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Experimental Investigation of Performance and Emissions using Ethanol Petrol Blends in SI Engine-A Comparative Study of 2-Stroke and 4- Stroke SI Engines

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***Abstract*-The huge consumption of fossil fuels is directly affects the economy of our country as importing it from other countries so this may give scope for many researchers to find other alternatives to drag out the usage of petroleum. Thus, using bio-fuel as an alternative, the problem could be reduced. Also the transportation mainly depends on the fossil fuels particularly liquid fuels which are depleting at much faster rate than production. The transport vehicles also based on usage operated on 2-stroke and 4 –stroke engines. In present work both the test engines are considered for experimental study with approximately equal horse power and rated speed for comparative study, run with various blends of gasoline-ethanol and also evaluated using pure petrol fuel without any modification in a present engine. India is ranked second place in cultivating sugar cane, from which ethanol is produced and 99% purity ethanol is considered for the preparation of test fuels. Experiments were conducted using different blends of gasoline-ethanol such as E0 (Pure petrol), E20 (20% of ethanol in vol.based), E30 (30% of ethanol in vol.based), E40 (40% of ethanol in vol.based), and E50 (50% of ethanol in vol.based) and its effect on specific fuel consumption, break thermal efficiency and emissions with respect to the engine load taking pure petrol as datum. The results of experimental investigation were compared between 2-stroke and 4 –stroke engines. Results show that alternative fuel like ethanol blending with gasoline increases the thermal efficiency in 4-stroke engine, liberates less emission and also noticed the better combustion.**

***Index Terms*- Emission, ethanol, gasoline, thermal efficiency**

I. INTRODUCTION

Renewable energy resources have become an important mark of world energy strategy to reduce greenhouse gas emissions caused by usage of petroleum fuel. Many researchers proved that the alternative fuels like bio fuels, hydrogen, and natural gas are reduce the problem and dependency on petroleum products and its environmental impact [1]. Using ethanol-gasoline blended fuel in SI engines lead to higher engine torque in comparison with gasoline fuel.

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Using E40 and E60 blends led to a significant reduction of CO and HC emissions [2] that blends with ethanol allowed the compression ratio to increase by 50% without knock. The most suitable ethanol-gasoline fuel blend in terms of performance and emissions was E50 in a small gasoline engine with low efficiency [3]. Engine power increased by about 29% running with E50 fuel at high compression ratio compared to running with E0 fuel. The specific fuel consumption, CO, CO2, HC emissions were reduced by approximately 3%, 53%, 10% and 12% respectively [4], reported that with increasing the ethanol content in gasoline fuel, the heating value of the blended fuels is decreased, while the octane number of the blended fuels increases. NOx emissions are more dependent on the engine operating condition than the ethanol content of the fuel.

II. PRESENT WORK

The test engines selected for the present work is widely used in small two wheelers such as motorbike and scooters and small gen-sets. Approximately nearer horse power and rated speed engines, with a single cylinder four stroke air cooled spark ignition petrol engine and two stroke air cooled spark ignition petrol engine considered for experimentation.

The test fuels used to run the 2-stroke petrol engine and 4-stroke petrol engine are given in the figure 2.1 and also in Table 1 & 2. The Experimental set-up consist of spark ignition engines along with dynamometer, input fuel measuring system as well as intake air measuring system, temperature measurement, and digital tachometer. The specification of the test engines used for experimental investigations and comparative study is given in Table 3 and shown in figure 2.2 & 2.3. The experimentation carried out at five loads naming 0 loads to full load condition, at every load measured the specific fuel consumption and brake thermal efficiency along with emissions measurement for both the engines.

Figure: 2.1. Test fuel samples

S.No	Blend	Calorific Value kJ/kg	Specific gravity
1	E0	45000	0.71570
2	E20	40434	0.73697
3	E30	38540	0.74257
4	E40	36884	0.75258
5	E50	35054	0.76264

Table 1: Properties of blended fuel samples

S.No	Blend	Composition
1	E0	Ethanol 0% and Gasoline 100% in vol. basis.
2	E20	Ethanol 20% and Gasoline 80% in vol. basis
3	E30	Ethanol 30% and Gasoline 70% in vol. basis
4	E40	Ethanol 40% and Gasoline 60% in vol. basis
5	E50	Ethanol 50% and Gasoline 50% in vol. basis

