EXPERIMENTAL STUDIES ON CERMET COATING OF PISTON RING OF SINGLE CYLINDER DIESEL ENGINE

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***Abstract*—ThePistonRing isVeryCriticalComponent and fortheImprovement, CermetCoatingisDonebyTheHigh Velocity Oxygen FlowMethods (HVOF). Among Thermal Spraying Methods, HVOF Sprayings Most Easily Commonly Applicable Method in The Automotive Industries Because it has a High Spray Rate and Deposition, The Process Consumes Fuel Gases Which Are Inexpensive and Easily Obtainable. TheTechnical ReliabilityofHVOFSystemsisWellEstablished inIndustrial Applications.InParticular, Mo+NiCrBSi Coatingsby HVOFhaveEnhanced Resistance to Wear and Heat and Inconel625+ Cr_3C_2NiCr have high Strength Properties, High Temperature Resistance, Corrosion Resistance, High Hardness. In present study, various test like Radial Wall thickness, Ring end gap, Metal debris, Sulphated ash particle, Viscosity of oil and Ring Weight and some performance parameter was examined. Experimental has beenDonewith Coated ring with (Mo+NiCrBSi and Inconel625+ Cr_3C_2NiCr)andWithout CoatedPistonRings.**

***IndexTerms*—Cermet, Mo+NiCrBSi, Inconel-625+Cr_3C_2NiCr, HVOF.**

I. INTRODUCTION

The powder used in this research (Mo-NiCrBSi) was a blend of powders composed of 25 % Mo and 75 % self-fluxing alloy NiCrBSi. With the deposition of this powder a molybdenum base self-fluxing coating is obtained. This coating has high wear resistance, a low coefficient of friction and good scuffing resistance.

Second powder used in this research was a blend of powders composed of 80% Inconel625 and 20% self-fluxing Cr3C2NiCr alloy. Inconel 625-Cr3C2NiCr used for hard facings, hard bearing surfaces and abrasive wear resistant coatings. It is also compatible with the most of the materials, especially with iron-based alloys. These coatings have higher wear resistance (approximately 20%) and higher tensile bond strength comparing to the molybdenum coatings. Amongst the spraying materials, nickel-based alloys are being widely used because they display good resistance to wear, oxidation and high temperature, as well as being low cost. NiCrBSi alloy is one of the alloys with better performances and it is commonly used in mechanical components such as rollers in cooling tables in hot strip mills, pump bushings and wearing plates sliding rings. The presence of boron and silicon in itscomposition lowers the melting point.silicon in itscomposition lowers the melting point of this type of alloys and gives them the "self-fluxing" character, which is especially suited HVOF coating process.

Coating Process

HVOF process is the most widely used coating method because it presents process flexibility and coating quality in combination. Micro cracks and porosity are undesired microstructural features because they increase permeability in the application requiring resistance to corrosion. The quality of the coatings manufactured by thermal deposition techniques depends on several parameters such as the sprayed particle size, the deposition temperature, the combustion gases, the feed speed, the angle and rate of deposition, the spray distance, the temperature of the substrate, the pressure applied during the process and, of course, the deposition technique.HVOF uses a different torch design that enables the flame to expand when the spray nozzle is activated. This causes a surge in acceleration, which in turn accelerates the mixture particles. When the mixture is released from the nozzle, the velocity of the mixture leads to a very thin and evenly applied coat. The final coating is well adhered, strong, and dense. Its hardness, corrosion resistance, and overall wear resistance is superior to plasma spraying. In this study, mechanical properties of the Mo-NiCrBSi, Inconel625-Cr3C2NiCr coating deposited by High Velocity Oxygen Fuel were analyzed. Cr3C2 NiCr HVOF thermally sprayed coatings have been extensively applied on industrial components working at high temperature to improve their erosion, corrosion and oxidation resistance.

