Performance Parameters of Two Stroke and Four Stroke Copper Coated Spark Ignition Engines

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ABSTRACT

Alcohols are renewable in nature. They have comparable properties with gasoline. Blending of alcohol with petrol is common technique to improve the performance of the engine. Gasoline engines are suitable for individual transport and have many advantages over diesel engines in terms of lower vibrations, less weight and more efficient. Two stroke petrol engines have higher mechanical efficiency than four stroke petrol engines. In order to improve the performance, copper coating was applied for two stroke and four stroke petrol engines. Little reports were available on comparative studies on performance characteristics of two stroke and four stroke petrol engines with methanol blended gasoline. Investigations were carried out to evaluate the performance of two stroke and four stroke of single cylinder, spark ignition (SI)engine having copper coated engine [CCE, copper-(thickness, 300 μ) coated on piston crown, inner side of cylinder head and liner fuelled with methanol blended gasoline (80% gasoline and 20% methanol by volume) and compared with conventional engine (CE) with pure gasoline operation. Performance parameters of brake thermal efficiency, exhaust gas temperature and volumetric efficiency were determined at different values of brake mean effective pressure (BMEP). Brake thermal efficiency increased, exhaust gas temperature decreased and volumetric efficiency increased with methanol blended gasoline with both versions of the engine. CCE showed improvement in the performance when compared with conventional engine (CE) with both test fuels.

Keywords

SI engine, Methanol, CE, CCE, Fuel Performance, Exhaust emissions and Catalytic converter

1.INTRODUCTION

In the context of fast depletion of fossil fuels, the search for alternate fuels has become pertinent. Alcohols are probable candidates as alternate fuels for SI engines, as their properties are compatible close to gasoline fuels. If alcohols are blended in small quantities with gasoline fuels, no engine modification is necessary.

There are many methods to improve the performance of the engine out of which engine modification [1-5] with copper coating on piston crown and inner side of cylinder head improves engine performance as copper is a good conductor of heat and combustion and pre-flame reactions were improved with copper coating. Out of many methods available to control pollutants from SI engine, catalytic converter is effective [6-9] in reduction of pollutants in SI engine. The reduction of CO and UBHC depends on mass of the catalyst, void ratio, temperature of the catalyst, air flow rate, BMEP, speed and compression ratio of the engine, Engine performance improved [10-15] with change in fuel composition also. It was further improved [16-20] with simultaneous change of fuel composition and engine modification. Alcohols are blended with gasoline and used in copper coated engine so as to improve the performance of the engine. However, no systematic investigations were reported with the use of methanol blended gasoline in 2 stroke and 4 stroke copper coated engine with varied engine parameters.

The present paper reported the performance evaluation of 2-stroke and 4-stroke CCE, with methanol blended gasoline and data was correlated with gasoline engine on conventional engine. .

METHODOLOGY

Figure 1 consisted 4-stroke CCE with methanol blended gasoline, used in the experimentation. A four- stroke, single-cylinder, water-cooled, SI engine (brake power 2.2 kW, at the speed 3000 rpm) was coupled to an eddy current dynamometer for measuring its brake power. The bore of the engine was 70 mm while the stroke was 66 mm. Compression ratio of engine was varied (3-9) with change of clearance volume by adjustment of cylinder head, threaded to cylinder of the engine. Engine speeds were varied from 2000 to 3000 rpm. Exhaust gas temperature was measured with iron- constantan thermocouples. Fuel consumption of engine was measured with burette method, while air consumption was measured with an air-box method.

