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EXPERIMENTAL INVESTIGATIONS ON WORKABILITY AND EXHAUST PRODUCTS OF PETROL ENGINE

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ABSTRACT

***Aim**: Tests were done out to estimate the workability of 4-S, mono cylinder, petrol engine with cuprum coated engine [CCE, Cu-(covering a layer of 0.3 mm) layer on top portion of piston, and interior side of head of cylinder] attached oxidizer with sponge iron as oxidizer with different test fuels of pure petrol, C2H5OH mixed with petrol (80% petrol) and CH3OH mixed with petrol (80% methanol) and correlated with base engine (CE) with petrol operation.*

***Variables of Study:** Workability variables of engine rotational speed, ratio of compression, BTE, EGT) were changed with variable BMEP.*

***Methodology:** The products of exhaust CO and UBHC were determined with variable BMEP. The engine was attached with oxidizer with sponge iron and manganese ore as oxidizers. Air injection facility was incorporated in to oxidizer. The workability was judged with one oxidizer with other oxidizer.*

***Brief Results**: There was an increase of BTE with C2H5OH mixed with petrol with both versions of the engine. There was rise in BTE with CCE with respect to CE with both experimental fuels. Ratio of compression had effect on BTE, while there was marginal effect on speed. Products of exhaust decreased with CH3OH rather than C2H5OH, which was reflecting on both versions of the engine. Air spray in to the oxidizer had great effect in reducing emissions with variable experimental fuels and different shapes of the engine.*

KEYWORDS: *Petrol Engine, C2H5OH, CH3OH, CE, CCE, Workability, Exhaust Products, and Oxidizer*

INTRODUCTION

The quantity of automobiles dictates the type of the civilization of any country. Individual transport requires gasoline leading to scarcity of the fuel owing to usage of the fuel by many numbers of persons causing exhaustion of conventional fuels, the finding of alternative fuels has become necessary apart from utility of these fuels in proper fashion which has been the main target of and scientists equipped with combustion & research of alternative fuel. Alcohols are important sources as alternative fuels for conventional engine, as their thermal properties are matching and somewhat superior to petrol. If blended in little volumes, there was no necessity to modify the configuration of the engine.

CO and UBHC, products of exhaust because of partial combustion of fuel, effect health and cause disorders [1-6]. Such substances also cause ill effects on life of biological livings like animal and plant, besides global warming and green-house effect. If alcohol is substituted for petrol, there was necessity of checking aldehydes. Aldehydes cause cancer. There are many variables effecting the amount of products of exhaust such as condition of the engine, layout of the road, density of traffic, adoptability of driving etc,. Hence to suppress these products of exhaust is an immediate strep. Wide variety of methods was available to upgrade the workability of the engine. Out of which engine Cuprum coating was one simple method. [7-11], because, Cuprum has a good thermal conductivity, which improved combustion. . Employing oxidizer is one method to regulate exhaust products. [12-19]. The reduction of CO and UBHC depends on oxidizer weight, ratio of void, oxidizer temperature, flow rate of oxygen, rotational speed and ratio of compression. Ratio of compression affects the workability of the engine.[20-25] along with fuel mix It further enhanced [26-27] with simultaneous change of composition of fuel composition and alteration of engine. Alcohols were mixed with petrol and used in CCE in order to enhance the workability of the engine. However, no scientific analysis was available of comparison of different alcohols in CCE with variation of variables of the engine.

The present paper analyzed the workability of CCE, with different test fuels of neat petrol, C2H5OH (petrol 80%) and CH3OH (petrol 80%) with different variables of rotational speed, ratio of compression, and correlated with CE with pure petrol operation. The product of exhaust CO, UBHC and aldehydes were regulated by oxidizer with different oxidizers of sponge iron and manganese ore and they were compared with one over the other.

MATERIALS AND METHODS

Figure 1 shows line diagram of tests carried out to make investigations on CCE with alcohol mixed petrol. A 4-S, 1-Cylinder, cooling arrangement by water, petrol engine (brake horse power 3 HP @ 50 rps, which was attached to an power measuring device.