Table 2: Test fuel samples and composition


Figure: 2.2. 4-Stroke Test Engine


Figure: 2.3. 2-Stroke Test Engine

S.No	Parameters	Test Engines	
		2-Stroke	4-Stroke
1	Make	Bajaj	Crompton Greaves
2	BHP	2.5 HP	2.7 HP
3	No.of cylinders	1	1
4	Bore	57 mm	70 mm
5	Stroke	57 mm	66.7 mm
6	Orifice diameter	20 mm	20 mm
7	Cubic capacity	145.45 cc	256.69 cc
8	Rated speed	2900 rpm	3000 rpm
9	Compression ratio	8.78:1	4.68:1

Table 3: Test Engines specifications

III. RESULTS AND DISCUSSION

3.1. 4-Stroke Engine

Brake thermal efficiency observed as increasing in case of 4-stroke engine investigations. The addition of ethanol gives good thermal efficiency for all blends compared to the petrol operation figure 3.2. Also the specific fuel consumption decreased figure 3.1.The ethanol addition liberates less emission when compared to petrol operation it can be observed in figure.3.3 - 3.6.

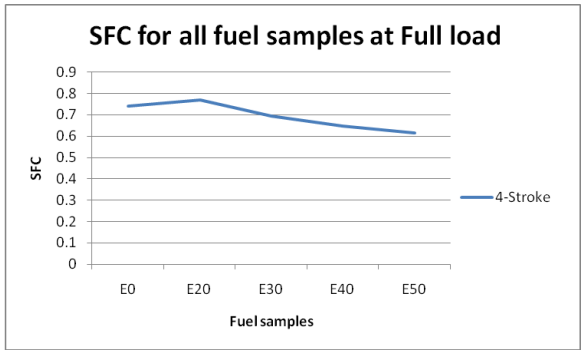

Figure: 3.1. S.F.C at full load

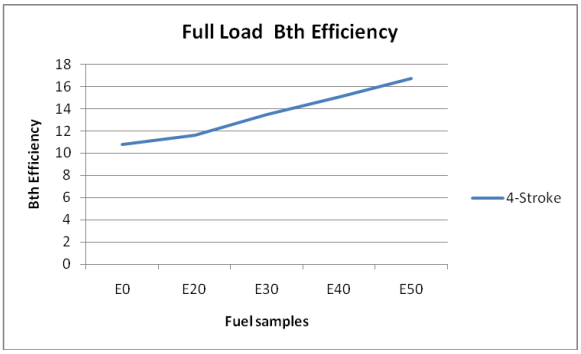

Figure: 3.2. Brake thermal efficiency at full load

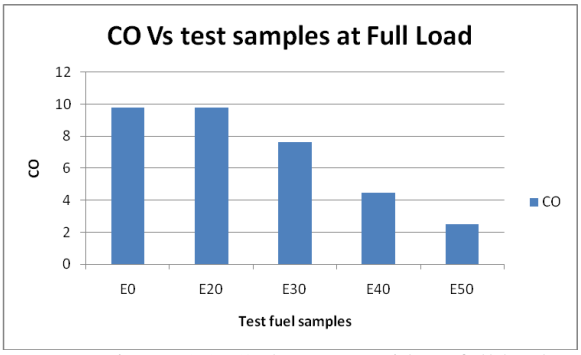

Figure: 3.3. Carbon monoxide at full load

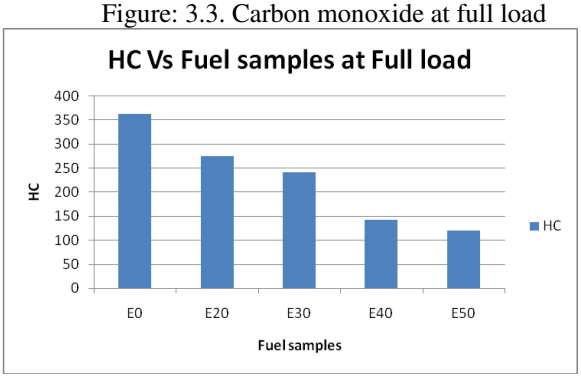

Figure: 3.4. Unburned HC at full load

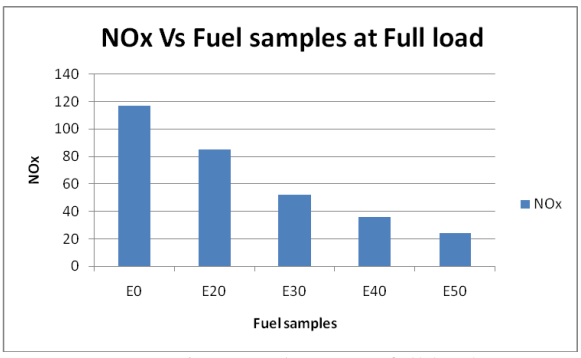

Figure: 3.5. NOx at full load