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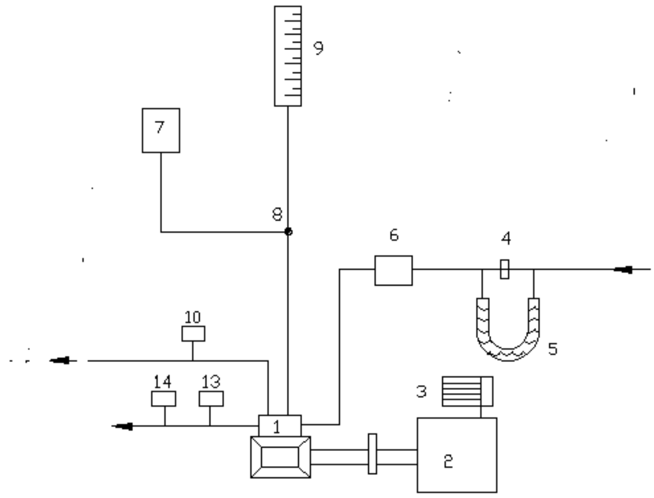
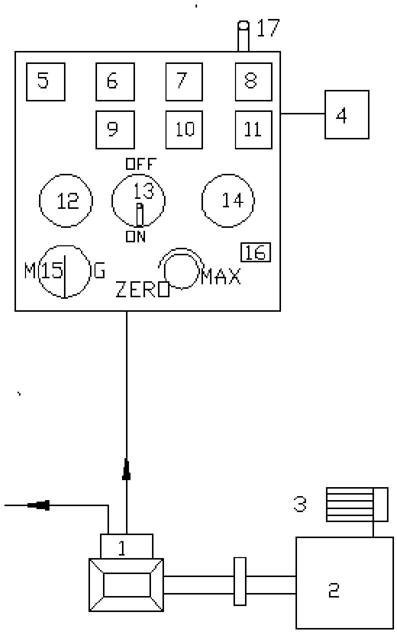


1. Engine, 2.Eddy current dynamometer, 3. Loading arrangement, 4. Orifice meter, 5. U-tube water monometer, 6. Air box, 7. Fuel tank, 8. Three-way valve, 9. Burette,10. Exhaust gas temperature indicator, 11 CO analyzer, 12. Air compressor, 13. Outlet jacket water temperature indicator, 14. Outlet jacket water flow meter,

Figure.1 Schematic diagram of the Experimental set up (4-Stroke Engine)

The experimental setup contained 2-stroke CCE with methanol blended gasoline is shown in Figure 2. A two- stroke, single-cylinder, air -cooled, SI engine (brake power 2.2 kW at the speed of 3000 rpm) was coupled to a eddy current dynamometer for measuring its brake power. The bore and stroke of engine cylinder was 57 mm each. Compression ratio of engine was 7.5:1. Exhaust gas temperature, speed, torque, fuel consumption and air flow rate of the engine were measured with electronic sensors. Compression ratio and speed of 4-stroke engine was made equal (3000 rpm and 7.5:1) to that of 2-stroke engine in order to maintain same conditions for comparison purpose.

In catalytic coated engine, piston crown and inner surface of cylinder head were coated with copper by flame spray gun. The surface of the components to be coated were cleaned and subjected to sand blasting. A bond coating of nickel- cobalt- chromium of thickness 100 microns was sprayed over which copper (89.5%), aluminium (9.5%) and iron (1%) alloy of thickness 300 microns was coated with METCO (Trade name of the company) flame spray gun. The coating has very high bond strength and does not wear off even after 50 h of operation [7].



1. Engine, 2.Electrical swinging field dynamometer, 3. Loading arrangement, 4.Fuel tank, 5.Torque indicator/controller sensor, 6. Fuel rate indicator sensor, 7. Hot wire gas flow indicator, 8. Multi channel temperature indicator, 9. Speed indicator, 10. Air flow indicator, 11. Exhaust gas temperature indicator, 12. Mains ON, 13. Engine ON/OFF switch, 14. Mains OFF, 15. Motor/Generator option switch, 16. Heater controller, 17. Speed indicator,

Figure 2 Schematic diagram of the Experimental Set-up (2-StrokeEngine)

Performance parameters of brake thermal efficiency (BTE), exhaust gas temperature (EGT) and volumetric efficiency (VE) were evaluated at different values of brake mean effective pressure (BMEP) of the engine.

3. RESULTS AND DISCUSSION

3.1 Performance Parameters

Fig.3 shows variation of brake thermal efficiency (BTE) with brake mean effective pressuer (BMEP) for test fuels with different configuration of the engine at a speed of 3000 rpm and compression ratio of 7.5:1. Curves from Figure 3 indicate that BTE increased up to 80% of full load operation due to increase in fuel conversion efficiency and beyond that load it decreased due to increase of friction power with an increase of BMEP with test fuels at a compression ratio of 7.5:1 and speed of 3000 rpm with both versions of the engine.