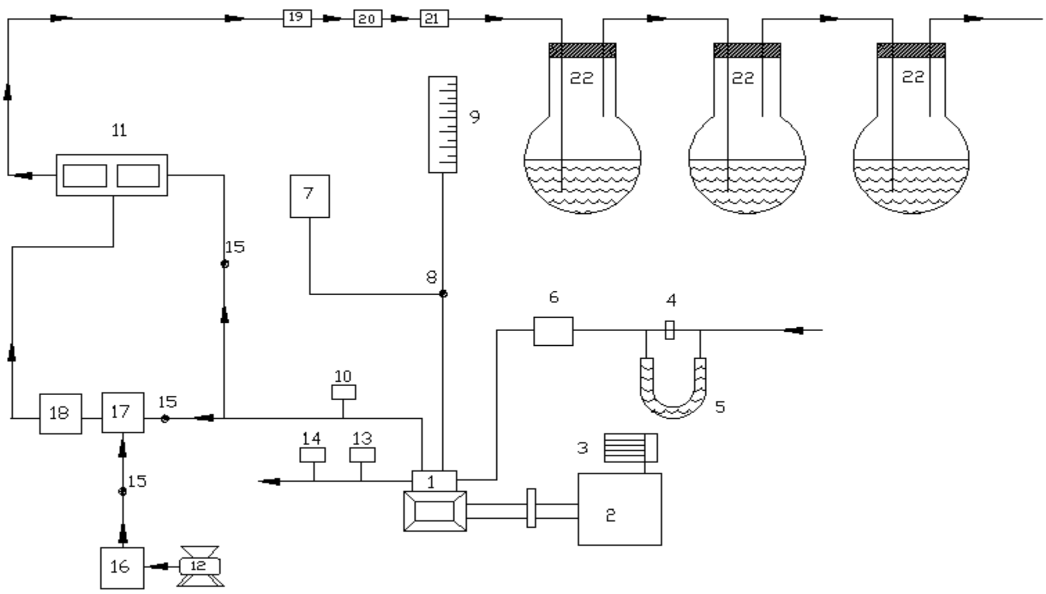
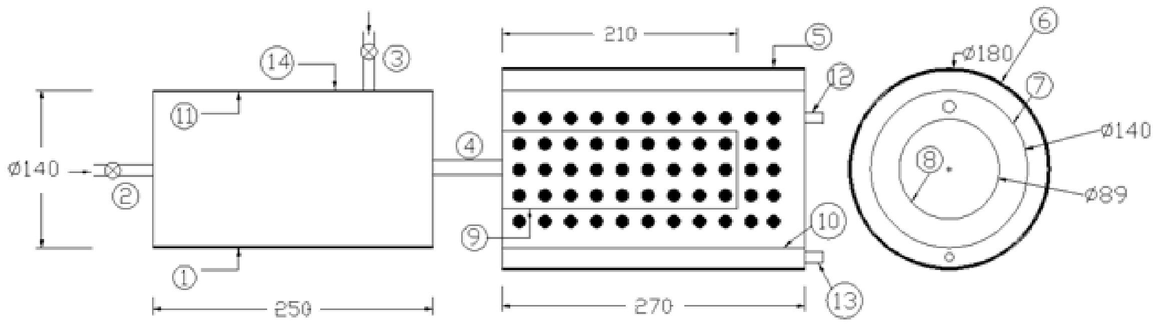


Figure 1: Experimental Set Up

1. Engine, 2.Power measuring device, 3. Variable rheostat, 4. Discharge deice, 5. Pressure measuring device, 6. Air pulsating device, 7. Fuel storage, 8. Directional valve, 9. Fuel measurement rate device, 10. EGT indicator, 11 CO analyzer, 12. Pressure pick-up device 13. Coolant temperature indicator, 14.Wter flow meter, 15. Directional valve, 16. Flow rate device 17. Oxygen chamber and 18. Oxidizer chamber 19. Filter, 20. Exhaust gas measurement device 21. Heating coil 22 DNPH solution container.

Ratio of compression of engine was altered (3:1-9:1) with varied volume of clearance by adjusting the wheel provided with cylinder head. There was adjustability of speed of the engine from 35 rps to 50 rps. Thermocouples were used to determine temperature of exhaust gas as well as coolant temperature. Determination of consumption of fuel was done method of burette, while air-box method was used to determine air consumption of the engine. In catalytic coated engine, top portion of piston and cylinder head's inner face was coated with cuprum by method of spraying of plasma spraying. A bond coating of CO-Cr-Ni alloy was applied (cover, 0.1 mm each) using a 80 kW METCO spray gun of plasma. Over bond coating, Cu (89.5%), Al(9.5%) and Fe (1.0%) were coated (cover 0.3 mm). The coating has strong affinity and does not peel off even after 3000 minutes operation [7]. Workability factors like BTE, EGT and VE were evaluated with varied BMEP of the engine. CO and UBHC emissions in exhaust product of engine were determined with Netel Chromatograph analyzer. DNPH system [15] was followed for assessing aldehydes in the experiment. The product of the exhaust of the engine was bubbled through 2,4 DNPH concentration of solution. The hydrazones formed were titrated into chloroform and were tested by providing HPLC to evaluate the percentage concentration of formaldehyde and acetaldehyde in the product of the exhaust.

A oxidizer [9] (Figure .2) was attached to the outlet pipe of engine. There was a facility to spray exact quantity of air into oxidizer. Air quantity taken from pressure increase device and sprayed into oxidizer was kept stationary so that backpressure will not shoot up. Tests were undertaken on CE and CCE with wide variety of experimental fuels under varied operating test conditions of oxidizer like set-A, without oxidizer and without air spray; set-B, with oxidizer and without air spray; and set-C, with oxidizer and with air spray. The uncertainty in the instrumentation used in the experiment is 0.1%.



Note: All dimensions are in mm.

Figure 2: Details of Catalytic Converter.

1. Oxygen chamber 2. Provision for inlet to oxygen chamber from the engine, 3. Provision for inlet oxygen chamber from the pressure –pick up device, 4. Provision for outlet for oxygen chamber, 5. Oxidizer, 6. Outermost cylinder, 7. Intermediate-cylinder, 8.Inner most cylinder, 9.Inner sheet plate, 10.Intermediate sheet plate 11. Outer sheet plate, 12. Outlet for product of exhaust 13. Catalyst depositorand, 14. Insulator.

RESULTS AND DISCUSSION

Performance Parameters

Figure 3 denotes that as ratio of compression ratio hiked, peak BTE also hiked in two models of the engine with experimental fuels at a speed of 50 rps. Work done on the piston will increase as gases are allowed to expand from lower value to higher value. There was optimum ratio of compression of 9:1, maximum BTE was noticed with experimental fuels in two models of the engine.

