of brake thermal efficiency and a lower value of specific fuel consumption is obtained (Puneet Verma, *et al*, 2015). During the research of application of n-butanol and diesel blends to a turbo-charged compression ignition engine it was noted that the addition of n-butanol to diesel caused a slight reduction in the value of torque produced. There was also a drop in the value of exhaust gas temperatures which led to an increased value of volumetric efficiency (Lennox Siwale, *et al*, 2013).

During the investigation of blending n-propanol along with diesel and using it on a four stroke diesel engine it was seen that there was the reduction of CO and NOx emissions by 44.12 and 9.33% at full load. The performance analysis revealed that there was a 11.78% increase in the brake thermal efficiency when for a blend containing 10% n-propanol along with diesel (T.Balamurugan, *et al*, 2014).In the experimental investigation of biodiesel-diesel-ethanol blends which

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DOI: http://Dx.Doi.Org/10.14741/Ijcet/22774106/6.3.2016.36

contained 10% of ethanol, on a compression ignition engine it was seen that there was a slight increase in the value of brake thermal efficiency along with a drop in HC, CO and NOx emissions (B.Manoj Kumar, *et al*, 2015).

The investigation of the use of cotton seed oil and diesel blends on a compression ignition engine demonstrated that at 195 bar injection pressure the blends showed better performance characteristics when compared to conventional diesel (S.Kirankumar, 2013).By the use of palm oil biodiesel with titantium oxide nanoparticles it was revealed that at a speed range of 2000-3000 rpm all the biodiesel fuels containing 0.1% of nanoparticles gave a higher value of brake power and exhibited a low value of exhaust emissions(K. Fangsuwannarak, *et al*, 2013).

The present investigation aims at determining the performance and emission characteristics of diesel methanol blends M10, M20 and M30 which contain 10%, 20% and 30% of methanol.

2. Methanol as an Alternative Fuel

Methanol which is also generally known as methyl alcohol or wood alcohol can be used as a suitable alternative fuel. They are highly advantageous because they can be manufactured widely from feedstock sources. Methanol is the lowest alcohol containing only one carbon atom along with four hydrogen atoms and also one oxygen atom. They are characterized by the ability to give a cleaner combustion with low value of pollutant emissions. Methanol is characterized by a number of advantages which include a low value sulfur content and a high latent heat of vapourization. But on the downside methanol is corrosive and has longer ignition delay

3. Materials

The conventional diesel fuel is obtained from Bharat petroleum limited. The methanol is obtained from a private laboratory. The methanol diesel blends containing 10%, 20% and 30% methanol are created by means of a mechanical stirrer.

Table 1 Comparison of properties of Methanol and diesel

Property	Methanol	Diesel
Chemical Formula	CH_3OH	$C_{14}H_{22}$
Boiling Point(°C)	64.5	10-340
Flash Point (°C)	11	52
Cetane Number	3	50-55
Calorific Value (kJ/kg)	23800	44500
Auto Ignition Temperature(°C)	464	180-240
Sulfur content (ppm wt)	0	<350
Oxygen Content (% wt)	50	0

4. Methodology

The experimental setup consists of a single cylinder, four-stroke, direct-injection, water cooled engine is coupled with an electrical dynamometer. An 8-bit data aquistion system is utilized. Devices such as the smokemeter, exhaust gas analyzer and the exhaust gas thermocouple are attached to the exhaust side of the engine.

Proper precautions have to be taken, the engine should not be started or stopped when loaded. The level of lubricating oil should be properly monitore. The cooling system should be in an effective working condition.

The experiments are first carried out on the engine setup by using neat diesel as the fuel to provide the base data. The performance and emission characteristics of diesel are estimated at 0%, 20%, 40%, 60% and 80% load. The experiments are then carried out by applying the methano-diesel blends to the engine. The performance and emission characteristics are estimated at the various loading conditions. The readings are tabulated and analyzed

Table 2 Engine Specifications

Make	Kirloskar AV 1 model
Number of cylinders	One
Speed	1500rpm
Maximum power output	3.5kw
Bore	87.5mm
Stroke	110mm
Compression ratio	17.5:1
Fuel injection timing	23°BTDC
Type of cooling	Water cooled
BMEP at 1500rpm	5.42 bar