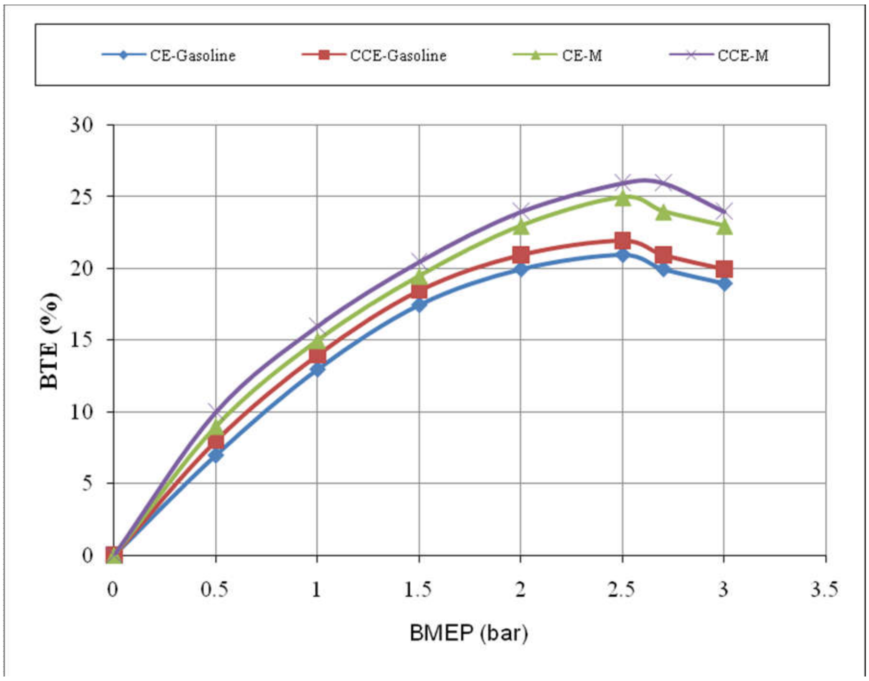


Fig.3. Variation of BTE with BMEP in two stroke engine

The reason for improving the efficiency with methanol blended gasoline at all loads over gasoline operation was because of improved homogeneity of the mixture with the presence of methanol, decreased dissociated losses, specific heat losses and cooling losses due to lower combustion temperatures. This was also due to high heat of evaporation of methanol, which caused the reduction the gas temperatures resulting in a lower ratio of specific heats leading to more efficient conversion of heat into work. Induction of methanol resulted in more moles of working gas, which caused high pressures in the cylinder. The observed increased in the ignition delay period would allow more time for fuel to vaporize before ignition started. This means higher burning rates resulted more heat release rate at constant volume, which was a more efficient conversion process of heat into work. The increase in efficiency with methanol blended gasoline was also due to lower stoichiometric air requirement of methanol over pure gasoline operation. CCE showed higher thermal efficiency when compared to CE with both test fuels at loads, particularly at near full load operation, due to efficient combustion with catalytic activity, which was more pronounced at peak load, as catalytic activity increased with prevailing high temperatures at peak load.

Fig.4 presents bar chart showing the variation of peak BTE with test fuels with different versions of the engine at speed of 3000 rpm and compression ratio of 7.5:1. Figure 4 showed that peak BTE with 4-stroke engine was higher than that of 2 stroke engine at same compression ratio and speed. This was due to increase and waste of fuel with 2 stroke engine.