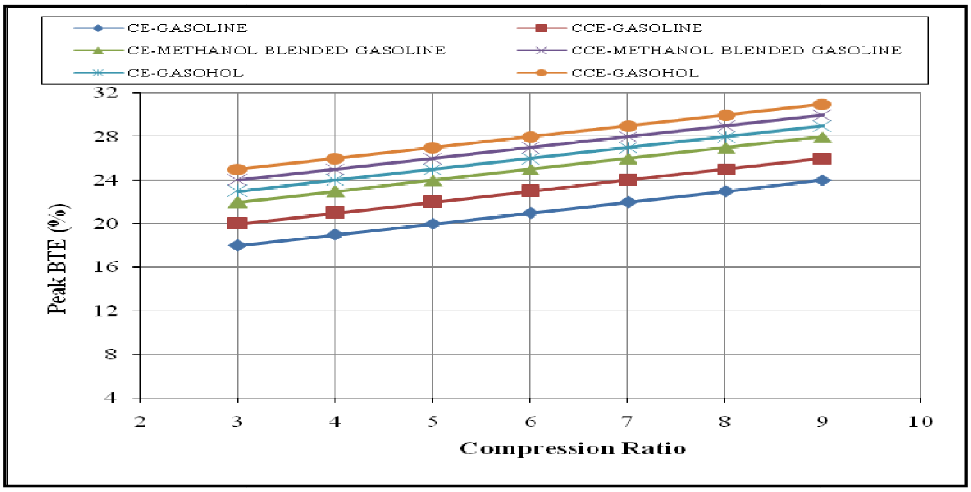


Figure 3: Variation of Peak BTE with Compression Ratio.

From Figure 4, there was increase of peak BTE, with change of speed, at ratio of compression 9:1. Turbulence was affected with change of speed. Catalytic activity was improved at higher speeds causing increase of higher BTE. At speed of the engine speed of 50 rps, maximum BTE was noticed with experimental fuels in two models of the engine.

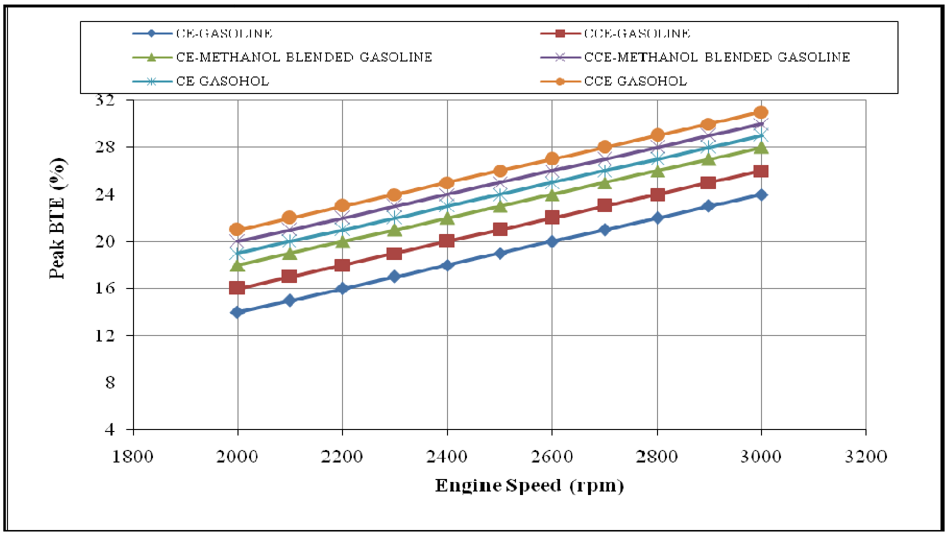


Figure 4: Variation of Peak BTE with Speed of the Engine.

Curves from Figure 5 indicate that there was increase of BTE up to 4.2 bar due to increase in efficiency of conversion of fuel, and beyond 4.2 bar, it decreased due to decrease of mechanical efficiency with experimental fuels at a ratio of compression of 9:1 and speed of 50 rps with two models of the engine.

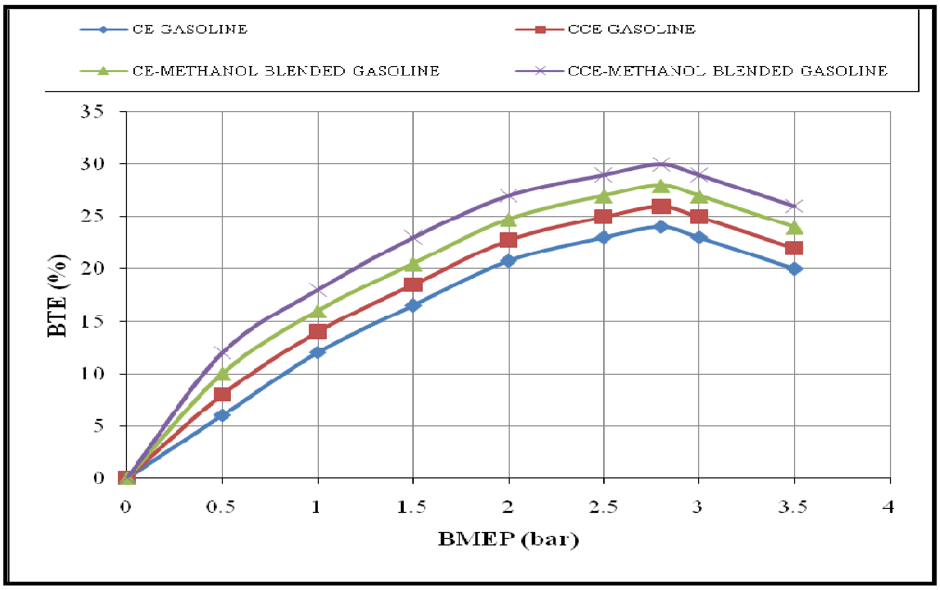


Figure 5: Variation of BTE with BMEP of the Engine.

CH3OH blend improved thermal efficiency with respect to petrol operation. This is due to improved single phase combustion, reduced carbon split-up losses, increase of ratio of specific heats and coolant losses due to lowered gas temperatures. More number of moles of working gas of CH3OH affected high pressures in the cylinder. Air fuel ratio requirement for CH3OH was lower with respect to petrol operation. This means large quantity of oxygen was available with combustion of CH3OH. CH3OH contained oxygen in its molecular composition, which improved combustion. CCE improved higher BTE with respect to CE with experimental fuels at loads, especially at near full load operation, due to improved combustion with catalytic activity.

