Experimental Investigation of Performance of Single Cylinder Diesel Engine Using Various Blends

Sanjay R. Lohar, Kaustubh M. Pimple, Smit S. Mhatre, Pramod D. Pansare, Rahul U. Mishra

ABSTARCT- Fast depletion of fossil fuel, rapid increase in the price of petroleum products and harmful exhaust emission from the engine jointly created renewed interest among researchers to find out suitable blend. In the present study of 4 stroke single cylinder diesel engine which was tested with three different blends. In the first case, Diesel-Kerosene blend (with 5% to 20% by volume), in the second case Diesel-Methanol blend (with 5% to 20% by volume) and in the third case Diesel-Ethanol blend (with 5% to 20% by volume) along with diesel was tested at constant engine speed of 2200 rpm. Different engine exhaust emission such as Carbon Monoxide (CO) and Carbon Dioxide (CO_2) were compared with Diesel. Using diesel-kerosene blend, exhaust emissions from diesel engine were more as compared to pure diesel. For Diesel-Methanol blend value of %CO was reduced at any mixing ratio i.e. the fuel combustion is proper and more CO was gets converted into CO_2. For Diesel-Ethanol blend value of %CO was reduced at any mixing ratio i.e. the fuel combustion was proper and more CO was gets converted into CO_2.. %CO was reduced by 57.14% as compared to Diesel for D20E. The performance characteristics of the blends were also compared with Diesel. For Diesel-Kerosene blend the fuel consumption was lower as compared to the Diesel and the lowest fuel combustion was observed for the 10% Kerosene blend. For Diesel-Methanol blend the fuel consumption was increases for all the mixing ratio and highest fuel consumption was observed for the 20% Methanol blend and for Diesel-Ethanol blend the fuel consumption was lower as compared to the Diesel and the lowest fuel consumption was observed for the 20% Ethanol blend.

KEYWORDS: Diesel engine, Kerosene, Methanol, Ethanol, Performance, Fuel properties, emission.

I. INTRODUCTION

The pollutants that are exhausted from the internal combustion engines, affect the atmosphere and cause problems such as global warming, smog, acid rain, respiratory hazards etc. These emissions are mostly due to nonstoichiometric combustion, dissociation of nitrogen and impurities in the fuel and air .Major emissions include Carbon Monoxide (CO), Nitrogen Oxides (NOx), unburn Hydrocarbons (HC), oxides of Carbon, oxides of Sulphur and other carbon particles or soot. There are various ways to treat these pollutants.

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Sanjay R. Lohar, Assistant Professor, Vidyavardhini's College of Engineering & Technology, Vasai, University Of Mumbai. India
Kaustubh M. Pimple, Student of Dept. Of Mechanical Engineering, Vidyavardhini's College of Engineering & Technology, Vasai, University Of Mumbai. India
Smit S. Mhatre, Student of Dept. Of Mechanical Engineering, Vidyavardhini's College of Engineering & Technology, Vasai, University Of Mumbai. India
Pramod D. Pansare, Student of Dept. Of Mechanical Engineering, Vidyavardhini's College of Engineering & Technology, Vasai, University Of Mumbai. India
Rahul U. Mishra Student of Dept. Of Mechanical Engineering, Vidyavardhini's College of Engineering & Technology, Vasai, University Of Mumbai. India

Two major ways are –treatment inside the cylinder and after treatment or treatment outside the cylinder. In this project blends are prepared which replaces the diesel fuel meant for the engine, and the emission and performance parameters are studied. The objective of this project is to create a new fuel that can be used in a diesel engine. The fuel is created by making a blend of diesel using a Kerosene, Methanol and Ethanol. The blend has to be stable for a longer period of time. This blend is then used in a laboratory installed diesel engine coupled with a Rope Brake Dynamometer. The emission and performance characteristics of the engine are thus noted down and put in tabular form. Then the engine is run with regular diesel fuel and same observations are taken. A comparison is done between the two cases in terms of performance and emission properties of the fuel. Blends are made from the constituents spontaneously or by a mechanical way. A mechanical agitator is used to mix the liquids thoroughly. After mixing them for some time, blends are formed.