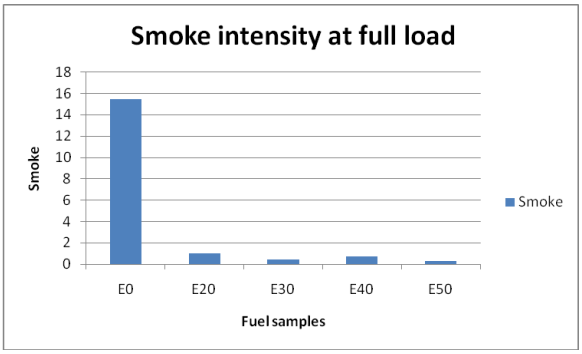

Figure: 3.6. Smoke at full load

3.2. 2-Stroke Engine

Brake thermal efficiency observed as decreasing in case of 2-stroke engine investigations. In the lower percentage blend at part loads it gives good thermal efficiency at other blends the efficiency is lower than the petrol operation figure 3.7. Also the specific fuel consumption increased figure 3.8.The ethanol addition liberates less emissions when compared to petrol operation it can be observed in figure 3.9 and 3.10 as at full load NOx and CO emission at full load less and decreasing with ethanol percentage increase only E30 CO emission increased.

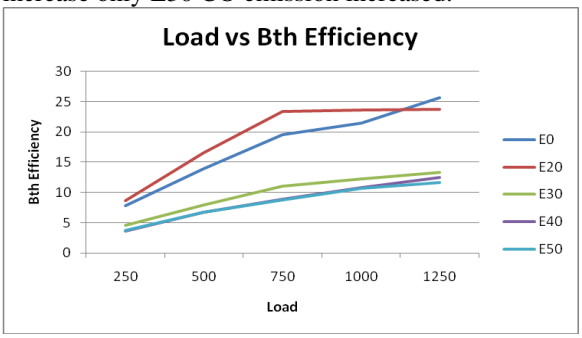

Figure: 3.7. Brake thermal efficiency Vs Load

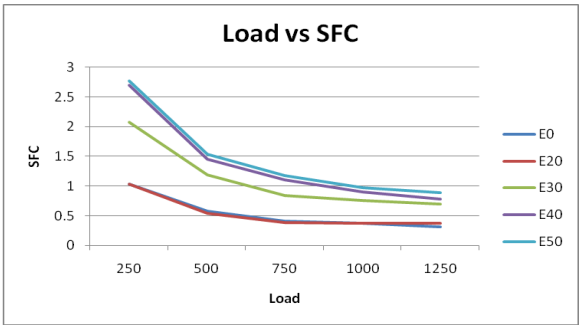

Figure: 3.8. S.F.C. Vs Load

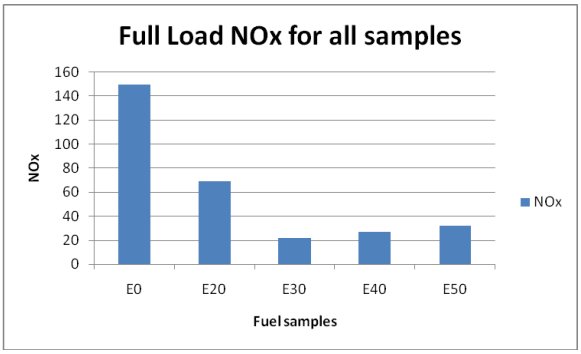

Figure: 3.9. NOx at full load

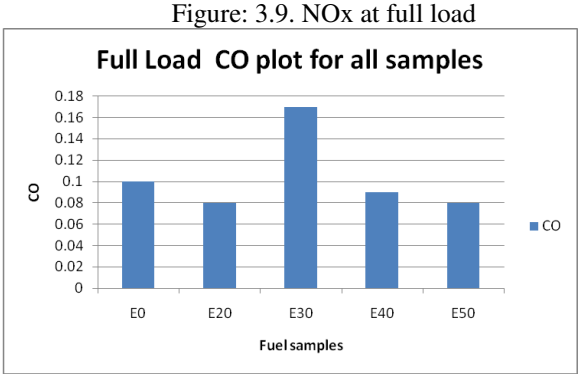

Figure.3.10. CO at full load

3.3. Comparison 2-Stroke and 4-Stroke Engines

30% to 50% increment in thermal efficiency at full load is observed when compared both 4-stroke and 2-Stroke engines Fig3.15.and specific fuel consumption decrease in all the cases, but in case of 2-stroke engines as it produces more power hence the fuel consumption also high.

