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V. S. KUMBHAR
Department of Automobile Engineering, Gourishiv Polytechnic Khatav, 415505, Satara, Maharashtra, vijayskumbhar@hotmail.com

D. G. MALI
Department of Automobile Engineering, Gourishiv Polytechnic Khatav, 415505, Satara, Maharashtra, dgmail_gps@gmail.com

P. H. PANDHARE
Department of Automobile Engineering, Gourishiv Polytechnic Khatav, 415505, Satara, Maharashtra, P.H.PANDHARE@GMAIL.COM

R. M. MANE
Department of Automobile Engineering, Gourishiv Polytechnic Khatav, 415505, Satara, Maharashtra, R.M.MANE@GMAIL.COM

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EFFECT OF LOWER ETHANOL GASOLINE BLENDS ON PERFORMANCE AND EMISSION CHARACTERISTICS OF THE SINGLE CYLINDER SI ENGINE

V. S. KUMBHAR[1], D. G. MALI[2], P. H. PANDHARE[3] & R. M. MANE[4]

[1, 2, 3,& 4]Department of Automobile Engineering, Gourishiv Polytechnic Khatav, 415505, Satara, Maharashtra
E-mail:vijayskumbhar@hotmail.com,dgmail_gps@gmail.com,

Abstract —Alcohols, basically ethanol is considered as a leading alternative fuel for automotive application because of its ability to reduce the air pollution and cost of the fuel. This paper investigates the effect of lower ethanol gasoline blends (up to 20% by volume) on performance and emission characteristics of the single cylinder four stroke SI engine. Tests were carried out for power, torque, fuel consumption and brake mean effective pressure, while exhaust emissions were analyzed for CO, CO2, and HC by using different ethanol gasoline blends on volume basis at wide open throttle and variable engine speed from 4000 to 8000 rpm. Results were compared with the pure gasoline. It showed that as the ethanol content increases the power, torque, fuel consumption, brake mean effective pressure and CO2 emission while reduces HC and CO emission.

Keywords*: Alternative fuels, Ethanol, wide open throttle, Ethanol gasoline blends.*

I. INTRODUCTION

Rapid depletion of the reservoirs of the fossil fuels world turns towards to the alternative options. There are different types of petroleum based alternative fuels like bio diesel bioethanols, natural gas, hydrogen etc. Ethanol is one of them, which can be produced from "cellulosic biomass", such as trees and grasses.

Ethanol (CH_3CH_2OH) is made up of a group of chemical compounds whose molecules contain a hydroxyl group, OH, bonded to a carbon atom. The most attractive properties of ethanol as a SI engine fuel are high octane number, flame speed and latent heat of vaporization as compared to gasoline. Additional oxygen content of the ethanol improves the combustion due its leaning effect [1].

II. LITERATURE REVIEW

Maher et al.(2011) had done experimentation on the four stroke SI engine for 20,40,60,80,100% ethanol in gasoline and they reported that using ethanol-gasoline blended fuels increases the power output of the engine dramatically (up to 50 %). While the (CO) and (HC) emissions decrease as a result of the leaning effect caused by the ethanol addition; and the CO_2 emission increases because of the improvement of combustion. Ahmet Necati Ozsezen & Mustafa Canakci (2011) compared the test results obtained with the use of alcohol-gasoline blends (5 and 10 percent ethanol by volume) to test results of pure gasoline and concluded that when the vehicle fueled with ethanol-gasoline blends, the peak power increases by 2.2% and 1.1% , while fuel consumption increases by 5.2% and 5.5% respectively for the E5 and E10.Tangka et al.(2011) had suggested some modifications for the standard SI gasoline engine to run successfully on gasoline/bio ethanol blends. These include advancing the engine timing and increasing the compression ratio. Ibrahim Thamer Nazzal (2011) had tested the SI engine for 12% ethanol and 6%ethanol with gasoline and reported that 6% ethanol blend is better in performance than that of the 12%. Costa et al. (2010) had tested FIAT engine and reported that for speeds over 4000 rev/min, the use of hydrous ethanol resulted in higher torque and BMEP in relation to gasoline ethanol fuel blend. Chen et al. (2010) investigated the effect of ethanol–gasoline blends on criteria of air pollutant emissions in a four-stroke motorcycle engine with original carburetor. The ethanol was blended with unleaded gasoline in seven percentages (3, 5, 10, 15, 20, 25 and 30% v/v). The efficiency of combustion could be improved by using gasoline blended with ethanol, because of ethanol provided extra oxygen to facilitate combustion. Regarding engine performance, E0 and E3 are similar; power output decreases, when more ethanol (>10%) is used. A. A. Abuhabaya and J. D. Fieldhouse (2010) tested petrol engine of Nissan micra for E5, E10, E20 at the speed 1000 to 3500 rpm and they are reported that ethanol blends produce higher torque, compared with gasoline, at speed higher than 2000 rpm, E20 performed best, compared with the other fuels as it produced 3.8% higher torque than gasoline, at 2500 rpm. At speeds of 3000 and 3500 rpm, it produced 3.9% and 8.6% higher torque than gasoline respectively. As seen from the literature review, ethanol gasoline blends increases the combustion efficiency while decreases the some harmful contents of the emission. But effect of this ethanol gasoline blends at wide open throttle does not cleared properly. At the time of WOT conditions engine may be under maximum mechanical stresses. The main objective of the present investigation is that to understand the effect of various ethanol gasoline

blends on performance and emission characteristics of the SI engine.