1. Diesel and Kerosene

Blend of diesel and kerosene prepared by 5%, 10%, 15% & 20% of Kerosene by volume.

2. Diesel and Methanol

Blend of Diesel and Methanol prepared by 5%, 10%, 15% & 20% of Methanol by volume.

3. Diesel and Ethanol

Blend of Diesel and Hexanol-Ethanol prepared by 5%, 10%, 15% & 20% of Ethanol by volume here Hexanol was used as a binder between Diesel and Ethanol.

Comparison of fuel properties

Property	Diesel	Kerosene	Methanol	Ethanol
Chemical formula	$C_{12}H_{26}$	$C_{10}H_{22}$	CH_3OH	C_2H_5OH
Boiling Point (^0C)	260-320	180-240	64.5	78
Density (kg/m^3)	824.2	780-810	796.6	788.2
Calorific Value (KJ/kg)	44500	45400	23800	29847

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II. LITERATURE REVIEW

DIESEL- KEROSENE BLEND

V P Sethi [3], has worked on performance of single cylinder diesel engine. Using diesel-kerosene blend, exhaust emissions from diesel engine were lowest (as compared to pure diesel) at 30% kerosene blend in pure diesel. Specific fuel consumption lowered by 3.67% using 30% kerosene blend in pure diesel. Fuel operating cost reduced by 2.6% at 30% kerosene blending pure diesel.

DIESEL METHANOL BLEND

P. C. Jikar, M.D.Bawankure, A.G.Rokade [6], has worked on Performance Evaluation of Using Methanol-Diesel Blended Fuels in CI Engine. A comprehensive study on the methanol as an alternative fuel has been carried out. In this study, the diesel engine was tested using methanol blended with diesel at certain mixing ratio of 10:90, 20:80 and 30:70 of methanol to diesel respectively. Experimental results showed that the output power and torque for diesel fuel is lower compared to methanol-diesel blended fuel at any ratio. The best mixing ratio that produced the lowest exhaust temperature was at 10% of Methanol in 90% of Diesel fuel. The exhaust temperature for diesel fuel was higher compared to any mixing of the blended fuel. The brake specific fuel consumption for the three mixing ratios was not varying significantly but the lowest was for 30% Methanol and 70% Diesel. The specific fuel consumption for diesel fuel was much lower compared to any mixing ratio. It was noticed that brake thermal efficiency was thus improved in almost all operation conditions with the methanol and diesel blended fuels.

DIESEL HEXANOL-ETHANOL BLEND

A.P. Sathiyagnanam, C.G. Saravanan and M. Gopalakrishnan [4], Hexanol was added in ethanol – diesel fuel to prevent separation of ethanol from diesel in this study. The ethanol blend proportion can be increased upto 45% in volume by adding the Hexanol. Engine performance and emissions characteristics of the fuel blend were investigated on a diesel engine and compared with diesel fuel. Experimental results show smoke emission decreases significantly with the increase of oxygen content in the fuel. When blended fuels are used, nitrogen oxides (NOx) emission is almost the same as or slightly higher than the NOx emission when diesel fuel is used.

EXPERIMENTAL SETUP

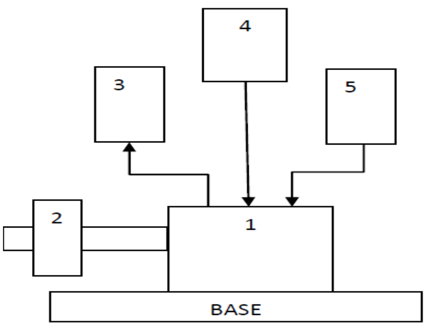

Figure 1. Schematic diagram of test rig Engine specification

Parts of the test rig:

