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Experimental investigation of Methanol blends with gasoline on SI engine

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ABSTRACT
Automobile have become a very important part of our modern life style. And it runs on fossil fuel. But the excessive use of fossil fuels will very soon leads to the energy crises so the future of automobile based on fossil fuels has been badly affected by two major problems. That is less availability of fuel and environmental degradation. So it is very important to found some new renewable non polluting alternative fuels to ensure the proper and safe survival of internal combustion engines. In present study we evaluate the performance of two stroke single cylinder spark ignition engine with ratio of 10%, 20% and 30% of methanol and gasoline by volume. Performance parameters (brake thermal efficiency, brake specific energy consumption and brake specific fuel consumption) were determined at various loads on engine with methanol blended gasoline. The comparison was made on performance of conventional SI engine with pure gasoline operation.
As a result, brake thermal efficiency and brake specific fuel consumption showed improved performance when compared with pure gasoline performances.
Keywords – Brake thermal efficiency, Blends, ethanol, gasoline, methanol,

I. INTRODUCTION

Day by day the large amount of pollutants emitting out from the exhaust of the automotive vehicles run on fossil fuels are increasing and these pollutants are proportional to number of vehicles. The civilization of any country is measured on the basis of number of vehicles. Hence the Government has to spend huge amount of money for importing crude petroleum to meet the fuel needs of the automotive vehicles, in the context of fast depletion of fossil fuels. In view of heavy consumption of gasoline due to individual transport, the search for alternative fuels has become compulsory. The alcohol as a alternative fuel has been suggested for automobiles. The alcohol used to change/modify the attitude toward the present fuel, i.e., gasoline and Search for New alternatives. In this study, the first approach was selected with the aim of improving the combustion characteristics of gasoline, which will be reflected in improving the engine performance and that is done by mixing methanol as a Additives is integral part of today's fuel. They are chemicals, which are added in small quantities either to enhance fuel performance or to correct a deficiency. They can have surprisingly large effects even when added in little amount.

Alcohol is a good substitute as alternative fuel for use in SI engine. It has good compatible property with gasoline fuels. Their octane rating is also more than 100.if alcohols are added in a small amount with gasoline in SI engine then there is no need to make any modification in engine. As we all know that modification in engine and change in composition of fuel are two methods by which we can improve the performance of an engine and can reduce the environmental pollution.

Here in this experiment we tried to change the composition of fuel by blending of methanol with gasoline in a suitable amount to improve the performance of engine.

In recent years several researches have been carried out to the influence of methanol on the performance of spark ignition engines.

Among the alcohols, methanol has the lowest combustion energy. However, it also has the lowest stoichiometric or chemically correct air-fuel ratio. Therefore, an engine burning methanol would produce the maximum power. A lot of research has been done on the prospect of methanol as an alternative fuel. Methanol, CH3OH, is the simplest of alcohol and originally produced by the destructive distillation of wood. However, methanol can be produced from many fossil and renewable sources which include coal, petroleum, natural gas, biomass, wood landfills and even the ocean [1].

