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EXPERIMENTAL INVESTIGATION ON TWO-STROKE ENGINE WITH COPPER COATED PISTON USING GASOLINE-BUTANOL BLENDS

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Abstract: The concept of catalytic combustion in spark ignition engines has been tried by various researches which offers improved thermal efficiency and reduced exhaust emissions due to oxidation of fuels with aid of catalyst. In this century, it is believed that crude oil and petroleum products will became very scarce and costly. However, enormous increase in number of vehicles has started dictating the demand for fuel. Gasoline and diesel will become scarce and costly in the near future. With increased use and depletion of fossil fuels, alternative fuel technology will become more common in the coming decades. In this study we use Butanol as an alternate fuel for gasoline. The main problem related with the combustion in S.I. engine is scavenging. This research includes copper coated piston and Butanol-gasoline blends to study performance and exhaust emissions of two-stroke engine. In this work an effort is made to study the effect of the piston top coated with catalytic materials such as copper using plasma spray gun. Experimental investigations are carried out to evaluate the performance and to measure the exhaust emissions from two-stroke, single cylinder, spark ignition (SI) engine with Butanol Gasoline Blends (90% Gasoline and 10% Butanol by volume, 80% Gasoline and 20% Butanol by volume, 70% Gasoline and 30% Butanol by volume) piston crown is Copper coated to a thickness of 300µthe results thus obtained are comparing with that of conventional s.i engine with pure gasoline operation. Performance parameters such as Brake thermal efficiency, Mechanical efficiency, Brake specific fuel consumption and exhaust emissions like carbon monoxide (CO) and un-burnt hydro carbons (UBHC) are measured by applying different loads on the engine. Copper coated piston with Butanol blended gasoline has improved performance and reduced pollutants as compared with conventional engine with pure gasoline operation. The test results indicate that blend B10 (10% Butanol & 90% Gasoline by Vol) gives better performance and emission results compared to all fuel mixtures and gasoline under this study.

Keywords: Butanol, S.I Engine, CE, copper coated combustion chamber, Butanol-Gasoline blends, exhaust emissions CO, UBHC.

I.INTRODUCTION

This project deals with performance of S.I engine and exhaust emissions such as Carbon monoxide (CO) and un-burnt hydrocarbons (UBHC) formed due to incomplete combustion which leads to scavenging. TheEngine modification with copper coating on piston crown improves engine performance as copper acts as a good catalyst for combustionreaction and hence ensures complete combustion and higher operating temperatures.

Alcohols have been suggested as an engine fuel almost since automobile was invented [1]. In recent years severalresearches have been carried out to the influence of methanol and ethanol on the performance of spark ignition engines. Alvydas Pikunas, SaugirdasPukalskas& Juozas Grabys [2] presented the influence of composition of gasoline -ethanol blends on parameters of internal combustion engines .The study showed that when ethanol is added, the heating value of the blended fuel decreases, while the octane number of the blended fuel increases .Also the results of the engine test indicated that engine power and specific fuel consumption slightly increase. M .Abu-Zaid O .Badran, and J .Yamin[3] have carried out an experimental study to investigate the effect of methanol addition to gasoline on the performance of spark ignition engines .The performance tests were carried out, at variable speed conditions, over the range of 1000 to 2500 rpm, using various blends of methanol-gasoline fuel .It was found that methanol has a significant effect on the increase the performance of the gasoline engine .The addition of methanol to gasoline increases the octane number, thus engines performance increase with methanol-gasoline blend can operate at higher compression ratios. D. Balaji [4] introduced influence of isobutanol blend in spark ignition engine performance operated with gasoline and ethanol .A four strokes; single cylinder SI engine was used for conducting this study. Performance tests were conducted for fuel consumption, volumetric efficiency, brake thermal efficiency, brake power, engine torque and brake specific fuel consumption, using unleaded gasoline and additives blends with different percentages of fuel at varying engine torque condition and constant engine speed .The result showed that blending unleaded gasoline with additives increases the brake power, volumetric and brake thermal efficiencies and fuel consumption addition of 5% isobutanol and 10% ethanol to gasoline gave the best results for all measured parameters at all engine torque values . In this paper we studied the effect of Butanol–gasoline blends on copper coated engine.Engine modification [5-6] 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. Catalytic converter is effective [7] in reduction of pollutants in SI engine. The present paper reports the performance evaluation of CCE, which consists of determining the performance parameters of CCE and comparison with CE with pure gasoline operation. The pollutants of carbon monoxide (CO) and unburnt hydro carbons (UBHC) are also compared with conventional engine (CE).