From Figure 6, it is found that CCE with C2H5OH blend gave higher peak BTE with respect CH3OH blend in tow models of the engine, due to its higher calorific value. The ratio of moles of products to the reactants for petrol and alcohols is as follows. [28]

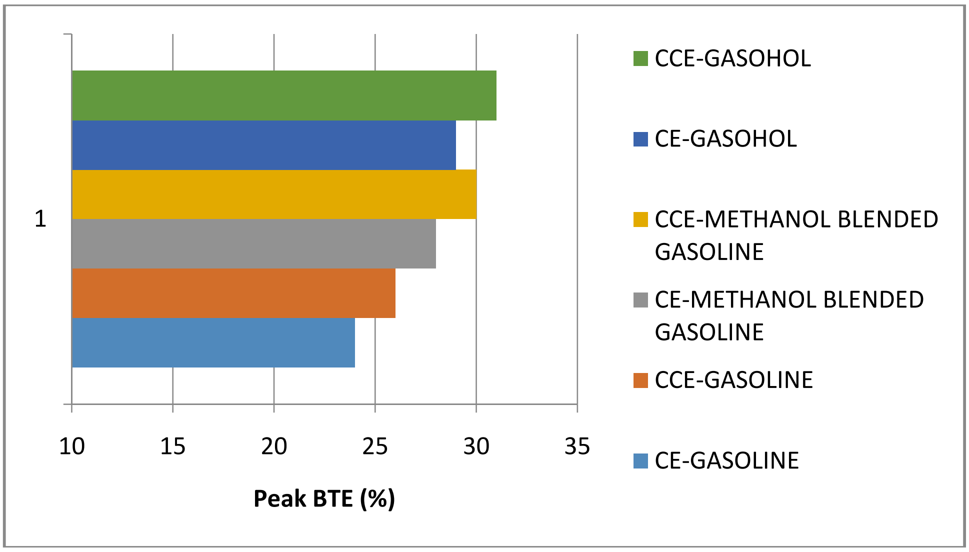


Figure 6: Bar Charts Showing the Variation of Peak BTE.

Reaction of gasoline [28]

1.058 C_8H_{18} + 12.5O_2 +47 N_2 →8 CO_2 + 9 H_2O +47 N_2

(60.5 moles) (64.0 moles)

Reaction of ethanol [28]

1.065 C_2H_5OH + 3 O_2 + 11.3 N_2 → 2CO_2 +3 H_2O +11.3 N_2

(15.3 moles) (16.3 moles)

Reaction of methanol [28].

1.061 CH_3OH + 1.5 O_2 +5.65 N_2 →CO_2+ 2H_2O +5.65 N_2

(8.15 moles) (8.65 moles)

Consider the fuel to enter the cylinder in liquid state points to a somewhat enhanced power output from ethanol on this rather simple basis..

From Figure 7, it There was increase of EGT with load due to more consumption of fuel. CH3OH gave lower value of with respect to petrol operation due to its higher latent heat of evaporation, causing absorption of gas temperatures. CCE showed lower value of EGT than CE. This once again confirmed that CCE improved performance than CE due to its lower heat rejection.

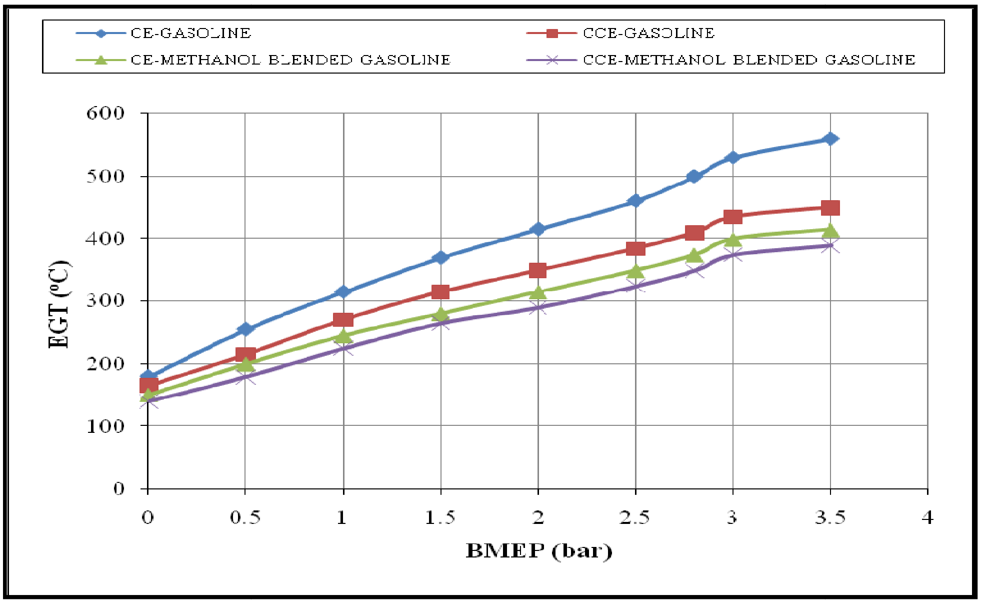


Figure 7: Variation of EGT with BMEP of the Engine.

From Figure 8, it is noticed that CH3OH gave lower value of EGT at full load with respect neat petrol and C2H5OH. Higher value of heat of evaporation of CH3OH contributed lower value of EGT at full load.

