Experimental Investigation and Optimization of SI engine using Methanol blends as a fuel

LavishaLobo[1],MrunalChikalande[2],MayuriKatare[3],ShilpaBuge[4], AbhimanyuChandgude[5]
Dept. of Mechanical Engineering, MIT Academy of Engineering, Alandi(D), Pune-412105

Abstract:-

In the past few years many have looked for alternative fuels to help to solve the problem of rising levels of pollution and fuel crisis. The objective of present work is to investigate the performance and emission characteristics of petrol engine fuelled with methanol blend. Methanol can be blended with petrol in any percentage (0-20%). The various performance characteristics we have studied are brake thermal efficiency (BTE), brake specific fuel consumption (BSFC) and the emission characteristics of unburnt hydrocarbon emissions (HC), carbon monoxide emission (CO), oxides of nitrogen (NOx) and carbon dioxide emissions (CO2) at different engine conditions. The result obtained from experimenting methanol blended petrol are compared with characteristics which are shown when pure fuel is used.

Keywords: ***Blending, Engine performance, Methanol, Petrol SI engine.***

I. INTRODUCTION

The first problem world is facing today is energy crisis. The conventional engine that we have is presently working on only pure petrol fuel. We don’t have any 100% alternative for petrol fuel but there are some alcohols that can be used with petrol by using with petrol by using technique of blending. Thus, this experiment is performed to find the effect of alcohol blending on engine performance. Therefore for optimization of petrol engine performance we are using Methyl alcohol blend.

Methanol or methyl alcohol is colourless liquid. It is able to form a explosive mixture with air and burns with nonluminus flame. Methnol is produced from distillation of wood, also by using direct combustion of carbon monoxide gas and hydrogen in presence of catalyst.

According to research methanol has potential to replace the petrol and diesel used in transportation and LPG, wood and kerosene required in cooking. By using methnol very less modification required in petrol internal combustion engine but methnol will required more in volume as compared to petrol. Methnol has higher octane number as compared to petrol leading to high compression ratio and increasing thermal efficiency of engine. Propogation speed of flame is high for methanol, lower boiling point, high oxygen content hence more cleaner burning as compared to petrol so help in lowering the emissions and serve as environment friendly fuel.

One of the disadvantage of methanol is it is highly flammable, air is lighter as compared to methanol vapour, so it can travel and ignite. To control the fire due to methanol it should extinguished with dry chemicals, carbon dioxide, water spray or alcohol resistant foam.

NITI Aaayog also helping and investing in the methanol economy, due to its potential NITI Aayog is developing a road map to increase methnol production and improve the efficiency of engine by using methnol as a fuel.As methanol is cheaper as compared to petrol and diesel by using this it will help in boosting economy and crude import from gulf countries can be reduced. Methanol is a bridge to dream of a complete 'Hydrogen based fuel system'.

II. EXPERIMENTAL DETAILS

The engine selected for conducting tests is Kirloskar TV1, four-stroke, single-cylinder, water-cooled, naturally aspirated, petrol engine. Optimization of SI Engine parameters for methanol was done experimentally by conducting series of tests on experimental set-up shown in Fig. 3.1. Initially engine was operated at various engine operating parameters such as load, fuel injection pressure, fuel injection temperature, compression ratio, blend etc. Eddy current dynamometer has been used for loading the engine. The engine was operated at a rated constant speed at 1500 rev/min. Moreover, all tests were conducted, and parameters were measured under steady state operation.

Table I: Operating parameters and test

Make	Kirloskar TV1
No. of cylinders	One
Orientation	Vertical
Cycle	Four stroke
Rated power	3.50 kw at1500 rpm
Compression ratio	7,8,9,10,11
Displacement volume	661.45 CC
Bore*Stroke	87.50 mm*110 mm

Cooling medium	Water
Connecting rod length	234 mm
Combustion chamber	Carburettor

III. METHODOLOGY

Set of tests were conducted on computerized single cylinder, four stroke engine to evaluate Performance – emissions characteristics. The engine started by hand cranking and allowed warm at no load condition. Testing was conducted at loads 0.5kw, 1kw, 1.5kw, 2kw and 2.5kw for five different CR's 7, 8, 9, 10 and 11. For each load, with different pressure 210, 225, 240, 255 and 270. The engine was operated for 2 minutes to allow the engine to stabilize under the new condition. The engine was also operated at optimized parameters with 100% petrol. At all the loads of different fuels the performance characteristics and the emission characteristics were measured.