II. LITERATURE SURVEYT.O. Wagner, et al. [1] in his experiment, he suggests that the alcohol used to change/modify the attitude toward the present fuel, i.e., gasoline and Search for new alternatives. He explains about practicality of usage of the alcohols in I.C engines. Alvydas Pikunas, et al. [2] in his experiments he tried ethanol-gasoline blends on I.C engine, he finds that the heating value of the blends decreases but octane number of the fuel has increases. Also the results of different blends of bio fuel made from Butanol oil and gasoline and the results were analyzed and compared, the engine test indicated

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that when ethanol–gasoline blended fuel is used, the engine power and specific fuel consumption of the engine slightly increase.

D. Balaji [4] in his experiments, he uses isobutanol blend in spark ignition engine performance operated with gasoline and ethanol .A four stroke, single cylinder SI engine was used for conducting his study. The result showed that blending unleaded gasoline with additives increases the brake power, volumetric and brake thermal efficiencies and fuel consumption addition of 5% isobutanol and 10% ethanol to gasoline gave the best results for all measured parameters at all engine torque values .

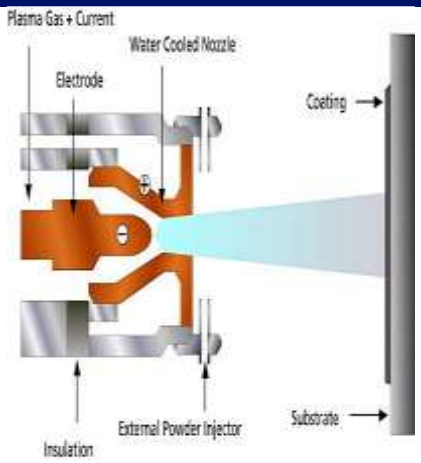
Dhandapani S, et al.[5-6] they use copper coating on engine parts and carried performance test on engine using catalytic converter. Coating on the engine parts improves engine performance as copper is a good conductor of heat and combustion is improved with copper coating.

Murali Krishna M V S, et al. [7] Studies on control of carbon monoxide emissions in spark ignition engine using catalytic converter.

Based on literature survey it is important that for increasing of thermal efficiency there are so many alternatives, among them coating is the best choice to enhance thermal efficiency of the engine and it can reduce the pollutants like CO, HC with the complete combustion of the fuel. The aim of this work is to analyze the performance and emission characteristics of gasoline engine by providing copper coating on piston crown with aid of Butanol-gasoline blends.Her in this paper we use Butanol as an alternative fuel for gasoline and providing copper coating on piston crown. A test was conducted on a two stroke, single cylinder, air cooled engine. This was fueled with gasoline and three Butanol blends compare with pure gasoline, exhaust emissions like CO and HC are reduced.

III. PISTON COATINGS AND METHODOLOGY

PLASMA SPRAY COATING PROCESS: Plasma spraying is the most common method for thermal spray coatings, and is applied as Air Plasma Spraying (APS) or spraying under controlled atmosphere. An electric arc is formed between a cathode and the concentric nozzle of the spray gun a mixture of gases with a high flow rate along the electrode is ionised by the arc, and forms plasma. This plasma stream is pushed out of the nozzle, where the powder of the coating material is injected into the plasma jet. The heat and velocity of the plasma jet rapidly melts and accelerates the particles so that they are propelled on to the substrate and form a coating. Plasma sprayed coatings have a denser structure than flame sprayed coatings.