AlvydasPikunas, SaugirdasPukalskas&JuozasGrabys[2] presented the influence of composition of gasoline -ethanol blends on parameters of internal combustion engines .The study showed that when ethanol is added, the heating value of the blended fuel decreases, while the octane number of the blended fuel increases .Also the results of the engine test indicated that when ethanol–gasoline blended fuel is used, the engine power and specific fuel consumption of the engine slightly increase. M .Abu-Zaid, O .Badran, and J .Yamin[3] introduced an experimental study to investigate into the effect of methanol addition to gasoline on the performance of spark ignition engines .The performance tests were carried out, at variable speed conditions, over the range of 1000 to 2500 rpm, using various blends of methanol-gasoline fuel .It was found that methanol has a significant effect on the increase the performance of the gasoline engine .The addition of methanol to gasoline increases the octane number, thus engines performance increase with methanol-gasoline blend can operate at higher compression ratios.M.V .Mallikarjun and Venkata Ramesh Mamilla[4]Experimental study in four cylinders,S.I engine by adding methanol in various percentages in gasoline and also by doing slight modifications with the various subsystems of the engine under different load conditions .For various percentages of methanol blends(0-15) pertaining to performance of engine it is observed that there is an increase of octane rating of gasoline along with increase in brake thermal efficiency, indicated thermal efficiency and reduction in knocking. M .Abu-Zaid[5] et al introduced an experimental study to investigate into the effect of methanol addition to gasoline on the performance of spark ignition engines .The performance tests were carried out, at variable speed conditions, over the range of 1000 to 2500 rpm, using various blends of methanol-gasoline fuel . It was found that methanol has a significant effect on the increase the performance of the gasoline engine .The addition of methanol to gasoline increases the octane number, thus engines performance increase with methanol-gasoline blend can operate at higher compression ratios. Kowalewicz[6] reviewed and analyzed the use of methanol as a fuel for spark ignition engines. He reported that a neat methanol engine has 30% more efficiency than a regular engine, not only due to high compression ratio but also due to methanol's higher heat of vaporization that cools the air in the engine to a larger extent, thus increasing the density and allowing more air in. This results in a leaner fuel mixture, possibly lowering emission of CO due to more complete combustion. Liu et al.[7] experimented on a 3-cylinder port fuel injection engine to study the performance and emission characteristics using methanol /gasoline fuel blends. They reported that the engine power and torque decreased with the increase fraction of methanol in the fuel blends without any retrofit of the engine. They also observed 30% reduction in HC emission and 25% reduction in CO emission when the engine was fuelled with M30 (30% methanol + 70% gasoline). Najafi et al.[8]in his study tested the four stroke, four cylinder, direct injection diesel engine using methanol blended 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 was 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. Turkcan et al.[9] studied the influence of methanol/diesel and ethanol/diesel fuel blends on the combustion characteristic of an IDI diesel engine at different injection timings by using five different fuel blends (diesel, M5, M10, E5 and E10). The tests were conducted at three different start of injection {25o, 20o (original injection timing) and 15o CA before top dead center (BTDC)} under the same operating condition. The experimental results showed that maximum cylinder gas pressure (Pmax) and maximum heat release rate (dQ/dθ) max increased with advanced fuel

Delivery timing for all test fuels. Although the values of Pmax and (dQ/dθ)max of E10 and M10 type fuels were observed at original injection and retarded injection (15o CA BTDC) timings, those of the diesel fuel were obtained at advanced injection (25o CA BTDC) timing. From the combustion characteristics of the test fuels, it was observed that ignition delay (ID), total combustion duration (TCD) and maximum pressure rise rate (dP/dθ) max increased with advanced fuel delivery timing. The ID increased at original and advanced injection timings for ethanol/diesel and methanol/diesel fuel blends when compared to the diesel fuel. Suresh et al.[10] modified a single cylinder vertical air cooled diesel engine to use methanol dual fuel mode and to study the performance, emission, and combustion characteristics. The primary fuel, methanol with air, compressed, and ignited by a small pilot spray of diesel. Dual fuel engine showed a reduction in oxides of Nitrogen and smoke in the entire load range. However, it suffers from the problem of poor brake thermal efficiency and high hydrocarbon and carbon monoxide emissions, particularly at lower loads due to poor ignition. In order to improve the performance at lower loads, a glow plug was introduced inside the combustion chamber. The brake thermal efficiency improved by 3% in the glow plug assisted dual fuel mode, especially at low load, and also reduced the hydrocarbon, carbon monoxide, and smoke emissions by 69%, 50% & 9% respectively. The presence of glow plug had no effect on oxides of nitrogen. ChuWeitao[17]investigated the influence of M0, M5and M15 methanol / diesel fuel mixture on diesel engine performance in a single-engine ZS195. Test results show that with adding of methanol, the driving force of the engine was weaker; fuel economy was improved; diesel smoke and CO emissions are significantly reduced; NOx emissions are more at M5, but were reduced about 8% atM15; HC emissions were increased when the diesel engine parameters remained unchanged. Shenghua et al. [11] operated a three-cylinder SI engine with several fractions of methanol (10%, 15%,20%, 25% and 30%) in gasoline under the full load condition. They saw that the engine power and torque decreased, while the brake thermal efficiency improved with the methanol fraction increase in the fuel blend. Bilgin and Sezer [12] studied the effect of methanol addition to leaded and unleaded gasoline on the engine performance. They stated that the maximum brake mean effective pressure (bmep) was obtained from M5 fuel blend. Yanju et al. [13] tested three typical methanol–gasoline fuel blends M10, M20, and M85 in an SI engine. They stated that with the increase of them ethanol fraction in gasoline, the CO emission decreases and the reduction is 25% for M85, and the low methanol ratio fuel blends have no significant effect on reducing the NOx emission while M85 gives an 80% reduction.