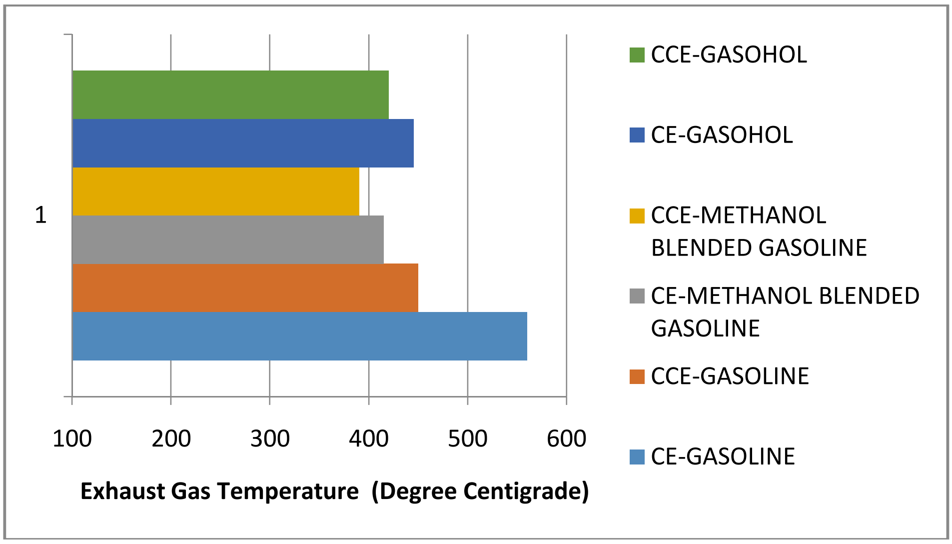


Figure 8: Bar Charts Showing the Variation of EGT at Peak Load Operation.

Figure 9 finds that there was decrease of volumetric efficiency (VE) with load, due to increase of gas temperatures because of consumption of fuel. CH3OH recorded higher VE with respect to petrol operation in two models of the engine due to hike of mass and density of air with decrease of the temperature of air due to high heat of evaporation of CH3OH. CCE exhibited higher VE at all loads with respect to CE with experimental test fuels, due to decrease of un-burnt fuel convention at combustion chamber walls.

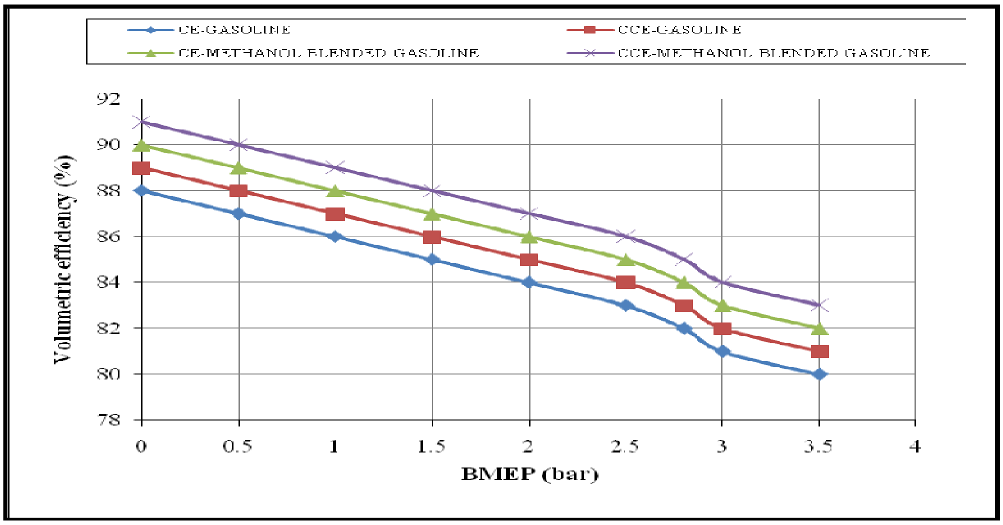


Figure 9: Variation of VE with BMEP of the Engine.

From Figure 10, it is noticed that CH3OH blend in CCE showed marginally increase of VE with respect to C2H5OH in the same configuration of the engine, due to higher heat of evaporation.

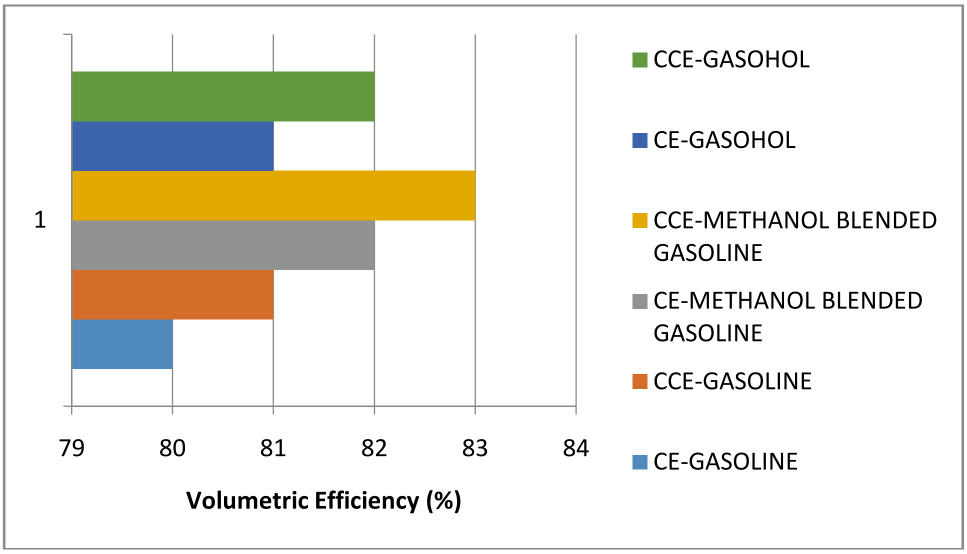


Figure 10: Bar Charts Showing the Variation of Volumetric Efficiency at Peak Load.