Schematic diagram of the plasma spraying process


Before Coating


After Coating

Technical Specifications of the Engine:

TYPE	Motorcycle
Engine type	2 stroke, air cooled
Maximum power	7.8 bhp@5500 rpm
Maximum torque	9.8 Nm@5000 rpm
Top speed	82 kmph
No of cylinders	1
Bore	50 mm
Stroke	50 mm

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Fuel type	Petrol
Fuel capacity	12 liters
Compression	6.7:1

IV. RESULTS AND DISSCUSSIONS

The performance of the engine was evaluated in terms of brake specific fuel consumption, brake thermal efficiency and mechanical efficiency. The emission characteristics of the engine were studied in terms of concentration ofCO, HC the results obtained for Butanol and their blends with pure gasoline were compared with the results of pure gasoline [9].

1. *Brake Thermal Efficiency*: Fig 1 shows that A significant improvement is observed at the 80% of load condition, the brake thermal efficiency increases above 2.83% in the coated piston it is due to the TFC of coated piston is 1.5 Kg/hr. less than the uncoated piston at 80% load for the coated engine, whereas at full load condition it is 0.88% in the coated piston it is due to the TFC of coated piston is 2 Kg/hr. less than the uncoated piston at full load for the coated engine.The brake thermal efficiency enhances as compared to conventional engine due to copper coating on piston. It ensures higher operating temperatures in the combustion chamber and the TFC of the engine is lowered after coating, this will increase the brake thermal efficiency of the engine. The maximum brake thermal efficiency is recorded with 10% of the Butanol blend on copper coated engine [10].

