Volume 5, Special Issue, June 2018 ISSN: 2348-8565 (Online)

International Journal of Modern Engineering and Research Technology

Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

National Conference on
Advances in Mechanical Engineering and Nanotechnology (AMENT2018)
29-30 June, 2018
Organized by
Department of Mechanical Engineering, University College of Engineering (A),
Osmania University, Hyderabad, TS, India

Experimental Measurements on Exhaust Emissions on Modified Two Stroke Spark Ignition Engine with Alcohol Blended Gasoline Using Catalytic Converter

S. Narasimha Kumar
Department of Mechanical Engineering
Chaitanya Bharathi Institute of Technology
Hyderabad (T.S.) [INDIA]
Email: narasimha71110@gmail.com

ABSTRACT

Experiments were conducted to control the exhaust emissions from two-stroke, single cylinder, spark ignition (SI) engine, with alcohol blended gasoline (80% gasoline, 10% ethanol, 10% butanol by volume) having copper coated combustion chamber [CCCC, copper-(thickness, 300 μ) coated on piston crown, inner side of cylinder head] provided with catalytic converter with sponge iron as catalyst and compared with conventional SI engine (CE) with pure gasoline operation. Aldehydes were measured by wet chemical method. Exhaust emissions of CO and UBHC were evaluated at different values of brake effective pressure, while aldehydes were measured at full load operation of the engine. A microprocessor-based analyzer was used for the measurement of CO/UBHC in the exhaust of the engine. Copper coated combustion chamber with alcohol blended gasoline considerably reduced pollutants in comparison with CE with pure gasoline operation. Catalytic converter with air injection significantly reduced pollutants with test fuels on both configurations of the engine. The catalyst, sponge reduced the pollutants effectively with both test fuels in both versions of the engine.

Keywords:— *S.I.Engine, CE, copper coated combustion chamber, Exhaust Emissions, CO, UBHC, Catalytic converter, Sponge iron.*

I. INTRODUCTION

Carbon monoxide (CO) and un-burnt hydrocarbons (UBHC), major exhaust pollutants formed due to incomplete combustion of fuel, cause many human health disorders [Sharma, 2004; Khopkar, 2005]. These pollutants cause asthma, bronchitis, emphysema, slowing down of reflexes, vomiting sensation, dizziness, drowsiness, etc. Such pollutants also cause detrimental effects on animal and plant life, besides environmental disorders Age and maintenance of the vehicle are some of the reasons for the formation of pollutants [Ghoseet al., 2004].

Engine modification 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 is improved with copper coating. [Nedunchezhianet al., 2000; Murali Krishna et al., 2010]. The use of catalysts to promote combustion is an old concept. More recently copper is coated over piston crown and inside of cylinder head wall and it is reported that the catalyst improved the fuel economy and increased combustion stabilization. However, in previous studies, copper coating was restricted to crown of the piston and inside portion of cylinder head only. However, copper coating was not attempted on inside potion of liner.

Catalytic converter is one of the effective methods to reduce pollutants in SI engine. [Murali Krishna et al., 2005; Murali Krishna et al., 2008; Kishoret al., 2010; Murali Krishna et al., 2010]. Reduction of pollutants depended on mass of the catalyst, void ratio (ratio of volume occupied by the catalyst to volume of the catalytic chamber), temperature of the catalyst, amount of air injected in the catalytic chamber. A reduction of 40% was reported with use of sponge iron catalyst while with air injection in the catalytic chamber reduced pollutants by 60%.

Alcohol was blended with gasoline to reduce pollutants. CO and UBHC emissions reduced with blends of alcohol with gasoline. [Murali Krishna et al., 2012].