Exhaust Emissions

From Figure 11, there was a decrease of CO emissions with decrease of ratio of compression, due to hike of EGT causing oxidation of CO emissions in the exhaust blow pipe modifying CO to CO2. Similar tendencies were narrated earlier. [26].

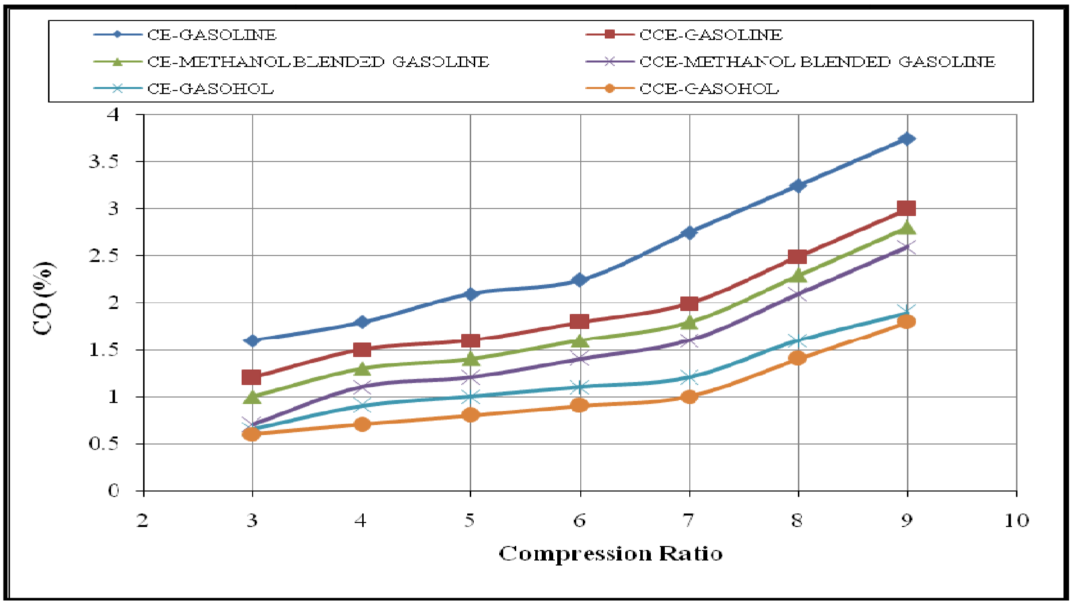


Figure 11: Variation of CO Emissions with Compression Ratio in Both Versions of the Engine.

Curves from Figure 12 showed that CH3OH blend reduced CO emissions at all loads with respect to petrol operation on CCE and CE, as there were no fuel-cracking reactions with CH3OH blend. The exhaust product of CH3OH is water vapor than free carbon atoms as CH3OH blend has lower C/H ratio of 0.25 versus 0.44 of petrol. CH3OH blend has O2 in its structure and lower theoretical air fuel ratios. Hence, more O2 was available for combustion, which caused for the reduction of CO emissions. CCE decreased CO emissions with respect to CE. Cuprum promotes combustion and produced the formation of CO_2 instead of CO.

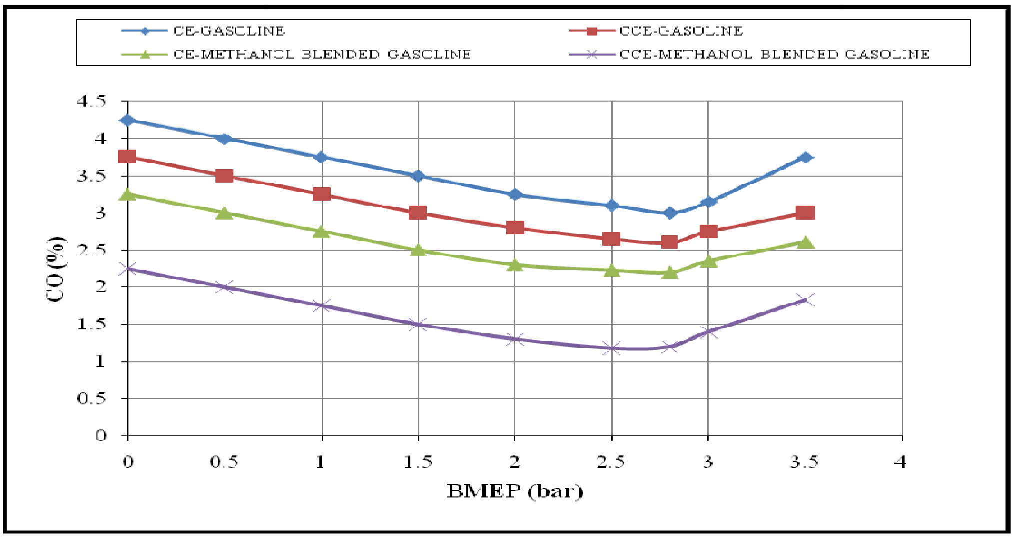


Figure 12: Variation of CO Emissions with BMEP of the Engine.

From Figure 13, it is noticed that CO emissions were observed to be marginally less with CH3OH with respect to C2H5OH at full load operation on two models of the engine. Lower value of C/H ratio of CH3OH blend dictates reduction of CO emissions.