According to the emissions the comparative study shows the CO emission decreased both the test engines, observed that 70% reduction and 20% reduction respectively at full load Fig.3.11. Similarly the decrease conditions for CO_2, HC and Nox from Fig.3.12-3.14.

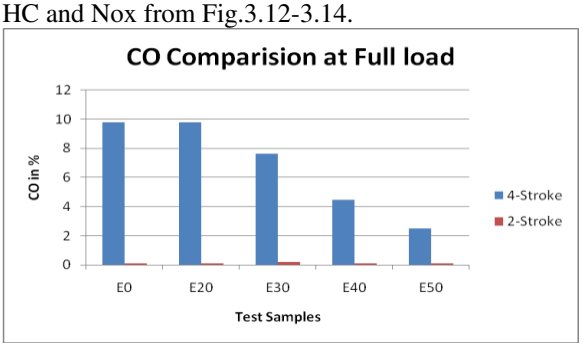

Figure: 3.11. CO at full load

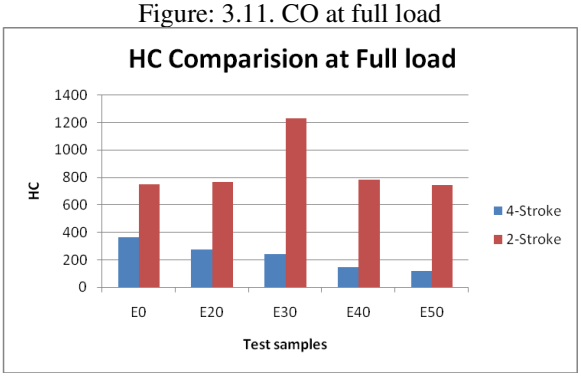

Figure: 3.12. HC at full load

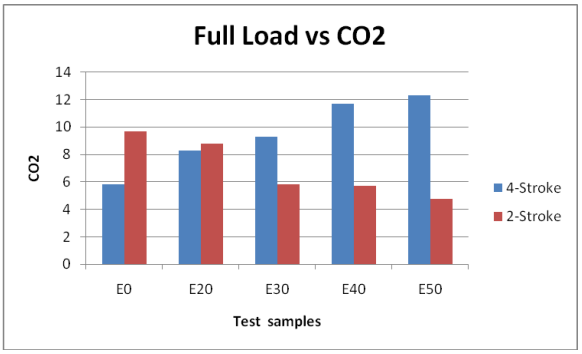

Figure: 3.13. CO_2 at full load

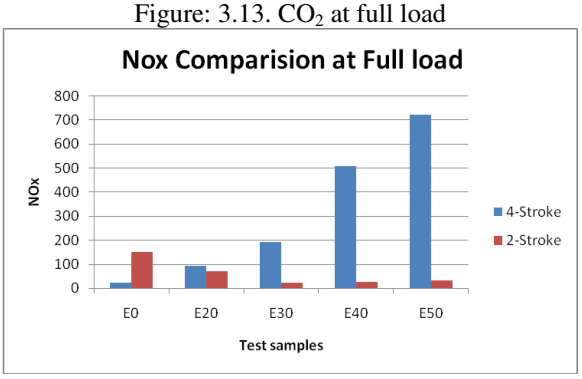

Figure: 3.14. NOx at full load

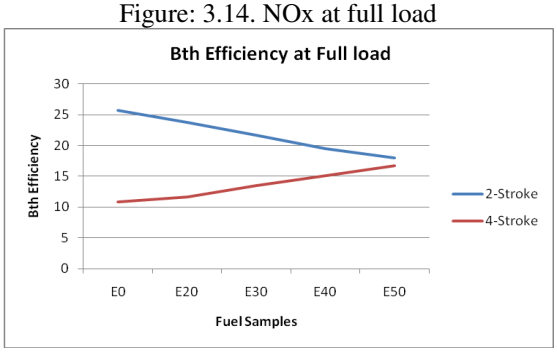

Figure: 3.15. B'thermal efficiency at full load

IV. CONCLUSIONS

Based on the experimental observations and investigational study after comparison between 2-stoke and 4-stroke engines, concluded as following.

1. Blending mechanism works effectively with improved engine performance and reduced emission using ethanol blends with gasoline.
2. Using ethanol blends there is a possibility of fuel saving up to 50 %, hence saving for future.
3. There is also an improvement in thermal efficiency and lesser emission like CO & HC while increasing the ethanol %.

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