Table II: Operating parameters and test

Sr. No.	Parameter	Specification
1	Speed in rpm	1500
2	Load in kw	0.5, 1, 1.5, 2, 2.5
3	FIP in bar	210, 225, 240, 255, 270
4	CR	7, 8, 9, 10, 11
5	Blend in %	0, 5, 10, 15, 20
6	FIT in degrees	21, 22, 23, 24, 25
7	Fuel studied	Methanol

IV. RESULTS AND DISCUSSION

Following results were obtained at different load conditions with different blending concentrations which are further discussed in terms of performance characteristics.

Table III: DOE by Taguchi method.

Load in KW	Blend in %	BSFC KG/KW hr	BTE in %	HC in ppm	CO in %	CO2 in %	NOx in ppm
0.5	0	0.955	8	235	0.18	9.76	34
0.5	5	0.996	8.2	210	0.17	10.02	35
0.5	10	1.08	8.4	195	0.16	10.98	37
0.5	15	1.151	8.6	185	0.14	11.98	39
0.5	20	1.198	8.8	175	0.13	12.86	41
1	10	0.562	13.4	165	0.15	11.68	86
1	15	0.601	14	155	0.13	12.89	90
1	20	0.621	14.5	145	0.12	13.23	99
1	0	0.491	12.6	198	0.16	10.75	70
1	5	0.521	13	178	0.16	11.11	78
1.5	20	0.52	21	84	0.1	15.01	130
1.5	0	0.371	17	134	0.15	11.56	110
1.5	5	0.399	18.5	126	0.14	12.29	114
1.5	10	0.412	19	108	0.14	12.89	115
1.5	15	0.448	20	88	0.12	14.1	130
2	5	0.321	22.2	69	0.12	13.12	140
2	10	0.342	23	58	0.11	14.61	150
2	15	0.381	25	46	0.1	15.03	170
2	20	0.399	27	35	0.08	16.11	178
2	0	0.301	20	78	0.13	12.76	130
2.5	15	0.281	29	15	0.08	16.21	219
2.5	20	0.308	30	10	0.06	17.23	228
2.5	0	0.204	23	34	0.11	13.68	190
2.5	5	0.224	25	29	0.1	14.21	194
2.5	10	0.268	28	24	0.09	15.41	210

1. Brake thermal efficiency (BTE)

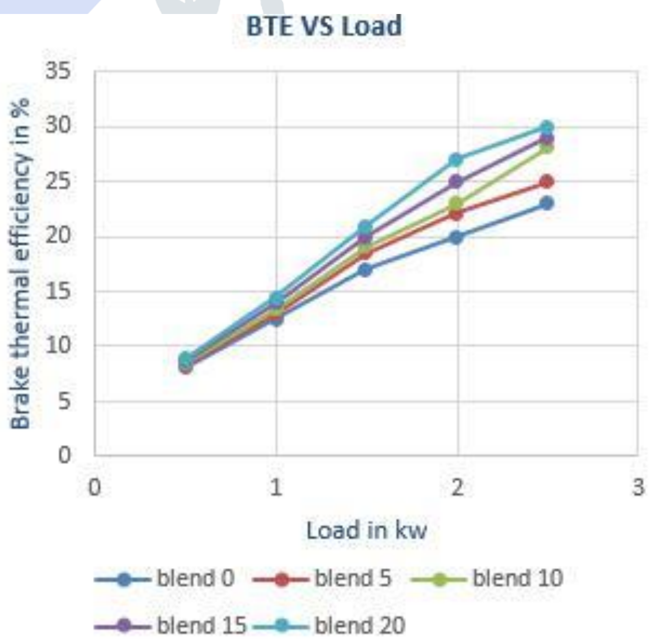

Fig 1: BTE vs Load

The variation in BTE with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can say that as concentration of methanol in petrol increases BTE decreases at all loads. It is also seen that as load increases BTE also increases.