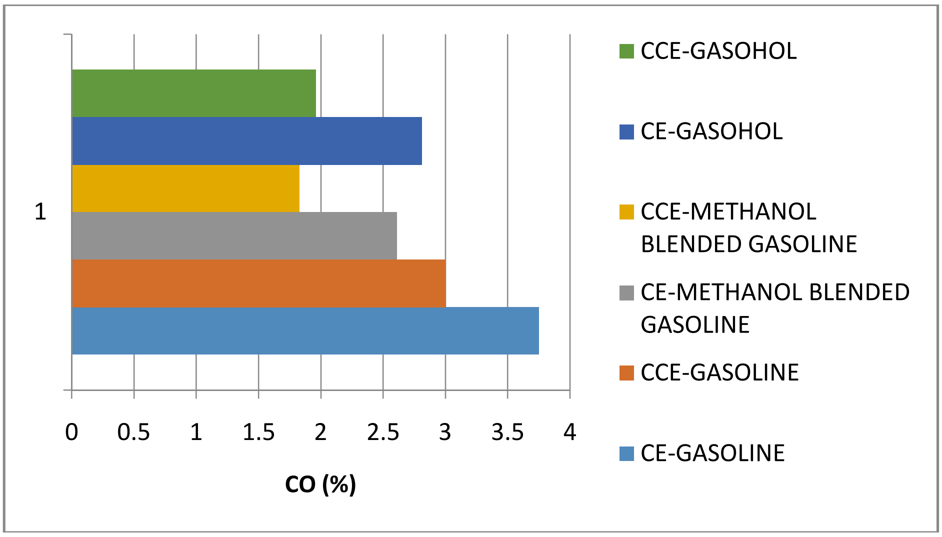


Figure 13: Bar Charts Showing the Variation of CO Emissions at Peak Load.

From Figure 14, there was a decrease of UBHC emissions with increase of speed due to improved turbulence causing efficient combustion.

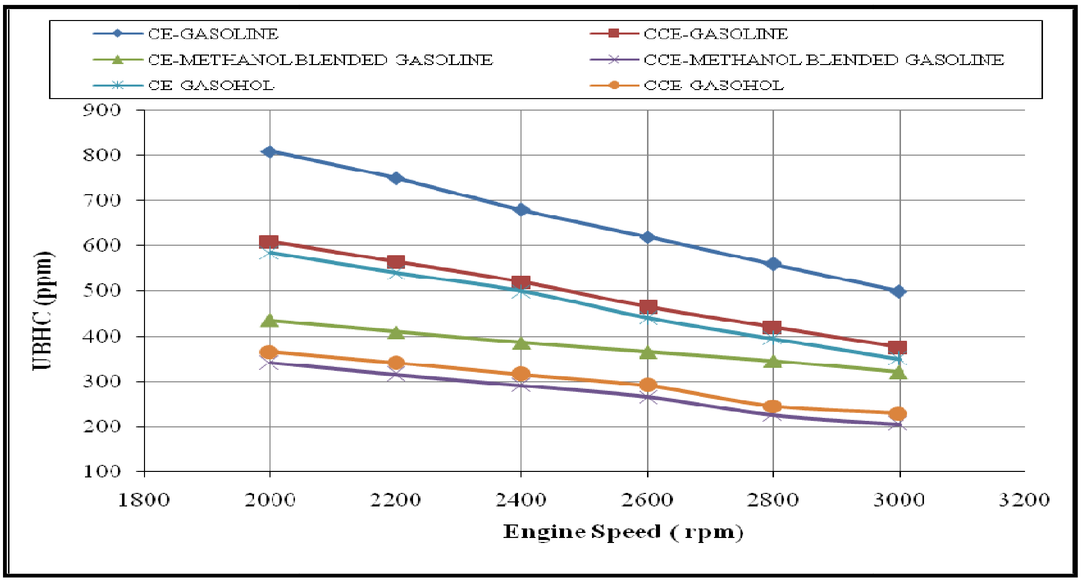


Figure 14: Variation of UBHC Emissions with Speed of the Engine.

Figure 15 showed that UBHC emissions followed the similar trend as CO emissions of both models of the engine due to increase of speed of the flame speed with pounced catalytic activity and reduction of crevice volume with CCE.

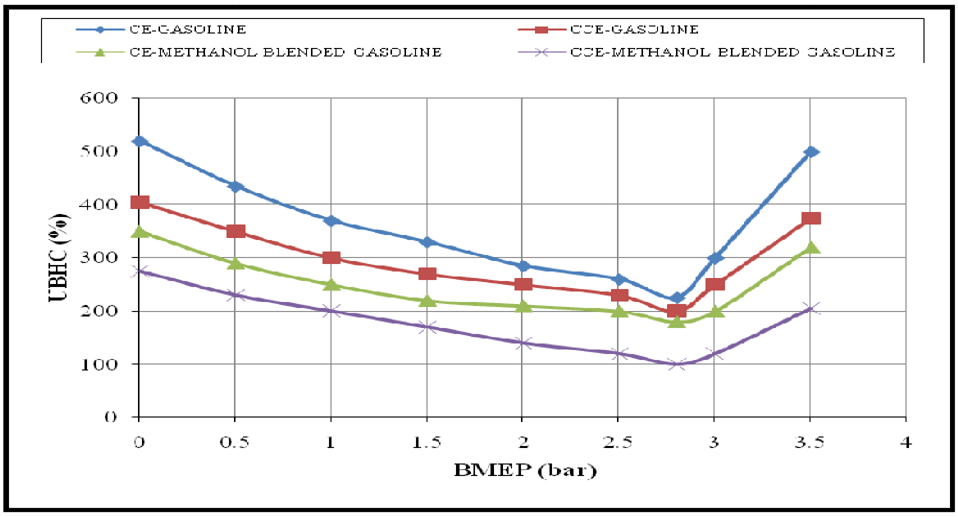


Figure 15: Variation of UBHC Emissions with BMEP of the Engine.