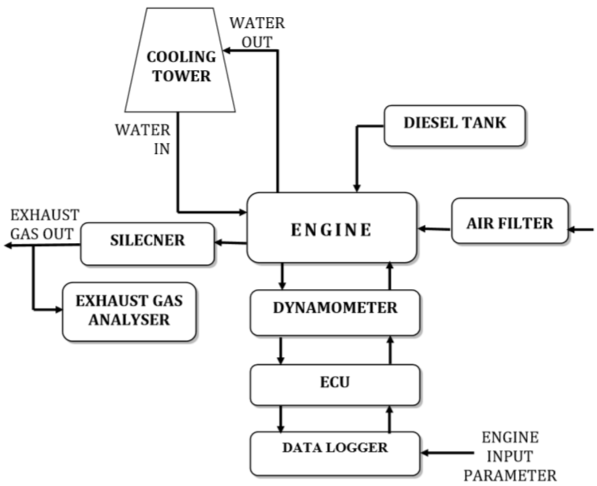

Fig.1 Engine Test Rig Setup

5. Results and discussion

5.1 Performance Characteristics

Brake thermal efficiency is defined as the ratio of the brake power to the combustion energy of the fuel. From Fig.1 it is seen that as the loading gradually increases there is an increase in the value of brake thermal efficiency for neat diesel and the blends. At 80%the efficiency increases by 1.4% and 5.5% for the M10 and M30 blends. The increase in efficiency of the blends is due to the increased oxygen content of methanol which promotes better combustion efficiency.

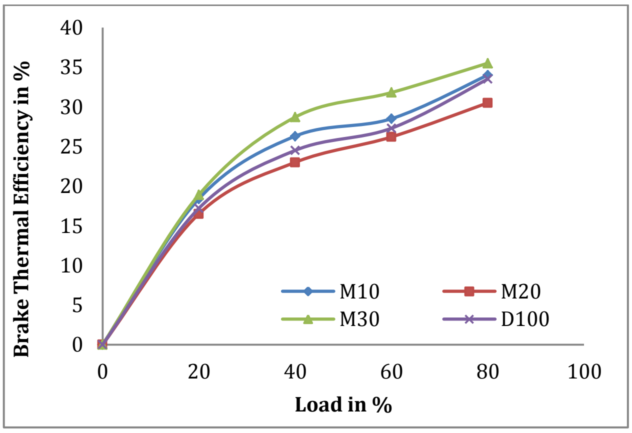

Fig.2 Variation of BTE with load for diesel and diesel-methanol blends

Brake specific fuel consumption is the fuel required to produce unit brake power. From Fig.3 it is seen that as the load increases there is a decrease in the amount fuel consumed for all the diesel methanol blends and diesel. The BSFC of all the blends are higher than that of neat diesel. There is an increase in the amount of fuel consumed with the increase in proportion of methanol in the blends. The increase in the BSFC of the blends is due to the low heating value of methanol.

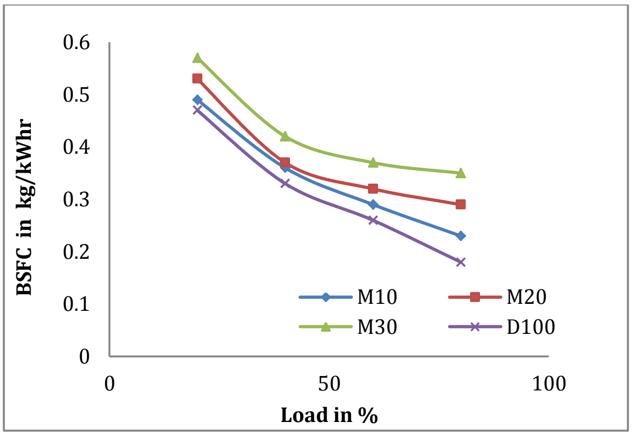

Fig.2 Variation of BSFC with load for diesel and diesel methanol blends

5.2 Emission Characteristics

From Fig.4 it is seen that there is an increase in the NOx emission as the load increases for all the blends and neat diesel. The NOx emission of the blends are lower than that of diesel. Higher the percentage of methanol lower is the NOx emission. At 80% load the NOx emission reduces by 4.05%, 18.9% and 39.1% for the M10, M20 and M30 blends. The addition of methanol reduces the combustion temperature thereby reducing NOx emissions. The decrease in NOx emission is also attributed to the high latent heat of methanol.

