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Development & Characterization of Low Friction Wear & Corrosion Resistant Coating for Automobile Application

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***Abstract*--- Multilayer protective coatings that are applied over a substrate are disclosed that comprise a plurality of superimposed multilayer units. Each multilayer unit contains two or more superimposed thin layers in which at least two layers are compositionally different. The properties of the resulting coating are a combination of the properties of the individual layers. One layer of the multilayer unit may provide hardness or wear resistance, another layer is corrosion resistant and another layer may provide lubricity. The substrate materials chosen are Inconel 600,625 and 718.The coating materials chosen to coat from the direction of substrate are Al2O3, Cr3C2 – NiCr and BN. The multilayer coated specimens will be subjected to various mechanical, wear and corrosion tests followed by morphological studies. Also suitable application of the developed coated specimens in various automobile/high temperature applications will be identified.**

***Keywords*--- Multilayer Coatings, Inconel, Al2O3, Cr3C2 – NiCr, BN, AFM, Wear, Corrosion, SEM & XRD**

I. INTRODUCTION

Corrosion is a process in which a material is oxidized by substances in the environment that cause the material to lose electrons. Corrosion IS Electro chemical process of a metal that withstand the deterioration and chemical breakdown that occur when the material is exposed to such an environment.

Corrosion resistance is the capacity to hold the binding energy of a metal and withstand the deterioration and chemical breakdown that would otherwise occur when the material is exposed to such an environment.

Corrosion of Industrial factory equipments, Thermal Furnaces , Boiler tube applications , Internal Combustion Engine parts and many other Automobile and Industrial machines is a major problem as it results in downtime and periodic shutdowns, which in turn accounts for a significant fraction of the total operating cost of power plants and installing new parts for the heavy machinery equipments. Inabilities to either totally prevent the hot corrosion or its detection at an early stage has resulted in several accidents, leading to loss of life and/or destruction of engines/infrastructures.

Hence coatings are developed with an objective to enhance the substrate life by protecting against hot corrosion in the energy conversion systems and other similar high temperature applications under simulated conditions

II. LITERATURE REVIEW

1. Thermal spraying is an effective and low cost method to apply thick coatings to change surface properties of the component. Coatings are used in wide range of applications including automotive systems, boiler components, and power Generation equipment, chemical process equipment, aircraft engines, pulp and paper processing equipment and ships.

2. Among the commercially available thermal spray coating techniques, Detonation Gun Spray and High Velocity Oxy Fuel (HVOF) spray are the best choices to get hard, dense and wear resistant coating as desired.

3. Detonation Gun (D-Gun) Spraying is one of the thermal spray processes, which gives an extremely good adhesive strength, low porosity, and coating surface with compressive residual stress.

4. Detonation Gun (D-Gun) offers highest velocity

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(800–1200 m s−1) for the sprayed powders that are unattainable by the plasma and HVOF condition. The higher particle velocity during deposition of coating results in desirable characteristics such as lower porosity and higher hardness of the coating.

5. Inconel 625 when powder coated with different metallic or non metallic alloys, the coating resulted in outstanding erosion–corrosion resistance.

6. It was learned from the literature that Inconel 600/625/718 is a widely used engineering material due to its better resistance to hot corrosion, high temperature strength and weld ability.

7. Because of its high thermal stability, Cr3C2-NiCr coatings are often employed at high temperatures.

III. OBJECTIVES

The objective of the paper is

1. The objective of the project is to improve surface properties of the substrate by D Gun (Detonation Gun) / HVOF(High Velocity Oxy Fuel) spray Technique.

2. To select suitable spray process parameters this can be used to develop high quality coatings.

3. To coat Cr3C2 – NiCr on Inconel Steel 600, 625 and 718

4. To study the effect Salt spray on high temperature corrosion of the developed coatings.

IV. D GUN COATING TECHNIQUE WAS SELECTED BASED ON THE FOLLOWING COMPARISONS

Properties	Plasma spraying	HVof Spraying	Detonation gun spraying
Flame or plasma exit temperature (^{0}C)	5550-8300	2500 -3100	3000
Particle impact velocity (m/s)	200-600	500-800	800-1000
Oxide content	0.1-1	0.2	0.1
Porosity level %	2-5	0.5-2	0.1-1.0
Coating material	Powder	Powder	Powder
Coating Adhesion MPa	40-70	70-80	65-85

V. CHARACTERIZATIONS

Microstructure & Morphology (SEM) Phase Identification (XRD)

Mechanical Properties (Micro Hardness) Corrosion Properties (Testing)