III. EXPERIMENTAL PROCEDURE AND EQUIPMENTS

In this study the blends were prepared on volume basis. Ethanol was blended in gasoline in concentration of 5%, 10%, 20% and these blends are known as E5, E10, and E20. The purity of the ethanol used for these experiments was 99.9 %.

TABLE I. TEST ENGINE SPECIFICATIONS

Sr. No	Particulars	Data
1	***Manufacturer***	***Bajaj Kawasaki***
2	Model	K TEC
3	No. of cylinder	01
4	Cubic capacity	100
5	Bore	50mm
6	Stroke	50.6mm

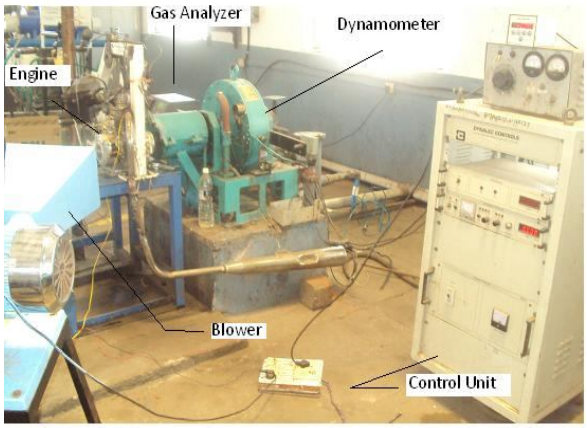

Fig. no.1 Experimental Set up

A single cylinder four stroke spark ignition engine was used. Tests were carried out at WOT condition. The specifications of the engine are given in Table I. The tests were performed at 4000, 5000, 6000, 7000 and 8000 rpm at wide open throttle (WOT) condition and exhaust emission were measured by using Multi-gas Analyzer NETEL (I) Ltd., model no NPM-MGA-2.

IV. RESULTS AND DISCUSSION

The effect of lower ethanol and gasoline blends on single cylinder engine performance and emission at WOT condition and variable speeds from 4000 to 8000 rpm were investigated. As the ethanol content in the blend increases, the power increases slightly for all speeds because of ethanol has higher heat of vaporization, which provides cooling of the air fuel charge, hence the density increases, thus more fuel can be used, and power increases. (fig. no. 2) The power at 6000 rpm using E5, E10, E20 increased by 2.31%, 2.77%,and 4.16% as compared to gasoline.

Addition of ethanol improves anti knock behavior which allows more advanced timing that result in higher combustion pressure and thus higher torque. (fig. no. 3) The torque at 6000 rpm using E5, E10, E20 increased by 0.29%, 0.59% and 4.77 % as compared to gasoline. Addition of the ethanol reduces the carbon atoms concentration in the blended fuel and high molecular diffusitivity and high flammability limits which improve mixing process and hence there will better combustion.