II. EXPERIMENTAL EQUIPMENTS AND PROCEDURE

The test rig comprises of air cooled petrol engine in which temperature is measured by digital temperature indicator the specification of engine is given as following

S.No.	Description	Data
1	Type of engine	Two stroke petrol engine
2	No. of cylinder	Single cylinder
3	Max B.P.	5.93 k.w
4	Max. speed	5000 rpm
5	Direction of rotation	Clockwise
6	Bore diameter	57 mm
7	Stroke length	57 mm
8	Cubic capacity	150 cc

Gasoline available in market is blended with Methanol in different blends. These are M-10 (10% Methanol + 90% gasoline) M-20 (20% Methanol + 80% gasoline) M-30(30% Methanol + 70% gasoline) initially density of gasoline is known from which density of different blends were calculated. Same is done for finding the calorific value of all the blends.

BLEND	DENSITY	CV
M-10	773.7	42.248
M-20	777.3	40.76
M-30	780.9	37.904

THE PHYSICAL AND CHEMICAL PROPERTY OF METHANOL AND PETROL

S.No.	Character	Methanol	Gasoline
1	Molecular weight	32.04	100-105
2	Composition	(O) = 50%	(c) = 85% (H) = 15%
3	Sp. Gravity	0.8	0.7-0.8
4	Density	791.8	700-780
5	Boiling Temp (^{0}C)	64.5	27-255
6	Freezing point (^{0}C)	-97.7	-57
7	Ignition Temp (^{0}C)	464	390-420
8	Air fuel ratio	6.42	14.7
9	Octane number	111	80-99
10	Cetane number	55-60	0-10

In recent times, methanol has been associated more in energy production and transportation. The use of methanol in fuel applications is expected to generate huge demands in future. Compared to other fuels, methanol is economically attractive, less polluting, less flammable, provides high performance and thus has become a favoured topic of research nowadays. Methanol is used in biodiesel production where it acts as catalyst in the transesterification process. Methanol has also been identified as good substitute for petrol or diesel in automobiles.

Methanol can be derived from coal at cost comparable to that of synthetic gasoline. It can be produced from any hydrocarbon source viz. naphtha, oil, wood, biomass, LPG, etc. It is commonly considered as a source of hydrogen, which is a very promising energy carrier for the future. Methanol is made from natural gas, coal, and biomass. It is also known as wood alcohol. It used to be used in vehicle concentrations as high as M-85 but it is not commonly used in such high blends. Methanol is very good for blending with gasoline to replace the harmful octane enhancers.

The benefits of using methanol are that it reduces emissions, which has a significant effect on bettering the environment. Methanol blended with gasoline increases the performance of the automobile. It also has a lower risk of flammability than normal gasoline. It is made from domestic renewable sources; this is also a great advantage of using methanol.

Figure:1 Experimental setup for the effect of methanol –gasoline blends

III. TEST METHOD:

At very first all different blends were prepared in laboratory and lubricating oil is added in sufficient ratio with gasoline The engine was started and allowed to warm up for a time period of 10 – 15 min. test were performed at constant speed and varying loads for each individual blends. Before testing with new blend the engine was allowed to run for sufficient time to consume the whole remaining fuel from previous blending. For getting an average value of result from each blending the test were performed four times for each mixture. The fuel consumption is measured via metred measuring jar. The consumption is measured for certain interval of time so that we can found the fuel consumption with respect to time. The same process is repeated for blends of M-10, M-20, and M-30and for pure gasoline.

The main purpose of this testing was to find an alternative source of fuel so that we can improve the performance of engine by using it and the fuel is methanol which is used as a additive with gasoline. The various readings obtained from the test and result are compared on graphs.

IV. EXPERIMENTALN DATA:

BTE IN % AT VARIOUS LOADS (W)				
	500	**1000**	**1500**	**2000**
GASOLINE	10	16	19	21
M-10	8	16	20	23
M-20	8	15	17	20
M-30	9	14	17	19

BSFC IN KG/W-HR AT VARIOUS LOADS (W)				
	500	**1000**	**1500**	**2000**
GASOLINE	0.9	0.5	0.4	0.2
M-10	1.2	0.7	0.6	0.4
M-20	1.2	0.8	0.7	0.5
M-30	1.3	0.9	0.8	0.6

V. RESULT AND DISCUSSION

Comparative study of gasoline and ethanol

- Brake thermal efficiency:

Brake thermal efficiency is defined as the gain of output from given input energy.the input energy is heat. As we know that increase in input heat energy increases the efficiency of the engine. Here we tested for various blending of methanol with gasoline and as a result we come to know that blends of methanol showing higher thermal efficiency when added in ratio of 10% methanol and 90% gasoline that is M10.