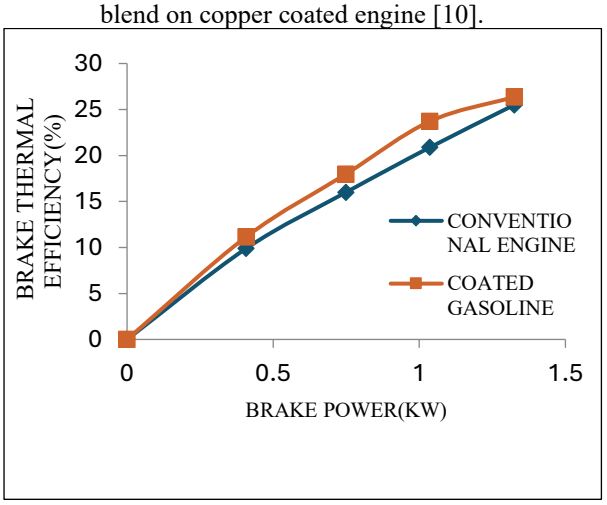

Fig 1 Brake power Vs Brake thermal efficiency

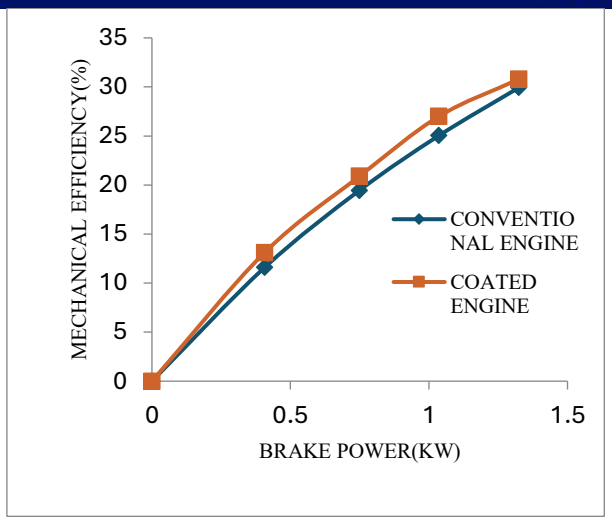

Fig 2 Brake power Vs Mechanical efficiency

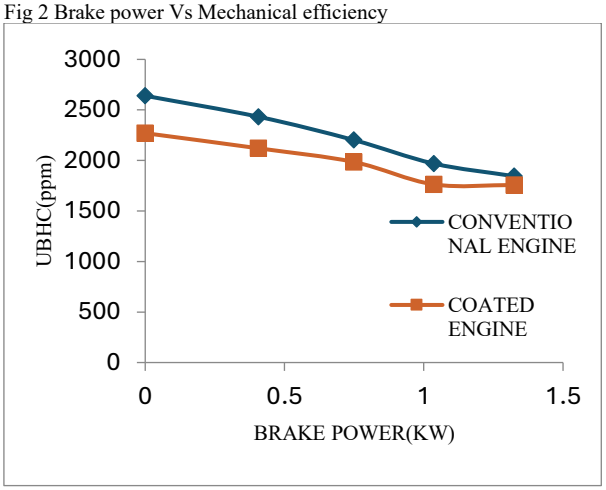

Fig 3 Brake power Vs UBHC

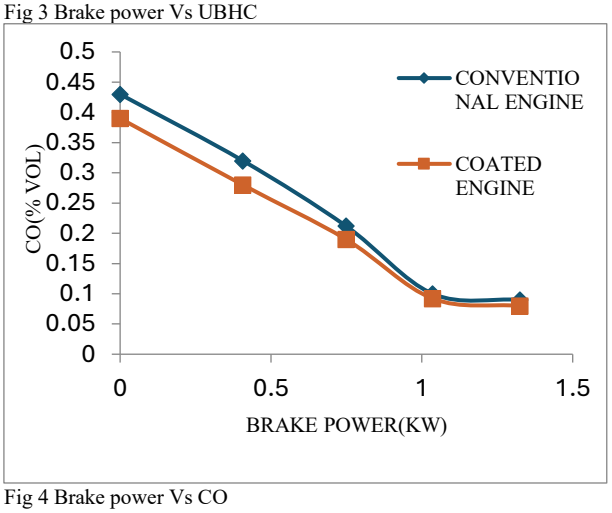

Fig 4 Brake power Vs CO

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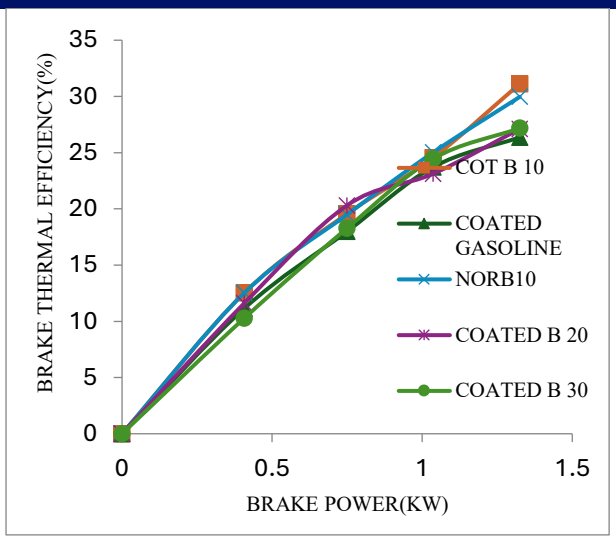