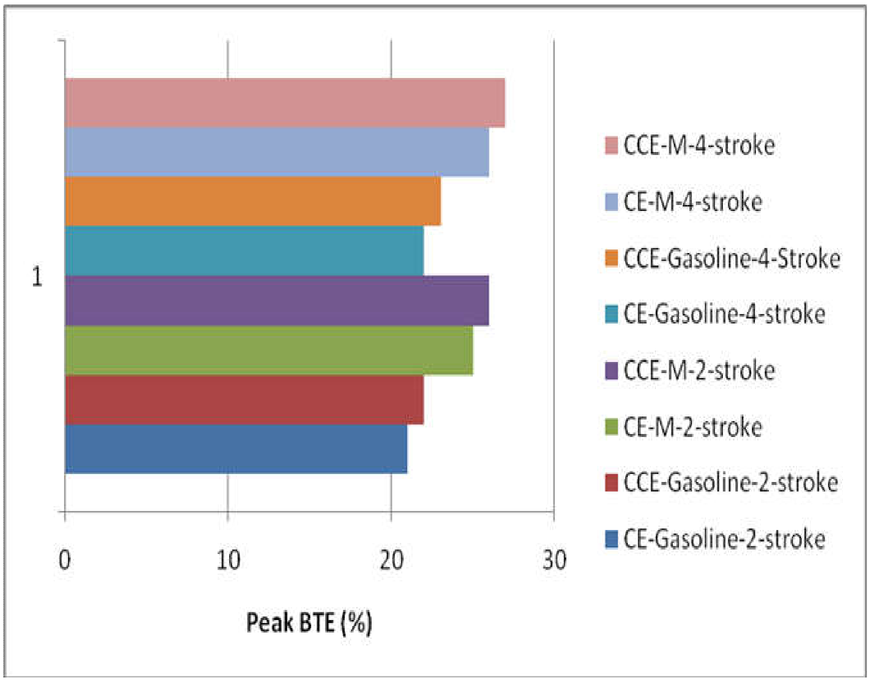


Fig.4 Bar chart showing the variation of peak BTE

Fig.5 shows variation of exhaust gas temperature (EGT) with brake mean effective pressure (BMEP) for test fuels with different configuration of the engine at a speed of 3000 rpm and compression ratio of 7.5:1. From Figure 5, it is evident that EGT increased with an increase of BMEP. EGT value was observed to be less with methanol blended gasoline with pure gasoline in both versions of the engine. This was due to higher value of latent heat of evaporation of methanol which absorbed heat from combustion. Pure gasoline operation on CE recorded higher value of EGT, while methanol blended gasoline operation on CCE gave lower value of EGT, as with methanol blended gasoline, work transfer from piston to gases in cylinder at the end of compression stroke was too large, leading to reduction in the magnitude of EGT.

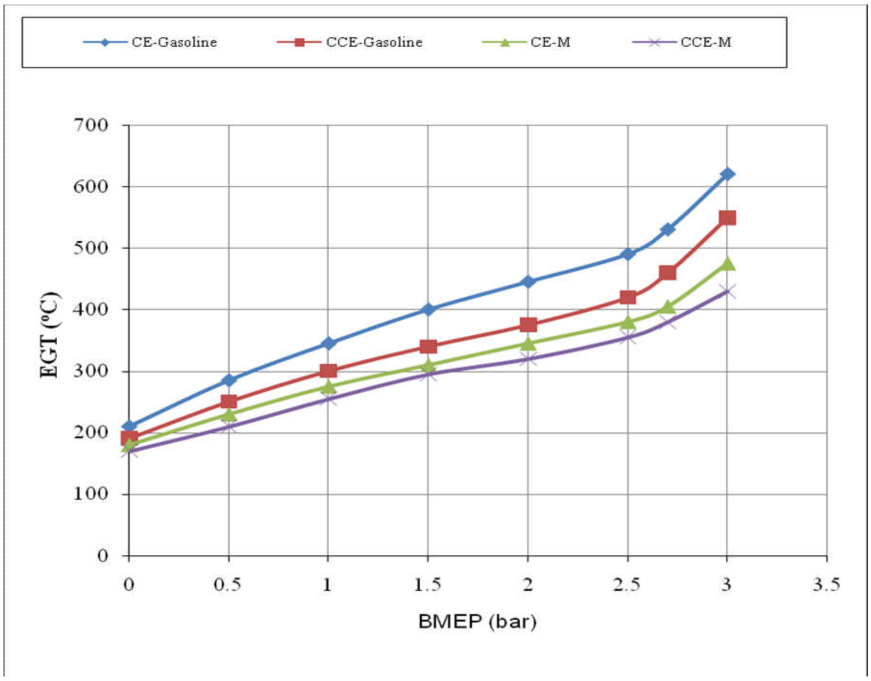


Fig.5 Variation of EGT with BMEP,

Fig.6 presents bar chart showing the variation of EGT at full load with test fuels with different versions of the engine at speed of 3000 rpm and compression ratio of 7.5:1.