HVOF Coating Benefits

- Reduced oxide content
- Reduced solutioning of carbides
- Smoother sprayed surface
- True coating uniformity

II. SPECIFICATION AND PHYSICAL VISUALIZATION

Table 1 Inconel625+Cr3C2NiCr Chemical Composition

Element	C	Mo	W	Ni	Co	Fe	Mn	Cr	Si
Wt (%)	1.98	11.92	2.96	55.04	1.28	0.8	0.16	25.73	0.08

Table 2 Mo+NicrBsi Chemical Composition

Element	Mo	Ni	Cr	C	Si	Fe
Weightage (%)	25	53.25	12.75	0.6	3	3

Table 3 HVOF Parameter

Parameter	**Value**
L.P.G gas Flow Rate [lph]	55 to 60
L.P.G gas pressure [kg/cm2]	5.5 to 6.0
O2 Gas Flow Rate [lph]	270 to 280
O2 Gas Pressure [kg/cm2]	10.5
Air Flow Rate [lph]	450
Air Pressure [kg/cm2]	6.0 to 6.5
Spray Distance [inch]	7 (177mm)
Powder Feed Rate [g/min]	120

Table 4 Engine Specification

Parameter	Specification
Engine type	single cylinder 4-stroke diesel engine AV1 KIRLOSKER
Brake power	5 HP or 3.7kw
Speed	1500 rpm
Bore	80 mm
Stroke	110 mm
Types of Loading	Rope Brake Dynamometer
Compression ratio	16.5:1
Injection pressure	185 bar
Swept Volume	553 cc
Fuel type	Diesel

Fig.1 Physical Visualization

III. RESULT OF EXPERIMENTS

Observation of experiment includes measurement of Experimental parameter. Continuous observation during the life cycle included Ring Weight, Radial Wall Thickness, Oil viscosity, Ring end gap, Sulphated ash particle,Metal Debris, Brake Specific Fuel Consumption, Mechanical Efficiency, Exhaust Gas Temperature, Indicative Mean Effective Pressure.

Followingistheresultandeffectofpistonringcoatingonthelifecycleof Sigle Cylinder Diesel Engine.