It is also considered as dangerous fuel, as nervous system will be damaged with the consumption of ethanol. Butanol improves the homogeneity of the fuel and it mixes readily with gasoline fuel. Excess of butanol content (more than 20% by volume) with gasoline abs orbs combustion temperatures leading to poor start ability of the engine at constant ignition timing. In order to improve the performance and reduce the pollution levels of the engine spark ignition timing was varied. However, in their investigations nitrogen oxide levels were not measured. The present paper reported the control of exhaust emissions of CO and UBHC from four-stroke SI engine with butanol blended gasoline in different configurations of the combustion chamber with catalytic converter with sponge iron/ copper/anthracite coal/copper as catalyst and compared with gasoline operation on CE. The present paper reported the control of exhaust emissions of CO and UBHCfrom four-stroke SI engine with butanol blended gasoline in different configurations of the combustion chamber with catalytic converter with sponge iron/ copper/ anthracite coal/copper as catalyst and compared with gasoline operation on CE.

II. METHODOLOGY

Butanol has oxygen in its structure and hence its blends have lower stoichiometric air requirements compared to gasoline. Therefore more oxygen that is available for combustion with the blends of butanol, leads to reduction of CO emissions. Butanol dissociates in the combustion chamber of the engine forming hydrogen, which helps the oxygen-air mixture to burn quickly and thus increases combustion velocity, which brings about complete combustion of carbon present in the fuel to CO_2 and also CO to CO_2 thus makes leaner mixture more combustible, causing reduction of CO emissions. Copper coated combustion chamber reduced CO emissions in comparison with CE. Copper or its alloys acts as catalyst in combustion chamber, whereby facilitates effective combustion of fuel leading to formation of CO_2 instead of

CO. Similar trends were observed with neat gasoline operation on copper coated combustion chamber [Nedunchezhianet al., 2000].

Figure 1 shows schematic diagram for experimental set-up used for investigations. A two-stroke, single-cylinder, air-cooled, SI engine (brake power 2.2 kW, rated s pee d 3000 A rpm and Compression ratio was 7.5:1) was coupled to an eddy current dynamometer for measuring brake power. The conventional engine had an aluminum alloy piston with a bore and stroke of 57 mm each. Exhaust gas temperature is measured with iron - constantan thermocouples. Fuel consumption of engine was measured with burette method, while air consumption was measured with air -box method. CO and UBHC emissions in engine exhaust were measured with Netel Chromatograph analyzer. A catalytic converter (Figure 2) is fitted to exhaust pipe of engine. Provision is also made to inject a definite quantity of air into catalytic converter.[Murali Krishna et al., 2012]. Air quantity drawn from compress or and injected into converter is kept constant so that backpressure does not increase. A definite quantity (250 grams each) of sponge iron/copper/anthracite coal was taken for reduction of pollutants in the experiment. There was provision for the catalytic chamber to deposit catalyst (component No.10).

1. Engine, 2. Electrical Swinging Field Dynamometer, 3. Loading Arrangement, 4. Fuel Tank, 5. Torquendicator/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, 18. Directional Valve, 19. Air Compressor, 20. Rotometer, 21. Heater, 22. Air Chamber, 23. Catalytic Chamber, 24. CO/HC Analyzer, 25. Piezoelectric Transducer, 26. TDC Encoder 27. Consol, 28. Pentium Personal Computer, 29. printer

A definite quantity (250 grams each) of spongeiron/copper/anthracite coal was taken for reduction of pollutants in the experiment. There was provision for the catalytic chamber to deposit catalyst (component No.10). These catalysts were grounded to size of 2cm×2 cm. Experiments are carried out on CE and copper coated combustion chamber with different test fuels [80% neat gas oline,10% ethanol and butanol blended gasoline (10% by vol)] under different operating conditions of catalytic converter like set-A, without catalytic converter and without air inject ion; set-B, with catalytic converter and without air injection; and set-C, with catalytic converter and with air injection.