We can see in tabulated data that the brake thermal efficiency is increasing with increasing load and the brake specific fuel consumption is slightly decreasing with increasing load. The graph plotted for comparison show that thermal efficiency for M10 is highest at full load condition but other blends are showing lower performance. It shows that the blending with methanol shows better performance for a fixed percentage of composition after that its performance is poor as we can see that the performance of M20 and M30 is slightly less in comparison of M10.

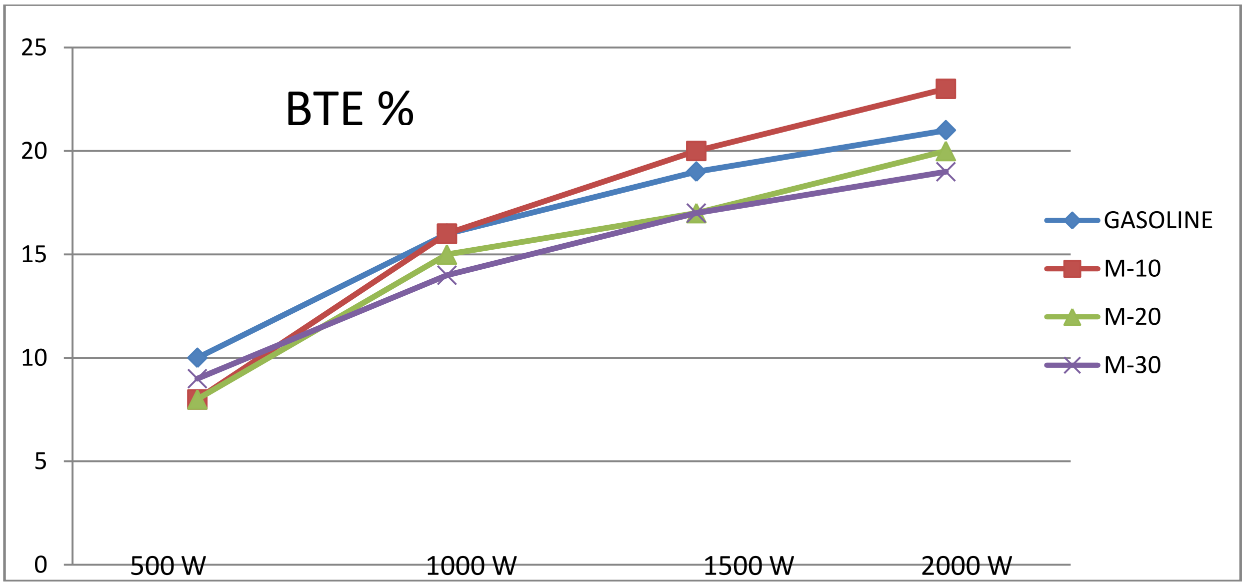

Fig.2 Brake thermal efficiency of methanol blends

- Brake specific fuel consumption:

Brake specific fuel consumption is define as the fuel consumed for one kilowatt power generation in one hour. Brake specific fuel consumption is decreases when load is increases. Brake specific fuel consumption is always least for full load condition. Fuel consumption is increases with load but brake specific fuel consumption decreases because it is function of fuel consumption and brake power. Graph plotted for methanol blends

showing brake specific fuel consumption at various loading condition. It shows that least fuel consumption of fuel for gasoline but at full loading condition the brake specific fuel consumption for M10 is least.
As we already discussed that the brake thermal efficiency is better for M10 and thus it shows least brake specific fuel consumption. The lower the calorific value of fuel the higher will be fuel consumption.