1. Diesel Engine
2. Rope brake dynamometer
3. Orsat apparatus
4. Air reservoir
5. Fuel tank

Table no. 1 Engine specification

Power	5 BHP / 3.7 kW
R.P.M.	2200
Lubricating Oil	SAE-30/40
Specific fuel consumption	275 g/kWh

III. OBSERVATIONS AND CALCULATION

Observation table:

Table no. 2 Performance characteristics

Fuel	Net Load (kg)	Speed (rpm)	Fuel Consumption (kg/hr)	Brake Power (kw)	Brake Thermal Efficiency (%)
Pure Diesel	0	2189	0.7	0	0
	5	2154	0.76	1.85	24.22
	10	2117	1.01	3.59	30.11
	15	2090	1.25	5.31	35.98
D10K	0	2165	0.67	0	0
	5	2144	0.73	1.09	11.95
	10	2111	0.925	2.504	21.66
	15	2047	1.08	3.82	28.27
D20M	0	2110	0.76	0	0
	5	2080	0.89	1.762	16.14
	10	2000	1.04	3.39	23.19
	15	1984	3.28	5.044	28.97
D20E	0	2116	0.6	0	0
	3.1	2036	0.7	1.79	23.09
	3.6	2056	0.75	3.49	42.01
	4.2	2048	0.83	5.21	56.67

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Table no. 3 Emission characteristics

Fuel	CO (%)	CO_2 (%)
Pure Diesel	0.16%	3%
	0.15%	3.50%
	0.16%	4%
	0.14%	5%
D10K	1%	2%
	1.50%	3%
	2.50%	4.50%
	3%	4.50%
D20M	0.10%	6%
	0.09%	6.50%
	0.10%	7%
	0.10%	7.50%
D20E	0.10%	5.70%
	0.07%	6%
	0.07%	6.50%
	0.06%	7.50%

Calculations:

1] Fuel Consumption (F.C.):

$$F.\,C. = \frac{\text{Volume of flow}}{\text{Time required in seconds}}$$

$$= \frac{0.00001}{40.2}$$

$$= 2.4875 \times 10^{-7}\ m^3/sec$$

$$= (2.4875 \times 10^{-7}) \times 850$$

$$= 2.1143 \times 10^{-4}\ kg/sec$$

F.C. = 0.76 kg/hr

2] Heat supplied by the fuel (H. S.):

H. S. = Fuel consumption X Calorific value of diesel

$$= (2.1143 \times 10^{-4}) \times 44500$$

H. S. = 9.408 KJ/ sec

3] Brake Power (B. P.):

$$B.\,P. = \frac{2\,\pi\,N\,T}{60 \times 1000}$$

Where,

N = Speed of Engine

T = Torque

= w x r

w = net load

r = effective radius

$$B.\,P. = \frac{2x\pi x2154 \times (5 \times 9.81x\ 0.165)}{60 \times 1000}$$

B. P. = 1.85 KW

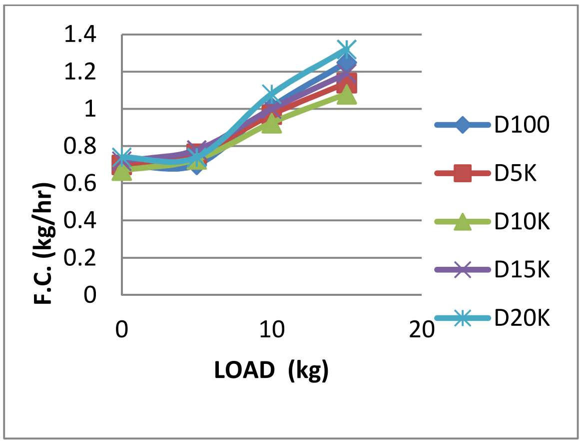
4] Brake Thermal Efficiency (b_{th}):