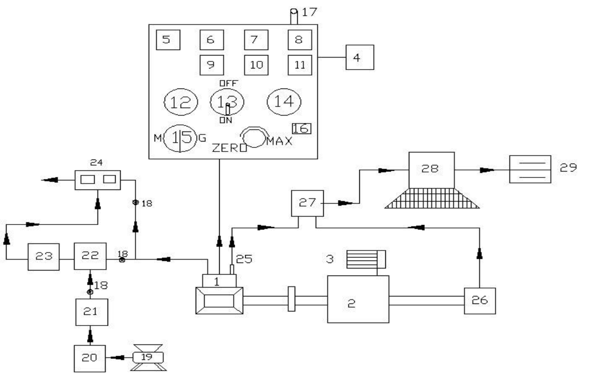

Figure 1: Schematic Diagram of Experimental Setup

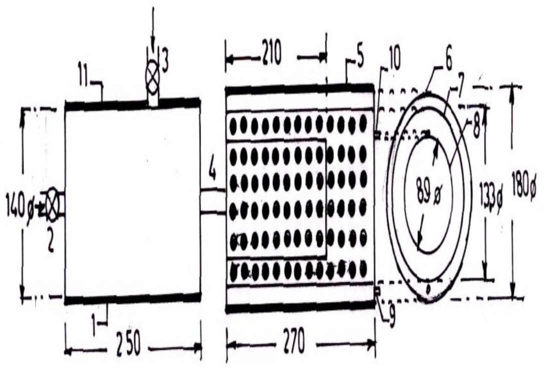

Figure 2. Details of Catalytic Converter

Note: All dimensions are in mm.

1. Air chamber, 2. Inlet for air chamber from the engine, 3. Inlet for air chamber from compressor, 4. Outlet for air chamber, 5. Catalyst chamber, 6. Outer cylinder, 7. Intermediate cylinder, 8. Inner cylinder, 9. Outlet for exhaust gases, 10. Provision to deposit the catalyst and 11. Insulation

III. Results and Discussion

Compression ratio of the engine was found to be 9;1 while speed was found to be 3000 rpm for improved performance of the engine. [Murali Krishna et al., 2015].

Figure 3 shows the variation of carbon monoxide (CO) emissions with brake mean effective pressure (BMEP) in different versions of the engine with both neat gasoline and butanol blended gasoline at a compression ratio of 7.5:1 and s peed of 2200 rpm. CO emissions decreased with butanol blended gasoline at all loads when compared to neat gasoline operation on copper coated combustion chamber and CE, as fuel-cracking reactions were eliminated with butanol [Murali Krishna et al., 2008]. The combustion of butanol produces more water vapor than free carbon atoms as methanol has lower C/H ratio of 0.4 against of 0.50 of gasoline. Butanol has oxygen in its structure and hence its blends have lower stoichiometric air requirements compared to gasoline. Therefore more oxygen that is available for combustion with the blends of butanol, leads to reduction of CO emissions. Butanol dissociates in the combustion chamber of the engine forming hydrogen, which helps the oxygen-air mixture to burn quickly and thus increases combustion velocity, which brings about complete combustion of carbon present in the fuel to CO2 and also CO to CO2 thus makes leaner mixture more combustible, causing reduction of CO emissions.

Copper coated combustion chamber reduced CO emissions in comparison with CE. Copper or its alloys acts as catalyst in combustion chamber, whereby facilitates effective combustion of fuel leading to formation of CO_2 instead of CO. Similar trends were observed with neat gasoline operation on copper coated combustion chamber [Nedunchezhianet al., 2000].

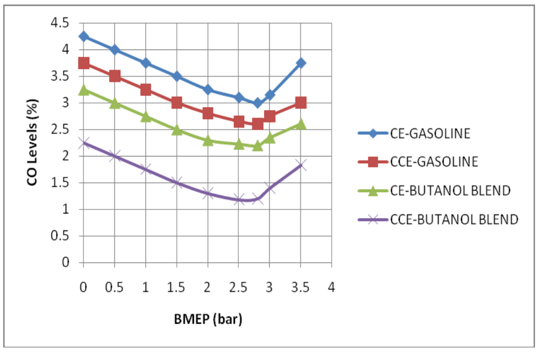

Figure 3. Variation of Carbon Monoxide levels (CO) with Brake Mean Effective Pressure (BMEP) with both Versions of the Engine with Test Fuels