A. Ring weight

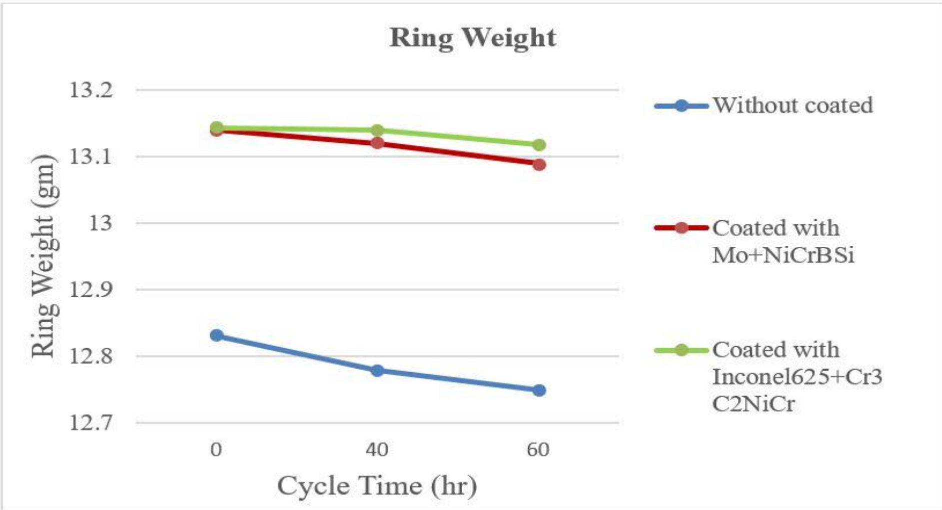

Fig 2 Ring Weight Vs Cycle Time

B. Radial Wall Thickness

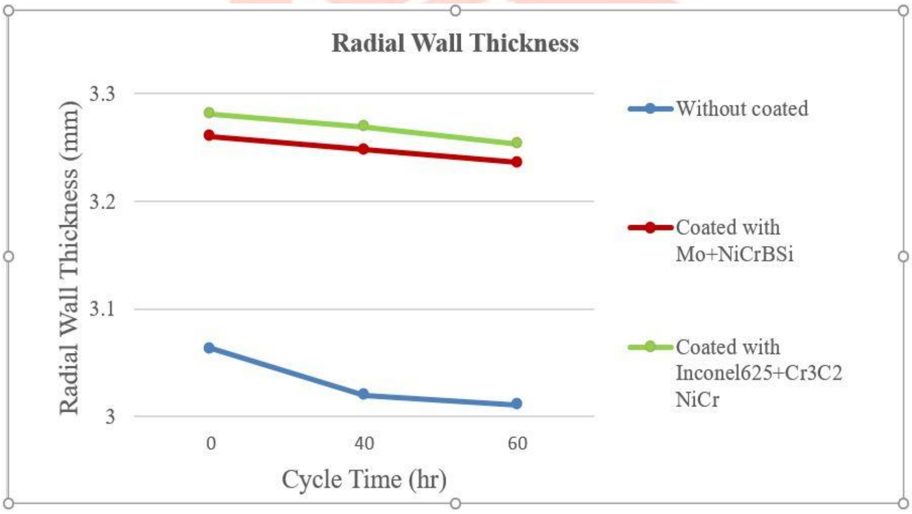

Fig 3 Radial Wall Thickness Vs Cycle Time

C. Oil Viscosity

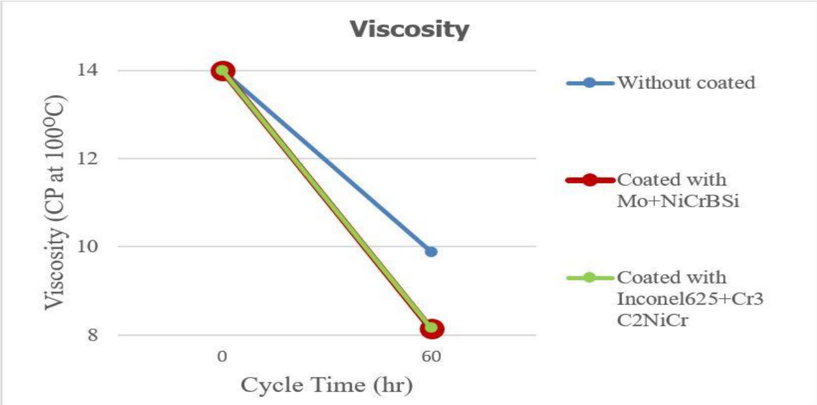

Fig 4 Oil Viscosity Vs Cycle Time

D. Ring End Gap

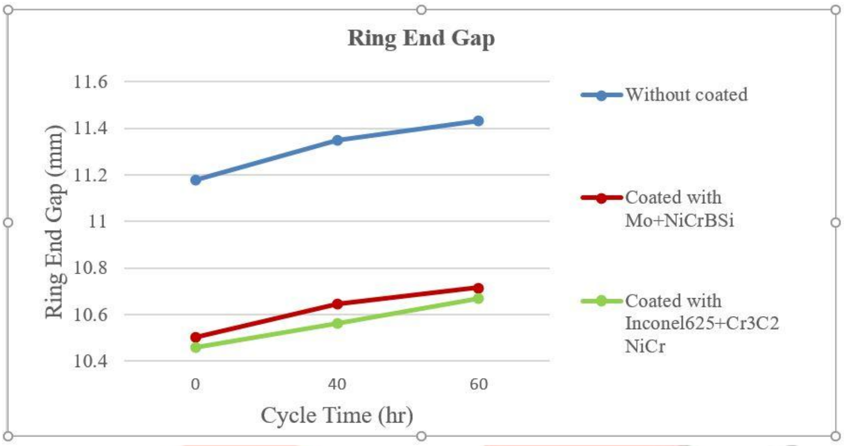

Fig 5 Ring End Gap Vs Cycle Time

E Sulphated Ash Particle

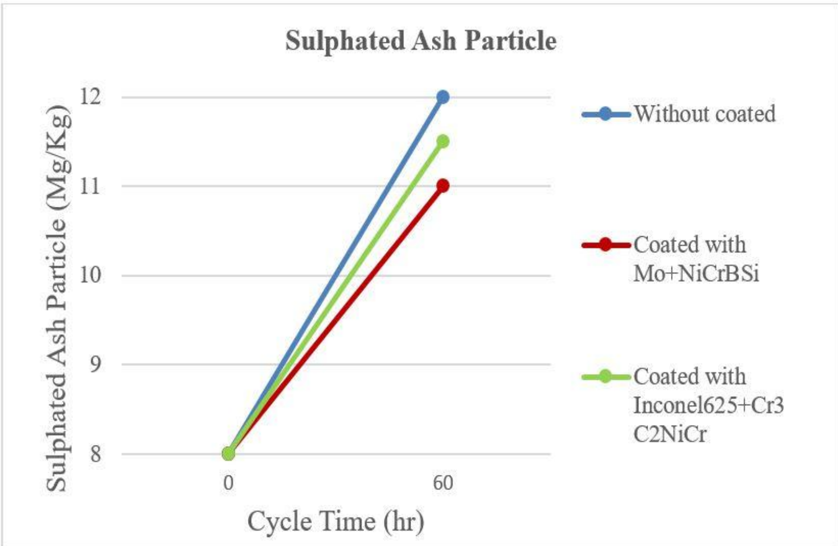

Fig 6 Sulphated Ash Particle Vs Cycle Time

F. Metal Debris