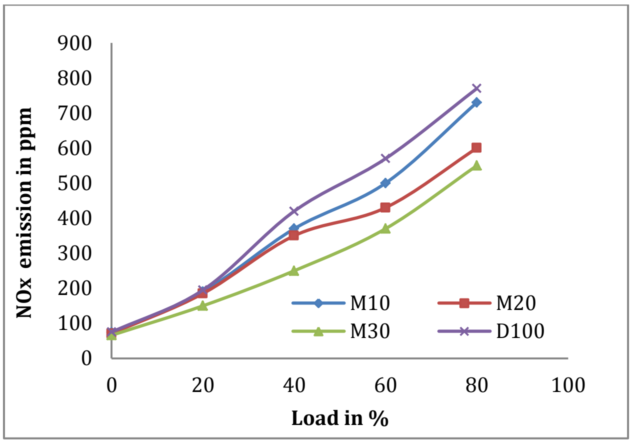

Fig.4 Variation of NOx emission with load for diesel and diesel-methanol blends.

The formation of CO takes place due to the insufficient availability of oxygen during combustion. But the addition of methanol improves the presence of oxygen thereby reducing the emission of CO. From Fig.5 it is seen that the CO emission is lower than diesel for all the blends. At 80% load there is a 19.5% reduction of CO for the M10 blend, a 40.7% reduction of CO for the M20 blend and a 31.7% reduction in the emission of CO for the M30 blend.

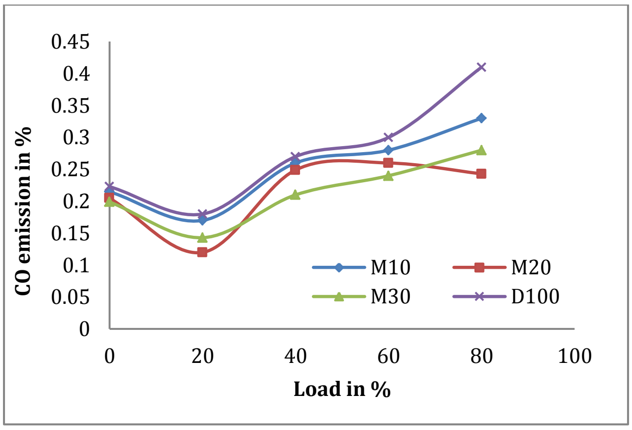

Fig.5 Variation of CO emission with load for diesel and diesel methanol blends

Fig.6 shows the variation of HC emission with the increasing value of load for diesel and diesel-methanol blends. It is seen that on an overall basis there is a reduction of unburnt HC emission for all the blends when compared to diesel due to the increased availability of oxygen which leads to complete combustion. At 80% load there HC emissions are reduced by 22% and 7% for the M10 and M30 blends but there is an increase in the emission by 4% for the M20 blend.

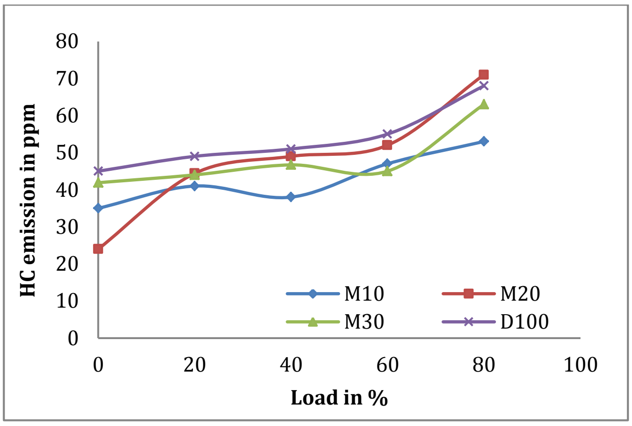

Fig.6 Variation of HC emission with load for diesel and diesel-methanol blends.

Conclusions

1) Due to the increased oxygen percentage as a result of methanol addition there is an improvement in the combustion efficiency and hence the brake thermal efficiency increases by 1.4% and 5.5% at 80% load for the M10 and M30 blends

2) The BSFC of all the blends are higher than diesel due to the low heating value of methanol.

3) As the combustion temperature reduces due to methanol addition there is a decrease in the NOx emission for the blends when compared to diesel. At 80% load the NOx is reduced by 4.09%, 18.9% and 39.1% for the M10, M20 and M30 blends

4) Due to the increased availability of oxygen CO emission is reduced by 19.5%, 40.7% and 31.7% for the M10, M20 and M30 blends at 80% engine load.

5) Complete combustion is produced due to increased presence of oxygen due to methanol addition in the blends. Therefore there is a decrease in the amount of unburnt HC emission. At 80% load the HC emission reduces by 22% and 7% for the M10 and M30 blends.

From the above discussion it is evident that methanol can be blended with diesel and used a an efficient alternate fuel in compression ignition engines.

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