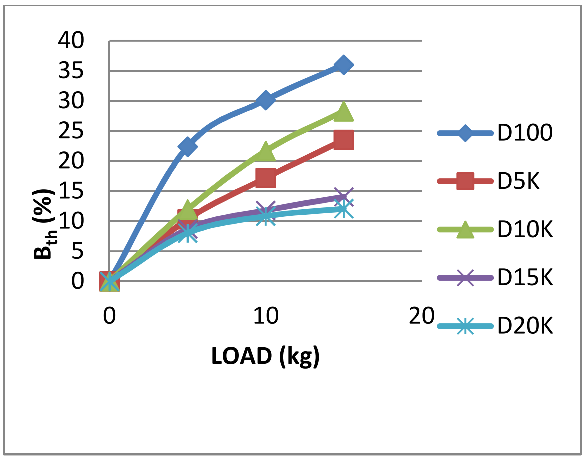
$$b_{th} = \frac{\text{Brake Power}}{\text{Heat Supplied}} \times 100$$

b_{th} = 24.22 %

IV. RESULT & DISCUSSION

1. DIESEL-KEROSENE





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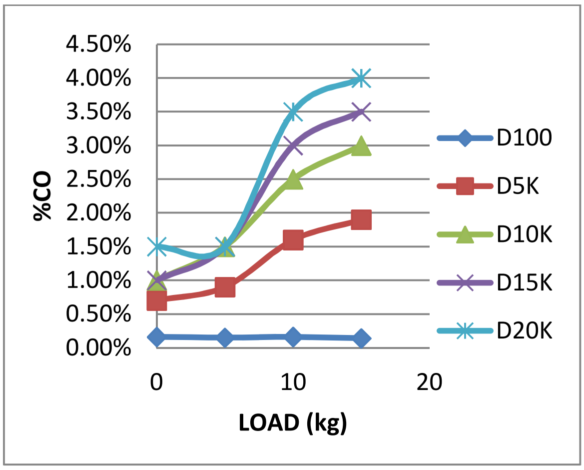
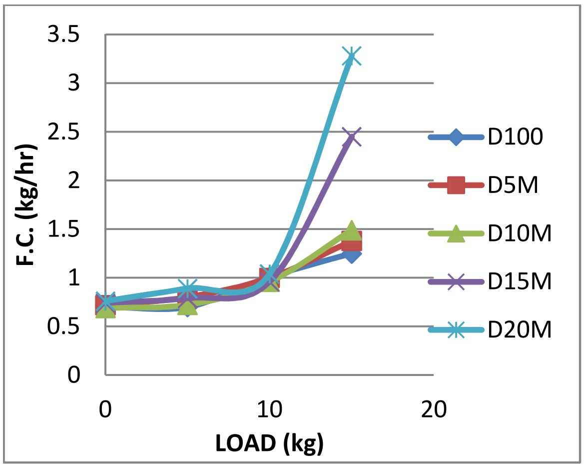
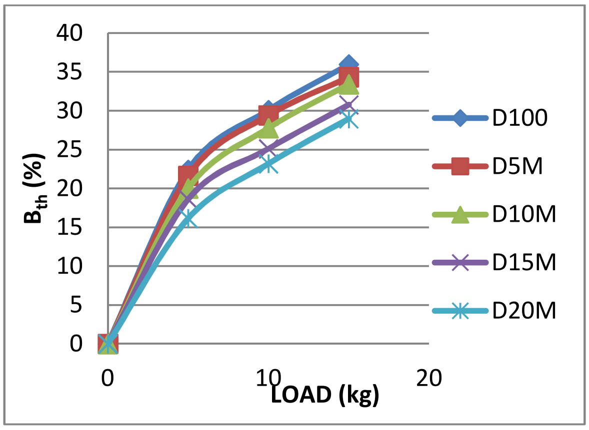
EMISSIONS