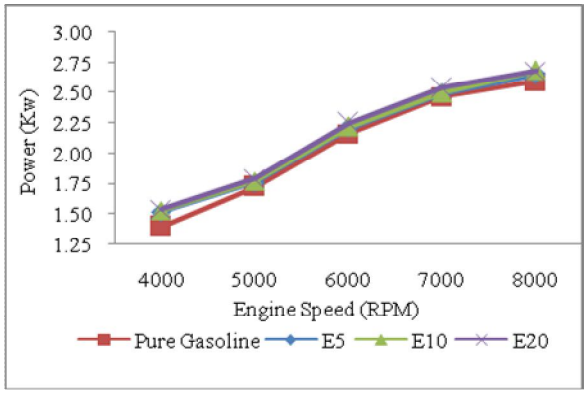

Fig. no. 2 Effect of ethanol blending on Power at various speeds

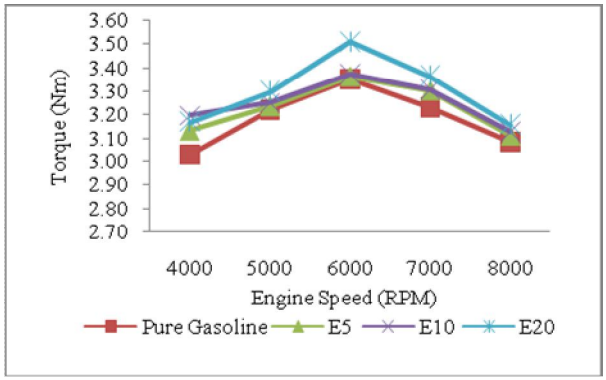

Fig. no.3 Effect of ethanol blending on Torque at various speeds

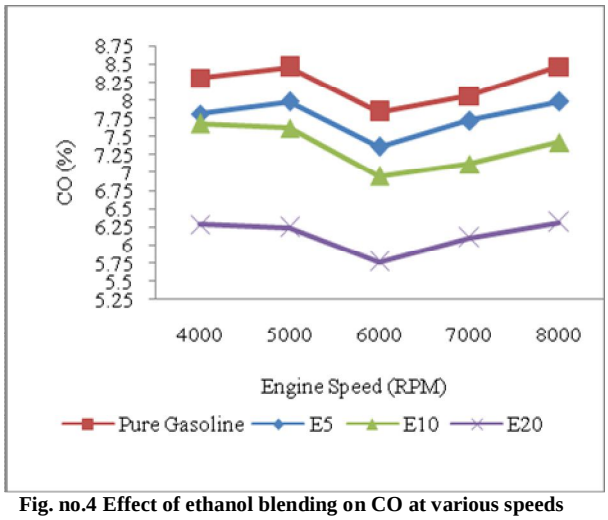

Fig. no.4 Effect of ethanol blending on CO at various speeds

CO is toxic gas that is result of incomplete combustion, ethanol contains oxygen its basic form. When ethanol is added in to the gasoline, it can provide more oxygen for the combustion process, So CO converts in to CO2, due to this CO2 emission increases and CO emission reduces. (fig. no. 4 and fig. no. 5 respectively) The CO concentration at 6000 rpm using E5,E10,E20 decreased by 6.12%,11.35%,and 26.53% as compared to gasoline while CO2 emission increased by5.64%,10.96%and20.34% respectively.

The HC concentration at 6000 rpm using E5, E10, E20 decreased by 3.81%, 5.50%, and 12.28% as compared to gasoline. (fig. no. 6)

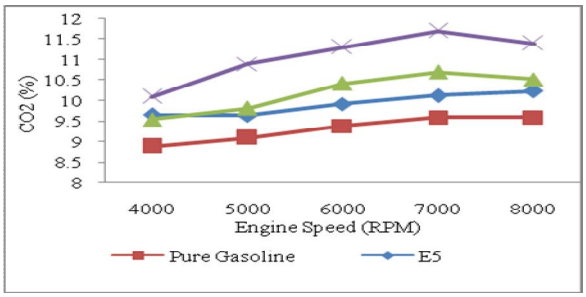

Fig. no. 5 Effect of ethanol blending onCO_2 at various speeds

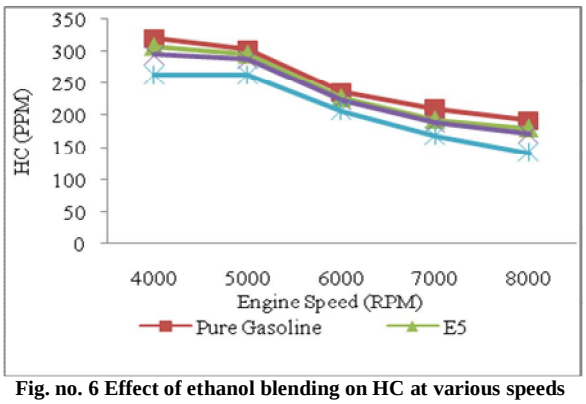

Fig. no. 6 Effect of ethanol blending on HC at various speeds

Specific fuel consumption decreases over the speed range of 4000 to 6000 rpm due to better combustion is shown in fig. no. 7 and increases over the speed range of 6000 to 8000 rpm, because of lower heat content of the ethanol.

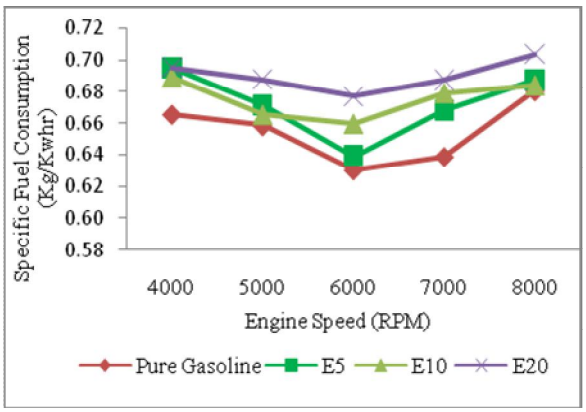

Fig. no. 7 Effect of ethanol blending SFC at various speeds

V. CONCLUSION

Ethanol is oxygenated fuel. As the ethanol content in the blend increases, hydrogen atom concentration in the blend decreases; this leads to leaner operation and improves the combustion. As the ethanol content in the blend increases, density of the mixture increases, leads to increase in power and slightly specific fuel consumption. As a result of improved combustion, reduction in CO and HC emission while increase in CO2 emission. The main findings of this experimentation without any modification in the test engine are as follows:

- For speed range 4000 to 6000 rpm, there is increase in torque, up to 4.77% higher torque obtained at 6000rpm with E20.
- Fuel consumption increases as the ethanol content in the blend increases.
- HC and CO emission reduced for all the blends because of better combustion CO gets converted in to CO2 and hence CO2 emission increases.

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