2. Brake specific fuel consumption (BSFC)

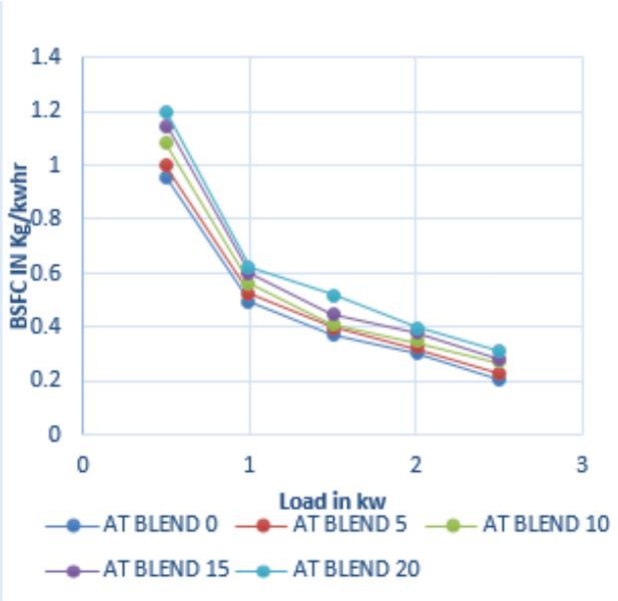

Fig 2: BSFC vs Load

The variation in BSFC with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can say that as load increases BSFC decreases with increasing concentration of methanol in petrol at different load conditions.

3. HC emissions (ppm)

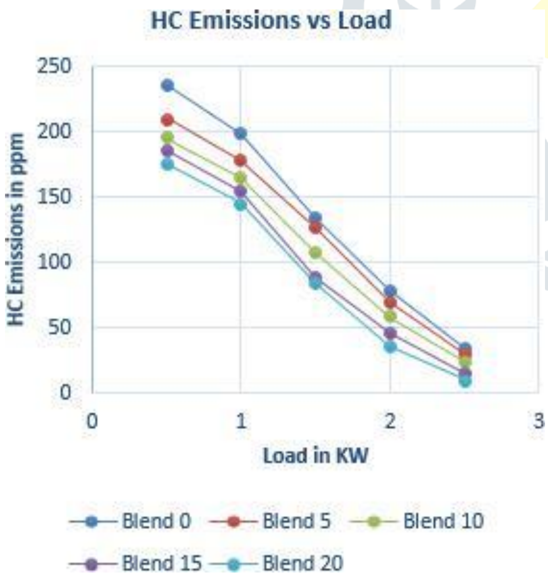

Fig 3: HC Emission vs Load

The variation in BTE with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can say that as we increase concentration of methanol in petrol at different loads HC emissions are decreased. We can also see that as load increases HC emissions are decreased.

4. CO Emissions (%)

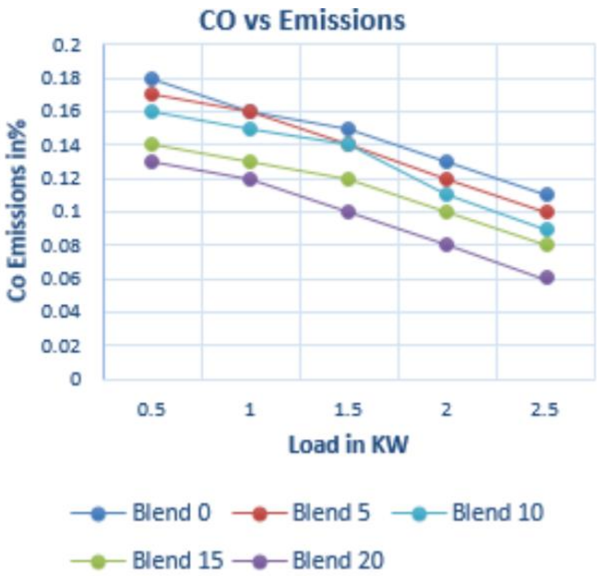

Fig 4: CO vs Load

The variation in BSFC with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can see that as we increase the concentration of methanol in petrol at different loads CO emissions decreases. As load increases emissions are seen to be reduced.

5. CO_2 Emissions (%)

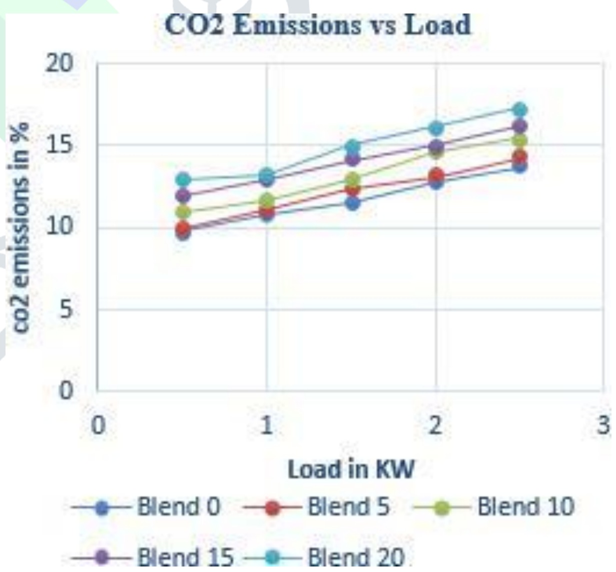

Fig 5: CO2 vs Load

The variation in BTE with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can say that as we increase concentration of methanol in petrol at different loads CO_2 emissions increases. It can also be seen that as load increases the CO_2 emissions are also increased.