Table-1 shows the data of CO emissions and UBHC emissions with different test fuels with different versions of the engine at different operating conditions of the catalytic converter with different catalysts. The catalytic converter was operated at room temperature and at a optimum void ratio of 0.6. The flow rate of air was maintained at optimum configuration of 6 l/s measured with rotometer. From Table, it can be observed that CO emissions deceased considerably (40%) with catalytic operation in set-B with butanol blended gasoline and further decrease (60%) in CO was pronounced with air injection with the same fuel. The effective combustion of the butanol blended gasoline its elf decreased CO emissions in both configurations of the combustion chamber. CO emissions were observed to be lower with butanol blended gasoline operation in comparison with neat gasoline operation in both versions of the combustion chamber at different operating conditions of the catalytic converter. Lower

C/H ratio of butanol blended gasoline might have lowered CO emissions at full load.

Copper as catalyst reduced CO emissions considerably than other catalysts as copper is a goo d oxidizing agent. It converts CO emissions to CO_2 emissions.

Figure 4 shows the variation of un -burnt hydro carbon emissions (UBHC) with BMEP in different versions of the combustion chamber with both test fuels. UBHC emissions followed the similar trends as CO emissions in copper coated combustion chamber and CE with both test fuels, due to increase of flame s peed with catalytic activity and reduction of quenching effect with copper coated combustion chamber. The trends observed with UBHC emissions were similar to those of CO emissions in both versions of the combustion chamber with both test fuels. From Table, it is observed that catalytic converter reduced UBHC emissions considerably with both versions of the combustion further oxidised to give less harmful emissions like CO2. Similar trends are observed with neat gasoline operation on copper coated combustion chamber [Nedunchezhian et al., 2000].

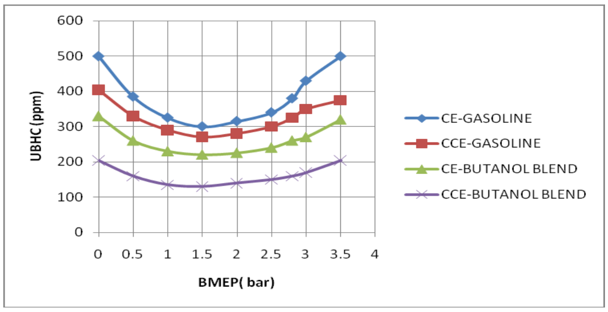

Figure 4. Variation of unburnt hydro carbon levels (UBHC) with brake mean effective pressure (BMEP) with both versions of the engine with test fuels

IV. Conclusions

- On the basis of fuel, Carbon monoxide levels and un-burnt hydrocarbon levels decreased, with butanol blended gasoline operation in comparison with neat gasoline operation
- On the bas is of Configuration of the engine, Carbon monoxide levels and un-burnt hydrocarbon levels decreased with copper coated engine in comparison with conventional

Table.1: Data of CO (%) and UBHC Emissions (ppm) at Full Load.

Set	Conventional Engine (CE)				Copper Coated Engine (CCE)			
	Neat Gasoline		Butanol blended gasoline		Neat Gasoline		Butanol blended gasoline	
	CO	UBHC	CO	UBHC	CO	UBHC	CO	UBHC
Set-A	**3.75**	**500**	**2.8**	**345**	**3.0**	**375**	**2.0**	**230**
Set-B								
Spongeiron	**2.25**	**300**	**1.7**	**160**	**1.8**	**205**	**1.3**	**130**
Coal	**2.0**	**275**	**1.5**	**135**	**1.6**	**180**	**1.1**	**105**
Copper	**1.8**	**250**	**1.3**	**110**	**1.4**	**155**	**0.9**	**80**
Set-C								
Sponge iron	**1.5**	**200**	**1.0**	**115**	**1.2**	**105**	**0.7**	**90**
Coal	**1.3**	**175**	**0.8**	**90**		**80**	**0.5**	**70**
Copper	**1.0**	**150**	**0.6**	**65**	**0.8**	**60**	**0.4**	**50**

engine.