Fig 5 Brake power Vs Brake thermal efficiency

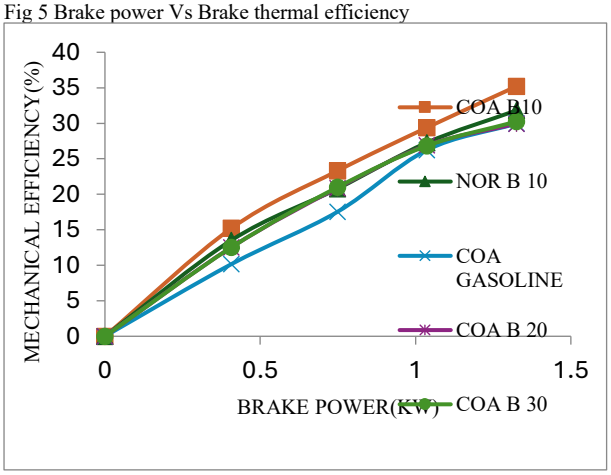

Fig 6 Brake power Vs Mechanical efficiency

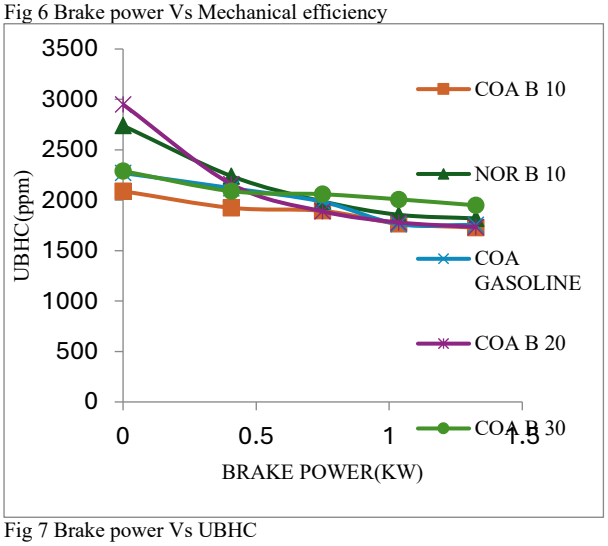

Fig 7 Brake power Vs UBHC

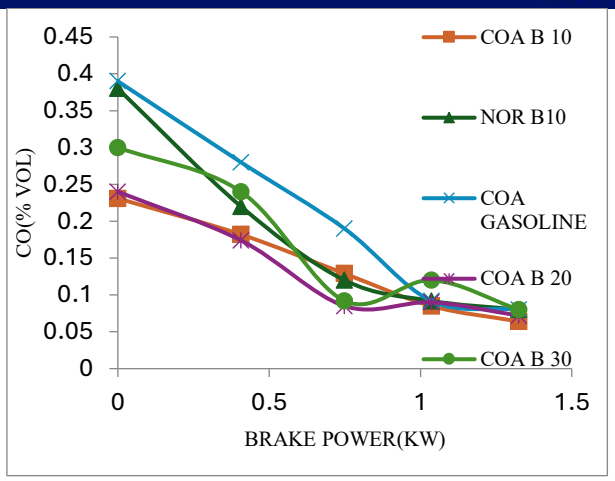

Fig 8 Brake power Vs CO

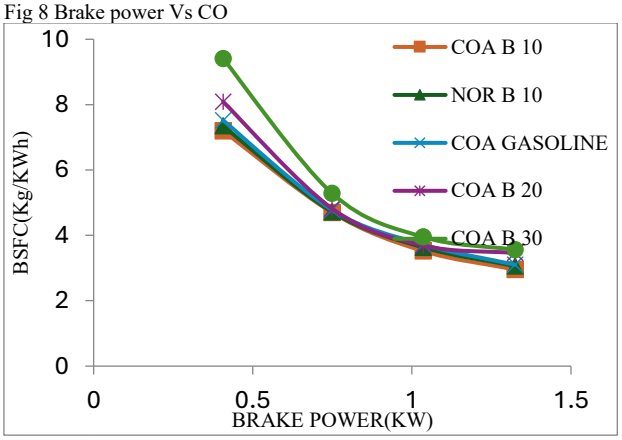

Fig 9 Brake power Vs BSFC

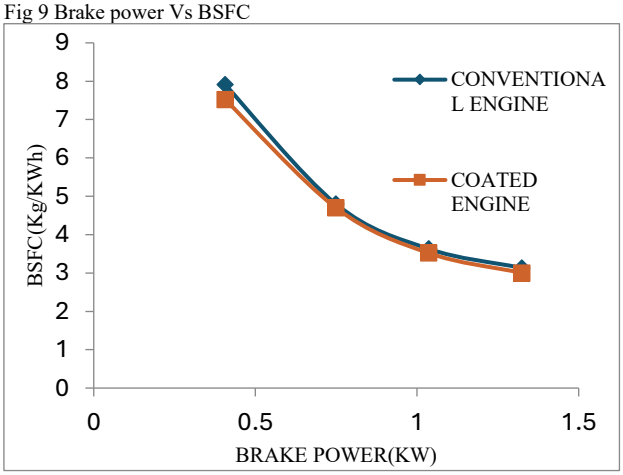

Fig 10 Brake power Vs BSFC

2. Brake Specific Fuel Consumption (BSFC): From fig 10 The BSFC is high for low brake power and it is decreasing when the brake power increases. The trends are similar in the case of coated and uncoated piston, but at the higher loads a significant change in BSFC occurs in coated pistons. The reduction of BSFC by 0.013Kg/KW-hr at full load condition for coated piston, it is due to the TFC increases for higher load conditions. And also the BSFC decreases for coated engine due to the increase in engine torque. This is normal consequence of the behavior of the engine brake thermal efficiency. Lower BSFC is foundwith B 10 fuel on coated engine when compared to conventional engine [11].

3. Mechanical Efficiency: In fig 2, the mechanical efficiency is increasing for the coated piston from low load conditions to a higher load conditions. The efficiency is 2 % higher in coated piston engine at 80% of the load, whereas at full load condition 1 % in coated engine due to higher brake power as compared to conventional engine. The mechanical efficiency is higher for the blend B 10 fuel on coated engine as compared to conventional engine [12].

*4. Unburnt Hydrocarbon (UBHC):*Fig 3 shows that the measured HC emissions are lower for coated engine as compared to conventional engine. Due to the coating ensures complete combustion and higher operating temperatures. The variation of HC at no load is about 370 ppm and at full load it is about 87 ppm are observed.

*5. Carbon monoxide (CO):*From fig 4 the CO emissions for conventional and coated engine at different loads, it is found that the CO emissions are lower in case of coated piston as compared to uncoated piston engine. The lower CO emissions in case of coated piston may be mainly attributes to oxidation of Coat later stages of expansion stroke due to higher operating temperatures. At no load CO emissions are 9.30 %(by volume) less than the uncoated piston. This range maintained up to 70% of the load.