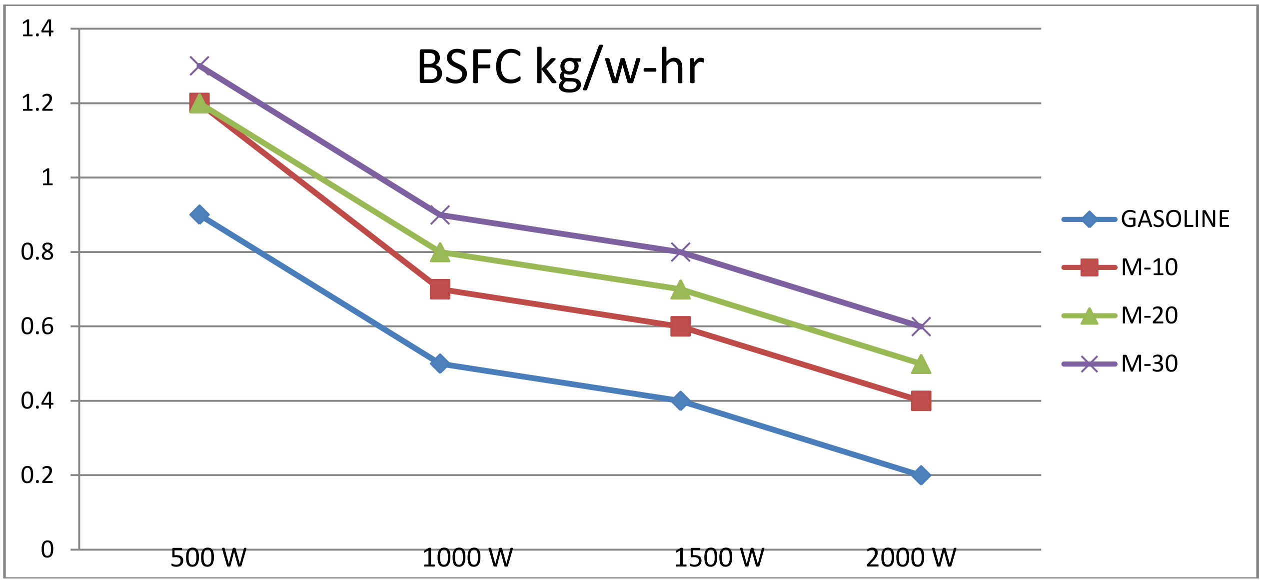

Fig.3.Brake specific fuel consumption for Methanol blends

-Brake specific energy consumption:

The function of BSEC is to provide a quantitative image about the amount of thermal energy consumed to generate one unit of work. BSEC is inversely proportional to the brake thermal efficiency. Figure shows the variation of brake specific energy consumption with various loading for various blends of methanol with gasoline.

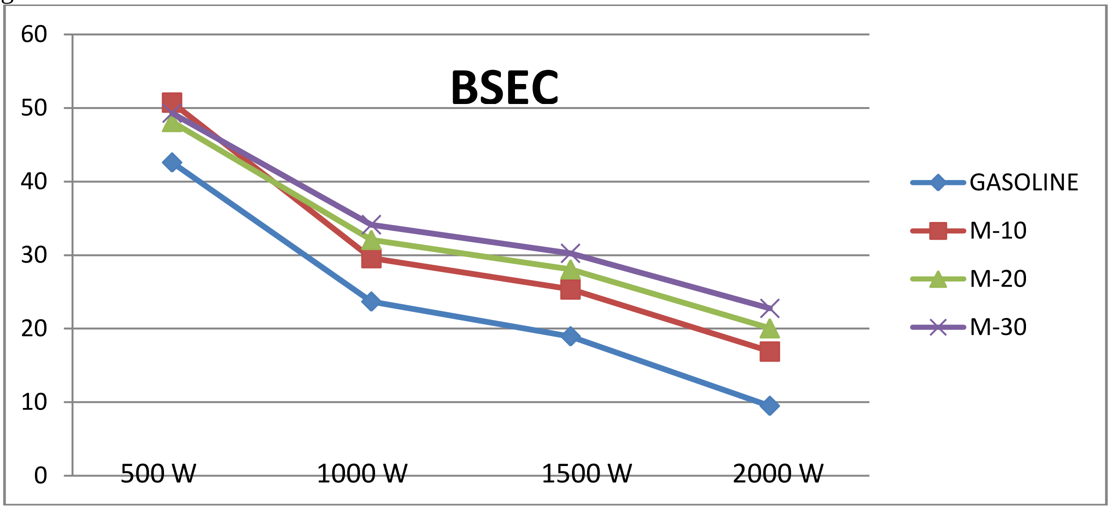

Fig.4.Brake specific energy consumption for methanol blends

VI. CONCLUSION:

In this study, the engine performances were measured on the utilization of the methanol blended fuels under different loading condition at constant speed. And we came to know that brake thermal efficiency is increases with blending of 10% methanol at full load. But after a particular fixed percentage of blends the performance is not so good and it shows a poor performance. Methanol has good octane number and it helps in good combustion of fuel. Performance of M10 shows highest result within group of various blends of methanol with gasoline. It shows least brake specific fuel consumption and better engine performance. Also the experiment shows that the brake specific fuel consumption for M10 is least in comparison of all other blends. So it may be concluded that methanol – gasoline blends can be used as a alternative fuel for automobiles for better performance of engine.

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