2. DIESEL-METHANOL





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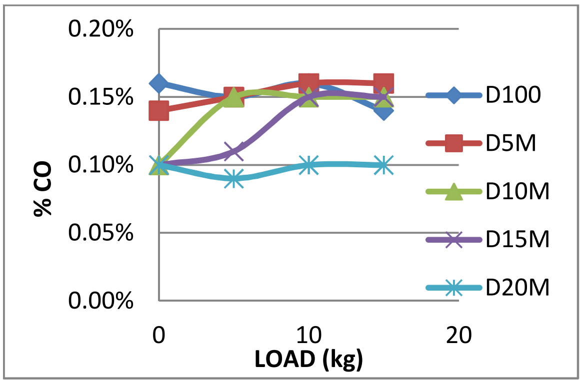
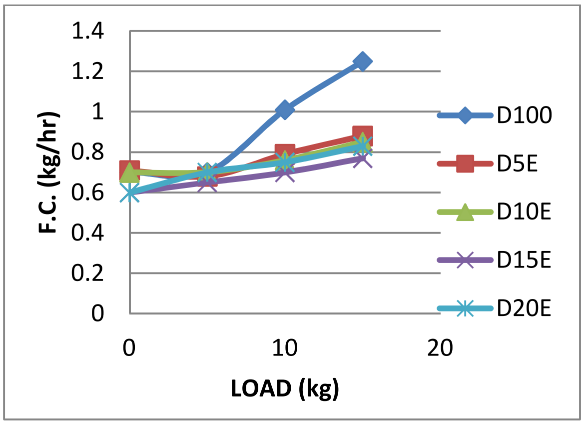
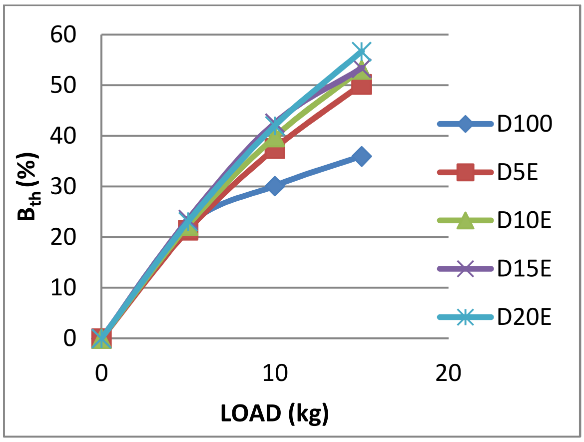


3. DIESEL-ETHANOL





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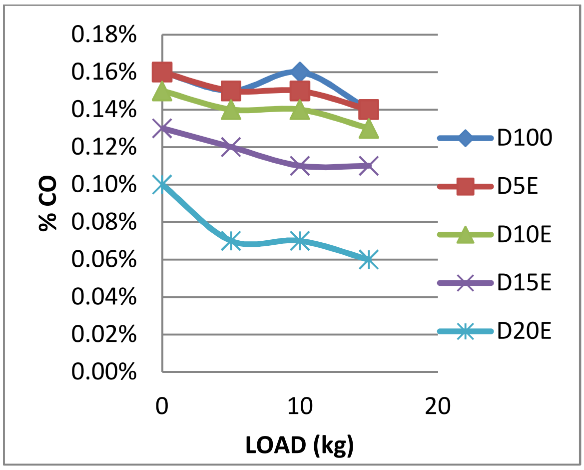

V. CONCLUSIONS

- Specific fuel consumption lowered by 13.6% using 10% Kerosene blend in pure diesel and further lowered by 4.8%.
- Using diesel-kerosene blends, exhaust emissions from diesel engine were more as compared to pure diesel.
- Methanol–diesel blended fuel was successfully tested in a diesel engine. Experimental results showed that,Also, the specific fuel consumption for the mixed fuel was higher than for the pure diesel fuel.
- For Diesel-Methanol blend value of %CO is reduced at any mixing ratio i.e. the fuel combustion is proper and more CO is gets converted into CO_2.
- Among the four blends of Ethanol, the D20E shows higher brake thermal efficiency than the other blends and

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diesel.

- For Diesel-Ethanol blend value of %CO is reduced at any mixing ratio i.e. the fuel combustion is proper and more CO is gets converted into $CO_{2.}$%CO is reduced by 57.14% as compared to Diesel foe D20E.

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