V. CONCLUSION

Copper acts as a good catalyst for combustion reaction and hence ensures complete combustion and higher operating temperatures. Therefore the efficiencies are increased and the emissions are reduced because of various chemical reactions takes place inside the cylinder at high temperature. Brake thermal efficiency and mechanical efficiency of coated piston are increased by the average value of 1.16% and 3.39% respectively. 3.66% reduction in total fuel consumption and 3.594% reduction in specific fuel consumption were achieved with the coated piston. 23.72% of unburned HC emissions were reduced by using the coated piston. CO emissions are reduced by 39.21% at initial conditions because of at high temperature C easily combines with O_2 and reduces CO emission.

From the results of the study, the following specific conclusions can be deduced:

1. Using Butanol as a fuel additive to unleaded gasoline and copper as a coating medium to the piston causes an improvement in engine performance and lower exhaust emissions.
2. The blends of Butanol (B 10) gives lower specific fuel consumption than the gasoline at full loads when operating on copper coated piston.
3. Brake Thermal efficiency of the tested Gasoline engine is improved when it is fuelled with Butanol-Gasoline blends operating on Coppercoated piston.
4. Mechanical efficiency is higher for B 10 compared to gasoline fuel operation is observed.
5. Unburnt HC emissions and CO emissions are reduced, due to complete combustion.

From the above analysis the main conclusion is the Butanol and its Gasoline blends are suitable substitute for Gasoline as they produce lesser emissions than pure gasoline on the copper coated engines.

SCOPE OF FUTURE WORK

In this work the piston crown is coated but this coating can also be extended to cylinder head so that, it may affect the performance as well as exhaust emissions of the engine. And also by varying coating thickness we can enhance the thermal efficiency of the engine..

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