6. NO_x emissions (%)

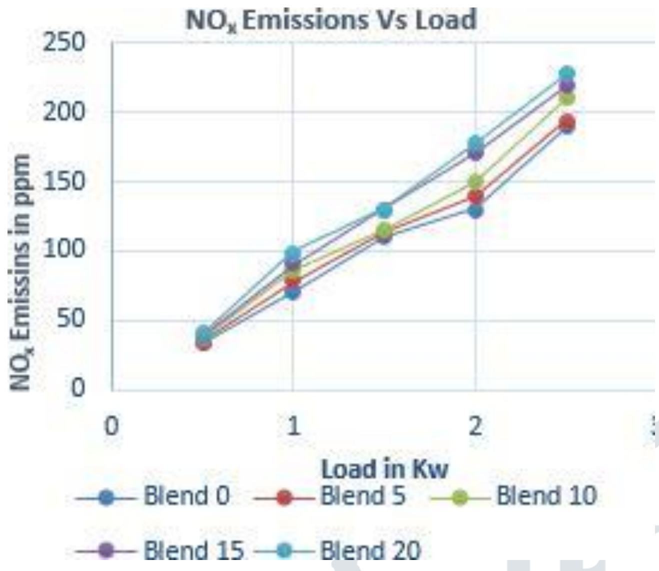

Fig 6: NOx Emission vs Load

The variation in BTE with variation in blend i.e. M0, M05, M10, M15, M20 with respect to varying load is shown in the fig. From this fig we can say that as we increase concentration of methanol in petrol at different loads NOx emissions are increased. It can also be seen that as load increase emissions are also increased.

V. CONCLUSION

Using methanol blends as alternative fuel in conventional IC engine, performance and emission characteristics were investigated and compared with petrol fuel. After conducting the experiment it was concluded that methanol blended fuel shows reduced amount of emissions but it's performance is not that efficient. It can also be concluded that reduced emissions can cause less environmental pollution and harm.

Effects of blended methanol fuel on performance characteristics:
-Increase in consumption of mass of fuel.
-Reduction in consumption of BSFC.
-Increase in BTE with load and reduction with methanol blend.

Effect of blended methanol fuel on emission characteristics:
-Increase in CO2 emissions.
-Increase in NOx emissions.
-Reduction in CO emissions.
-Reduction in HC emissions.

REFERENCES

[1] Gaurav Tiwari, Dr. Nitin Shrivastava,"Experimental investigation of Methanol blends with gasoline on SI engine" , Int. Journal of Engineering Research and Applications, vol. 4 , pp. 149-155 , 2014.

[2] A.N.Basavaraju, Dr.Joseph Gonsalvis ,Dr.B.Yogesha ,"PERFORMANCE STUDY OF METHANOL BLENDED PETROL IN SI ENGINE" , International Journal of Engineering Science Invention, vol. 02, pp. 01-07 , 2013

[3] Ashraf Elfasakhany,"Investigations on the effects of ethanol methanole gasoline blends in a spark-ignition engine:Performanceandemissionsanalysis". Engineering science and technology, an international journal 2015

[4] Tiegang Hu, Yanjv Wei, Shenghua Liu, and Longbao Zhou,'' Improvement of Spark-Ignition (SI) Engine Combustion and Emission during Cold Start, Fueled with Methanol/Gasoline Blends.'' American Chemical Society 11/29/2006 Received July 29, 2006. Revised Manuscript Received October 8, 2006

[5] Liu Shenghua, Eddy R. Cuty Clemente, Hu Tiegang , Wei Yanjv,"Study of spark ignition engine fueled with methanol/gasoline fuel blends". Applied Thermal Engineering 27 (2007) 1904–1910

[6] Soheil Babazadeh Shayan, Seyed Morteza Seyedpour, Fathollah Ommi, Mansour Alizadeh ," Impact of methanol-gasoline fuel blends on the performance and exhaust emissions of a SI engine", International Journal of Automotive Engineering , vol. 1, pp. 219- 227, 2011.