- The performance of the catalyst, Copper was proved to be efficient in reducing carbon monoxide levels and un-burnt hydrocarbon levels in comparison with coal and sponge.
- Operating Condition of the catalytic converter, Set-B, (with catalytic converter and without air injection) effective reduced pollutants by 40% while Set-C (with catalytic converter and with air injection) considerably decreased the same by 60% at full load operation.

ACKNOWLEDGEMENTS

Authors thank authorities of Chaitanya Bharathi Institute of Technology, Hyderabad for facilities provided. The financial assistance from Telangana Council of Science and Technology (TCOST), Hyderabad, is greatly acknowledged.

REFERENCES:

[1] Ghose, M. K., Paul, R. and Benerjee, S. K. 2004. Assessment of the impact of vehicle pollution on urban air quality. J Environ Science & Engineering. 46:33 -40.

[2] Kishor, K., Murali Krishna, M.V.S., Gupta, A.V.S.S.K.S., Narasimha Kumar, S. and Reddy, D.N.2010. Emissions from copper coated spark ignition engine with methanol blended gasoline with catalytic converter. Indian Journal of Environmental Protection. 30(3):177 -18.

[3] Murali Krishna, M.V.S. And Kishor, K. 2005. Control of pollutants from copper coated spark ignition engine with methanol blended gasoline. Indian Journal of Environmental Projection. 25(8):732 -738.

[4] Murali Krishna, M.V.S. and Kishor, K. 2008. Investigations on catalytic coated spark ignition engine with methanol blended gasoline with catalytic converter. Indian Journal (CSIR) of Scientific and Industrial Research.67: 543-548.

[5] Murali Krishna, M.V.S., Indira Priyadarsini, Ch., Nagini, Y., Naga Sarada, S., Ushasri, P. and Srikanth, D. 2015. Effect of spark ignition timing on copper coated spark ignition engine with alcohol blended gasoline with catalytic converter. ASME Journal of Energy.9(6): 01 - 08.

[6] Murali Krishna, M.V.S., Kishor, K. and Ramana Reddy, Ch. V. 2008. Control of carbon monoxide emission in spark ignition engine with methanol blended gasoline and sponge iron catalyst. Ecology, Environment & Conservation. 13 (4):13:17.

[7] Murali Krishna, M.V.S., Kishor, K., Murthy, P.V.K., Gupta, A.V.S.S.K.S. And Narasimha Kumar, S. 2012. Comparative studies on performance evaluation of a two stroke copper coated spark ignition engine with alcohols with catalytic converter. Journal of Renewable and Sustainable Energy Reviews.16:6333 –6339.

[8] Murali Krishna, M.V.S., Kishor, K., Murthy, P.V.K., Gupta, A.V.S.S.K.S. and Narasimha Kumar, S. 2010. Performance evaluation of copper coated four stroke spark ignition engine with gasohol with catalytic converter. International Journal of Engineering Studies.2(4):465-473.

[9] Murali Krishna, M.V.S., Kishor, K.,.

Gupta, A.V.S.S.K.S., Murthy, P. V. K. and Narasimha Kumar, S.2012. Performance of copper coated two stroke spark ignition engine with methanol blended gasoline with catalytic converter. Journal of Renewable and Sustainable Energy.4 (1): 013102.1–013102.9

[10] Murali Krishna, M.V.S., Kishor, K., Gupta, A.V.S.S.K.S., Narasimha Kumar, S. and D. N. Reddy. 2010. Control of pollutants from copper coated spark ignition engine with gasohol. Pollution Research. 29 (3):391 –395.

[11] Nedunchezhian, N. and Dhandapani, S. 2000. Experimental investigation of cyclic variation of combustion parameters in a catalytically activated two-stroke SI engine combustion chamber. Engineering Today.2:11 - 18.

[12] S.M. Khopkar. 2005. Environmental Pollution Analysis. New Age International (P) Ltd, Publishers, New Delhi :180-190.

[13] Sharma, B.K. 2004. Engineering Chemistry. Pragathi Prakashan (P) Ltd, Meerut:150 -160.

* * * * *