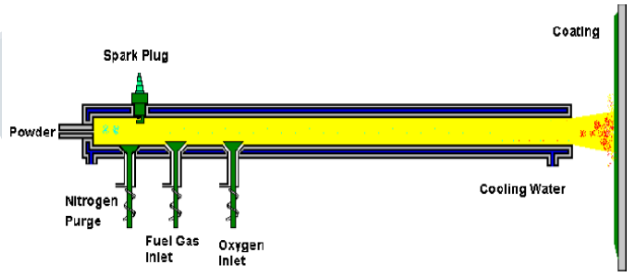
VI. KEY FEATURES OF D GUN COATING

Coatings are very hard, clean and dense

Coatings has low compressive stresses

Coatings has very high bond strength

Coating characteristics are superior than Flame spray, Wire arc and Plasma spray coatings



VII. TYPICAL COATINGS

Anti – Wear Coatings

Anti - Corrosion Coatings

Metallic Coatings

VIII. WORK DONE

For the development of this is, a Service providers were identified for procuring the Substrate, Coating material and D Gun / HVOF Spray Technique.

Details are as follows

For Substrate - Test coupon specimen shown below.

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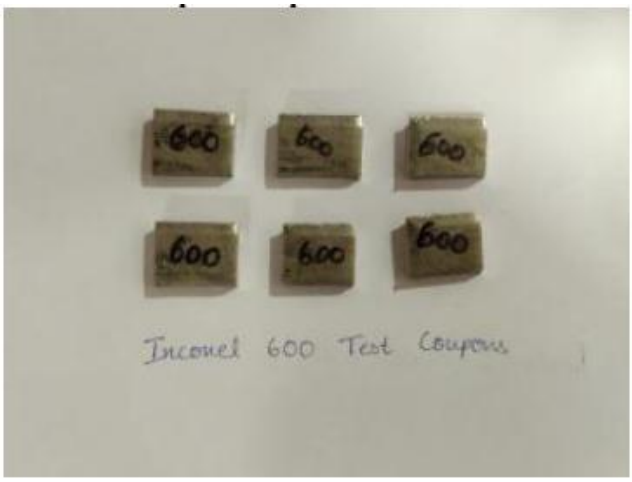
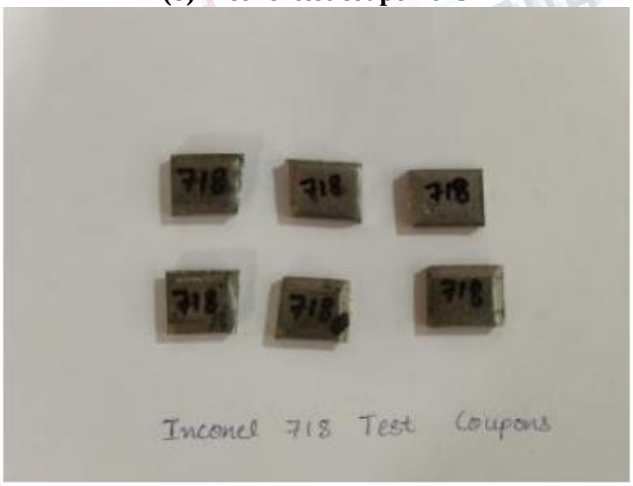


(a) Inconel test coupon 600

(b) Inconel test coupon 625



(c) Inconel test coupon 718

For Coating Material - Nickel Chromium Carbide **Cr_3C_2 – NiCr** selected and the procurement of this material is under survey process across various vendors and service providers. (Under process)

For Coating Process – For coating of the Inconel test coupons D Gun (Detonation Gun) or **HVOF** (High Velocity Oxy Fuel) method is used and the service providers identified are as follows.

Further works to be carried out are Coating of the Substrate/test coupons.

Heat treatment of coated samples in tubular furnace. Morphological Studies (XRD, SEM, Micro Hardness, and Corrosion Test).

IX. APPLICATIONS

In selecting a coating for a specific turbine application, one should consider many competing challenges.

Generally, the design requirements, component geometry, and part performance needs determine the type of coating and the process to be used to create that coating.

X. EXPECTED OUTCOMES

Improvement in the physical and Mechanical properties of the Substrate due to coatings.

The coated substrate has a high resistance to high temperature points and has very effective corrosion resistant phenomena.

The high temperature corrosion resistance coating provides a long term usage of the substrate.

The applications of the coated material are widely used in Industrial factories, Thermal Furnaces, Internal Combustion Engine parts and many other Automobile and Industrial uses.

XI. SUMMARY

Thermal spray coatings will continue to be applied in industrial turbine applications. The need for improved reliability of existing coatings for life extension and development of new materials and processes for higher temperature applications will drive future research. New coatings will enable more efficient, fuel flexible operation. The industry will have to respond to the global challenges.

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