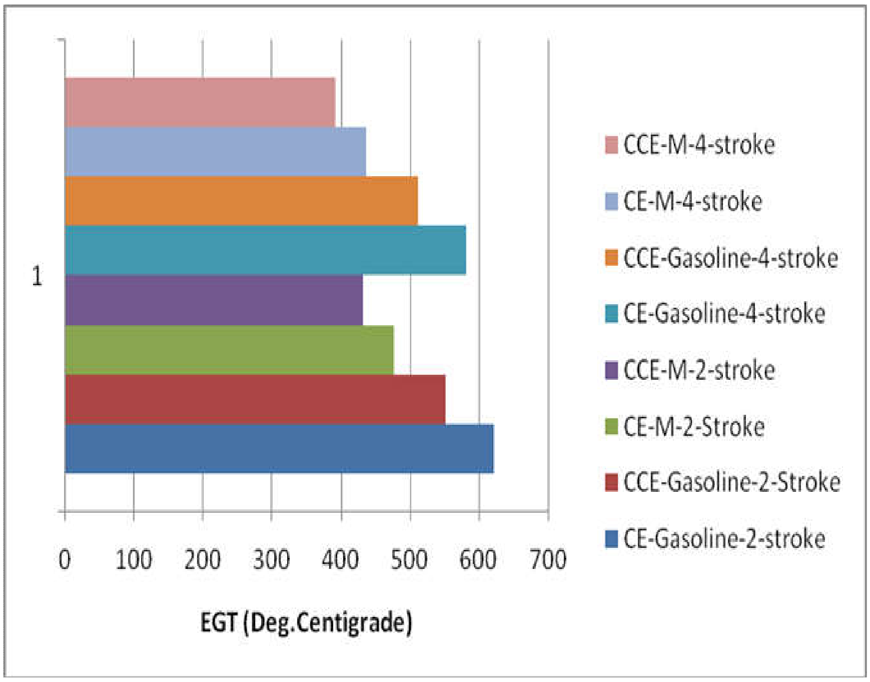


Fig.6 Bar chart showing the variation of EGT at full load

Figure 6 indicates that EGT was lower than with 4-stroke engine in comparison with 2 stroke engine at same compression ratio and speed with both test fuels and with both configurations of the engine. This was due to heat carried away by burning gases in 2-stroke engine which escaped through exhaust port, when transfer port opened.

Fig.7 shows variation of volumetric efficiency with brake mean effective pressure (BMEP) for test fuels with different configuration of the engine at a speed of 3000 rpm and compression ratio of 7.5:1