From Figure 16, it is noticed that that UBHC emissions at full load operation were observed to be lower with CH3OH blend with respect to C2H5OH at full load operation on two models of the engine. Good combustion with CH3OH blend making no participation of fuel in crevices of components of combustion chamber.

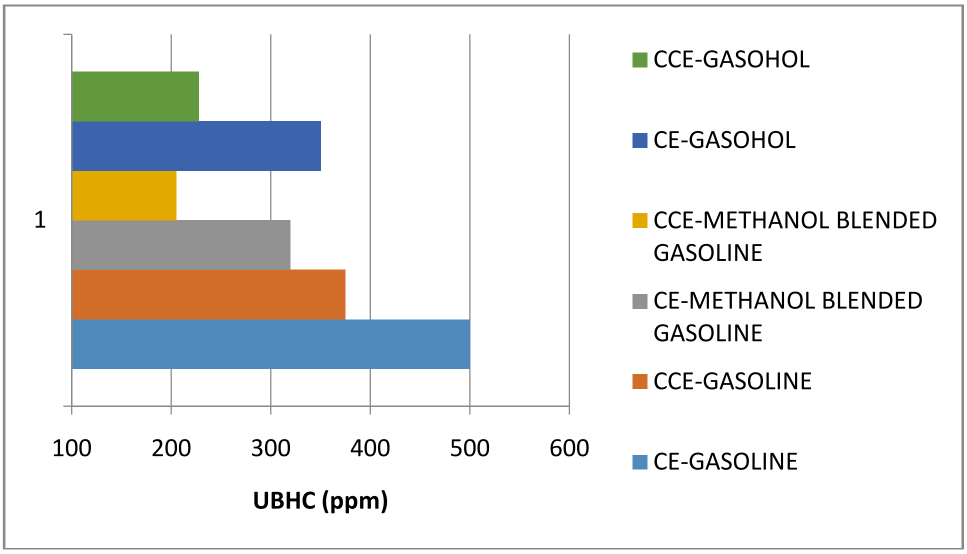


Figure 16: Bar Charts Showing the Variation of UBHC Emissions with BMEP of the Engine.

Catalytic Converter

From Table-1, it is noticed that Set-B operation decreased CO, UBHC and aldehyde levels, while Set-C further reduced CO, UBHC and aldehyde levels at full load in two models of the engine with experimental fuels.

Table 1: Data of Exhaust Emissions

Emissions	Set	Pure Gasoline Operation				Gasohol Operation				Methanol blended gasoline			
		CE		CCE		CE		CCE		CE		CCE	
		S	M	S	M	S	M	S	M	S	M	S	M
CO (%)	Set-A	3.75	3.75	3.0	3.0	2.81	2.81	1.9	1.9	2.6	2.6	1.8	1.8
	Set-B	2.25	2.79	1.8	2.22	1.54	2.16	1.4	1.5	1.5	2.02	1.1	1.35
	Set-C	1.5	1.86	1.2	1.51	0.98	1.44	0.7	1.0	0.8	1.11	0.5	0.85
UBHC (ppm)	Set-A	500	500	375	375	350	350	228	228	320	320	205	205
	Set-B	300	360	206	265	165	270	130	197	135	195	105	165
	Set-C	200	240	105	145	122	180	80	131	90	130	65	105
Formaldehyde (% Concentration)	Set-A	6.5	6.5	4.5	4.5	12	12	9.0	9.0	10.	10	9.0	9.0
	Set-B	4.5	4.9	2.5	2.9	5.6	6.1	5.1	5.6	7.3	7.8	3.4	5.6
	Set-C	2.5	2.9	1.5	1.9	4.8	5.4	3.4	3.8	4.2	4.6	2.3	3.8
Acetaldehyde (% Concentration)	Set-A	5.5	5.5	3.5	3.5	10	10	6.6	6.6	14	14	9.1	9.1
	Set-B	3.5	4.0	2.5	2.7	4.7	5.2	3.4	3.9	9,3	9.8	5.9	6.4
	Set-C	1.5	1.9	1.0	0.95	3.7	4.1	2.3	2.7	4.0	4.5	2.5	3.1

S= Sponge iron, M= Manganese ore, Set-A= without oxidizer and without air spray,
Set- B= with oxidizer and without air spray
Set- C= with oxidizer, with air spray CE= Conventional engine, CCE= Copper coated engine

Improved combustion with CH3OH blend and C2H5OH blend beside with oxidizing activity reduced CO levels in CCE. However, alcohol blended petrol increased aldehyde emissions drastically with respect to neat petrol operation. But CCE reduced aldehyde emissions with respect to CE. This is due to faster rate of combustion and improved heat release rate so that intermediate substances will not be accumulated. C2H5OH blend increased acetaldehyde levels, while CH3OH blend hiked formaldehyde levels.

CONCLUSIONS

A. On the Basis of Test Fuel

C2H5OH blend improved BTE, EGT at full load, while C2H5OH blend improved volumetric efficiency at full load , CO levels at full load, UBHC at full load. However, these alcohol blends increased drastically aldehyde levels.

B. On the Basis of the Model of the Engine

CCE improved BTE, at full load-EGT, Volumetric efficiency, CO levels, UBC levels, Aldehyde levels in comparison with CE

C. Speed of the Engine

Higher speed (50rps) improved workability parameters and product of exhaust.

D. Ratio of Compression

Lower ratio of compression reduced products of exhaust, while higher ratio of compression improved workability parameters

E. Oxidizer

Set-B; Set-B operation improved products of exhaust than Set-A

Set-C: Set-C operation improved product of exhaust than Set-B

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