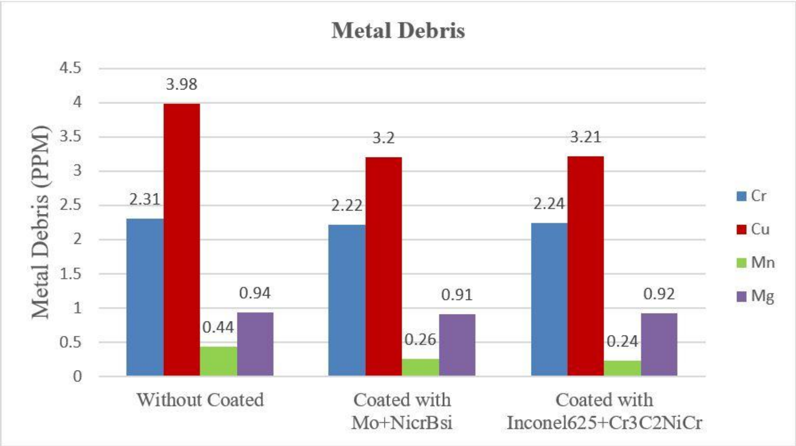

Fig 7 Metal Debris Vs Cycle Time

G. Brake Specific Fuel Consumption

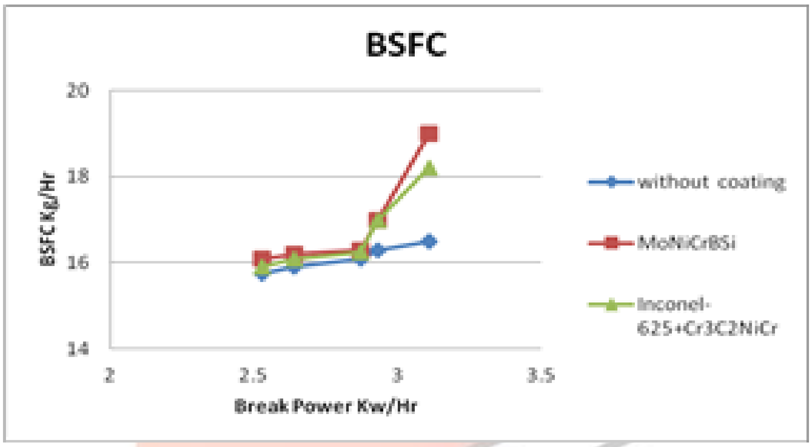

Fig 8 BSFC Vs BP

F Mechanical Efficiency

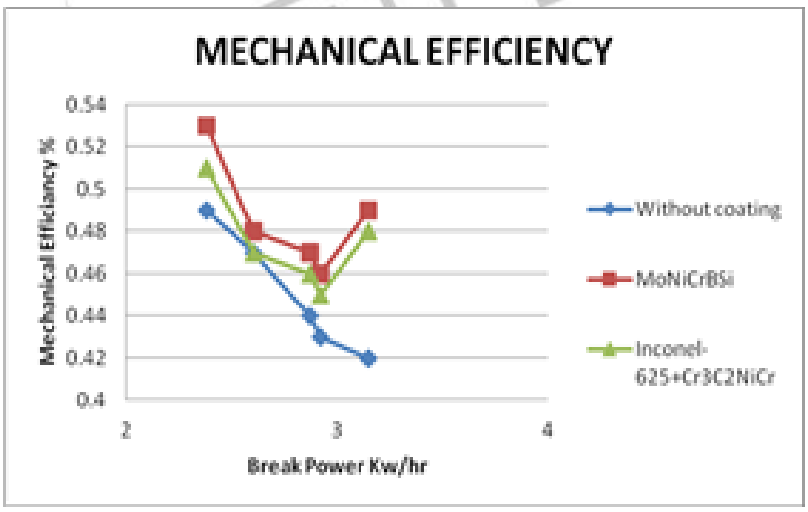

Fig 9 Mechanical Efficiency Vs BP

HExhaust Gas Temperature

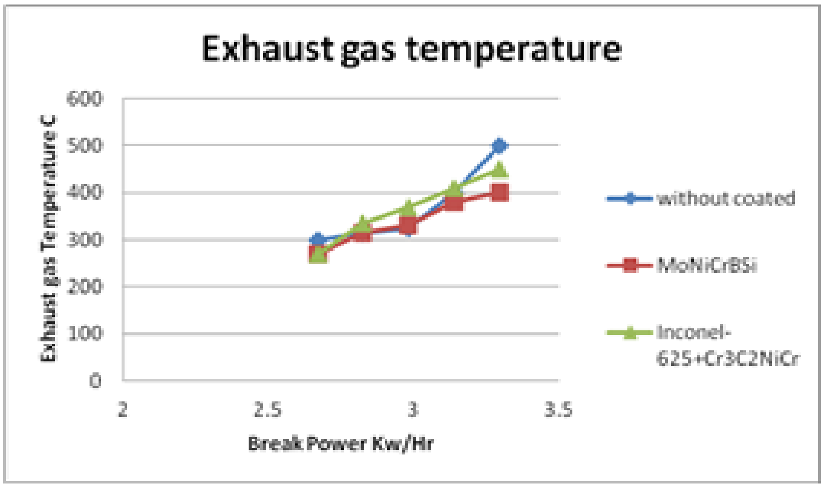

Fig 10 Exhaust Gas Temperature Vs BP

G Indicative Mean Effective Pressures

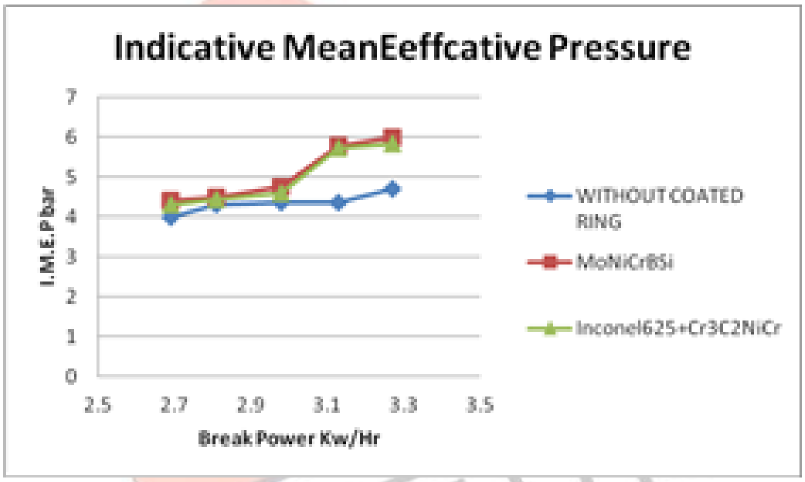

Fig 11 Indicative Mean Effective Pressure Vs BP

IV. Conclusion

(1) Various test was performed on piston ring thatcompared with each other we show that the results show Mo+NiCrBSi is the best combination of metal and ceramic (cermet) for single cylinder diesel engine instead of Inconel625+Cr_3C_2NiCr.

(2) Due to less wear between the cylinder wall and ring Face the heat generated is less and the gas produced from the burning of the oil film reduces causes less pollution in atmosphere.

V. References

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