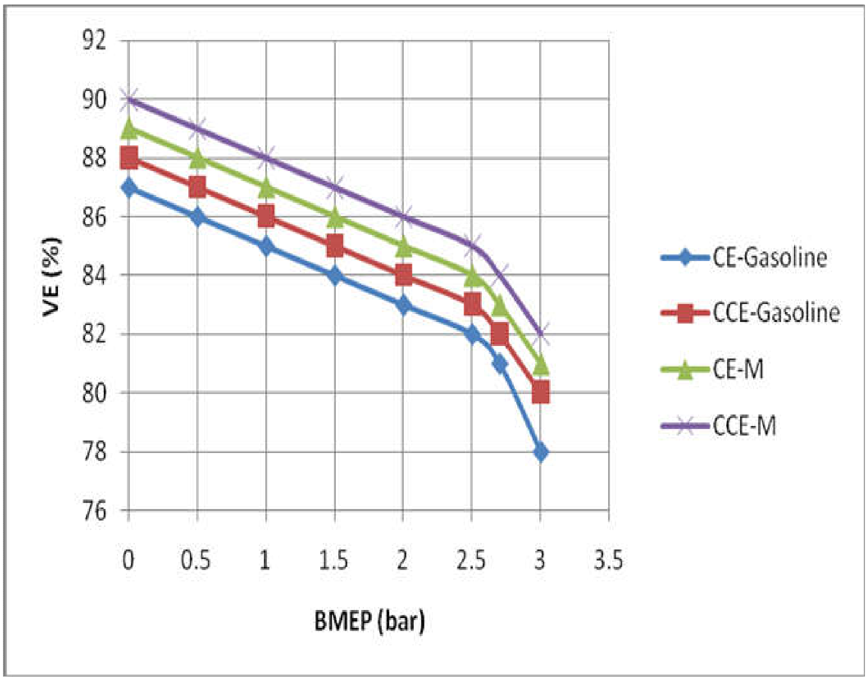


Fig.7 Variation of volumetric efficiency (VE) with BMEP

Figure 7 indicates that VE decreased with an increase of BMEP with test fuels in both versions of the engine. This was due to increase of gas temperatures with increase of BMEP. Methanol blended gasoline showed higher VE in comparison with gasoline operation in both configuration of the engine due to increase of mass and density of air with reduction of the temperature of air due to high latent heat of evaporation of methanol. CCE showed higher VE at all loads in comparison with CE with different test fuels, due to reduction of residual charge and deposits in the combustion chamber of CCE when compared to CE, which showed the similar trends as reported earlier [7] .

Fig8 presents bar chart showing the variation of volumetric efficiency at full load with test fuels with different versions of the engine at speed of 3000 rpm and compression ratio of 7.5:1.

Figure 8 shows that VE decreased with 2 stroke engine in comparison with 4 stroke engine as actual stroke volume of 2 stroke engine is less.

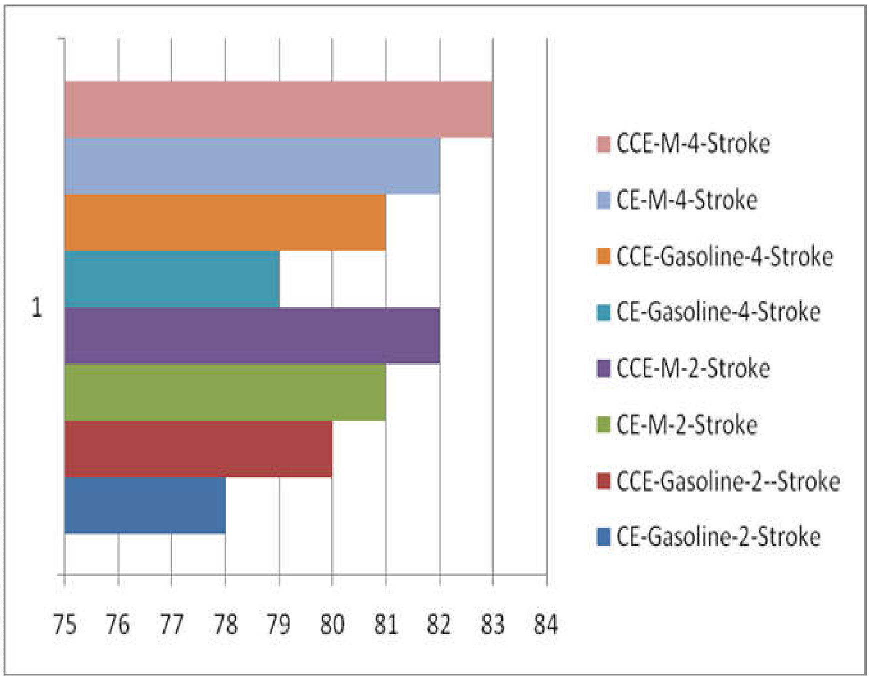


FIG.8. Bar charts showing the variation of volumetric efficiency

4. CONCLUSIONS

In comparison with 2-stroke CCE engine with methanol blended gasoline operation, 4-stroke engine increased peak BTE by 4%,decreased EGT by 40°C and increased volumetric efficiency by 1% ,

In comparison with 4-stroke CCE engine with methanol blended gasoline, Peak BTE increased by 24%, EGT decreased by 190°C, VE increased by 5% , when compared with CE with pure gasoline operation. CCE improved combustion

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