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Investigation on the Erosion Behavior of Coated Piston in the Hydraulic Actuators

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Abstract— **In today's world a huge number of process and techniques are done by the hydraulic systems. The system may undergo lot of erosion inside the cylinder and piston's material due to the fluid used in cylinder. To reduce the erosion we are going to coat on piston's crown with the ceramic coating. The Alumina Titania (Al_2O_3-TiO_2) and the Tungsten Carbide-Cobalt carbide (WC-Co) are the two powders that is going to coat on the crown of the piston. The erosion is due to the actuation in the cylinder that is by the presence of foreign particles and temperature of the fluid which is used to actuate the cylinder. In order to improving the adhesion strength and with stand to high temperature during actuation. The D-gun spray technique has been employed on the mild steel to enhance its erosion behaviour of the mild steel. The improved coating on hydraulic pistons can be used in long lasting life than other material or coated parts.**

Index Terms— **Plasma spray Coatings, Erosion, Hydraulic Actuators.**

I. INTRODUCTION

Coatings have historically been developed to provide protection against corrosion and erosion that is to protect the material from chemical and physical interaction with its environment. Corrosion, erosion and wear problems are still of great relevance in a wide range of industrial applications and products as they result in the degradation and eventual failure of components and systems both in the processing and manufacturing industries and in the service life of many components. Various technologies can be used to deposit the appropriate surface protection that can resist under specific conditions. They are usually distinguished by coating thickness: deposition of thin films (below 10 to 20 µm according to authors) and deposition of thick films. The latter, mostly produced at atmospheric pressure have a thickness over 30 µm, up to several millimetres and are used when the functional performance and life of component depend on the protective layer thickness. Both coating technology can also be divided into two distinct categories: wet and dry coating methods, the crucial difference being the medium in which the deposited material is processed.The former group (where we have took ideology of our project) mainly involves vapour deposition, thermal spray techniques, brazing, or weld overlays. This chapter deals with coatings deposited by thermal spraying. It is defined by Sathish et.al "Comparative studies on the Corrosion and Scratch behaviours of Plasma sprayed ZrO_2 and WC-Co coatings." Most processes are used at atmospheric pressure in air, thermal spraying, necessarily operated in soft vacuum. Also, plasma spraying can be carried out in inert atmosphere or vacuum is generally performed at atmospheric pressure but in a controlled atmosphere chamber to collect and recycle the spray gas (nitrogen or helium) because of the huge gas flow rates used (up to 5 m3.min-1). In the following only processes operated in air at atmospheric pressure will be considered, except when the coating material is very expensive, such as platinum that must be sprayed in a chamber to recover the overspray. The coating material may be in the form of powder, ceramic rod, wire or molten materials. The central part of the system is a torch converting the supplied energy (chemical energy for combustion or electrical energy for plasma- and arc-based --processes), into a stream of hot gases. The coating material is heated, eventually melted, and accelerated by this high temperature, high-velocity gas stream towards a-substrate. It impacts on the substrate in the form of a stream of droplets that are generated by the melting of powders or of the tips of wires or rods in the high energy gas stream. The droplets flatten or deform on the substrate and generate-lamellae called "splats". The piling up of multiple layered splats forms the coating.

Thermal spray processes are now widely used to spray coatings against, erosion, wear and corrosion but also against heat (thermal barrier coating) and for functional purposes. The choice of the deposition process depends strongly on the expected coating properties for the application and coating deposition cost. Coating properties are determined by the coating material, the form in which it is provided, and by the set of parameters used to operate the deposition process. Thermal spray coatings are generally characterized by a lamellar structure and the real contact between the splats and the substrate or the previously deposited layers determine to a large extent the coating properties, such as thermal conductivity, Young's modulus, etc. The real contact area ranges generally between 20 to 60 % of the coating surface parallel to the substrate. It increases with impact velocities of particles provided the latter are not either too much superheated or below their melting temperature. That is why roughly the density of coatings increases from flame, wire arc, plasma, HVOF or HVAF and finally D-gun spraying and self-fluxing alloys flame sprayed and then re-fused. Also thermal spray coatings contain some defects as pores, often globular, formed during their generation, un-molten or partially melted particles that create the worst defects, exploded particles, and cracks formed during residual stress relaxation. The cracks appear as micro-cracks within splats and macro-cracks running through layered splats especially at their interfaces and tending to initiate inter-connected

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porosities. Moreover, when the spraying process is operated in air, oxidation of hot or fully melted particles can occur in flight as well as that of splats and successive passes during coating formation. Thus, depending on the spray conditions and materials sprayed, the coatings are more or less porous and for certain applications must be sealed by appropriate means.

II. EXPERIMENTAL

A. *Heat Treatment*

EN8 or 080m40 can be tempered at a heat of between 550°C to 660°C (1022°F-1220°F), heating for about 1 hour for every inch of thickness, then cool in oil or water. Normalising of EN8 bright Mild Steel takes place at 830-860°C (1526°F-1580°F) then it is cooled in air. Quenching in oil or water after heating to this temperature will harden the steel.

B. *Chemical composition of steel*

	C	Mn	Si	P	S
Min	0.35	0.60	0.05	0.015	0.015
Max	0.45	1.00	0.35	0.06	0.6

CONDITIONED	Yield Stress x 106 Pa	Tensile Stress MPa	Elongation %
NORMALISED	280	550	16
COLD DRAWN-thin	530	660	7

C. *Plasma spray coating*

Chemical Composition of Alumina -Titania

Typical composition	Al_2O_3	TiO_2
Weight (%)	40	BALANCE

Physical properties of Alumina Titania

Melting point	1840^{0}C
Thickness of coating	100µm
Density(g/cc)	3.5
Porosity	Negligible
Dielectric strength(volts/Mil)	300
Emissivity	0.2-0.3
Thermal shock resistance	Very good

Physical Properties:

Melting point	2867°C
Thickness of coating	100µm
Density	3.9 g/cm3
Porosity	Low
Bonding	Good
Emissivity	0.15-0.28
Thermal shock resistance	Good

Chemical Composition of Tungsten carbide cobalt:

Typical composition	WC	Co
Weight (%)	88	12

III. RESULTS AND DISCUSSION

Coated surface revealed large amount of unmelted particles and Exhibited peaks corresponding To alumina particles (fig. 14a). the volume percentage of the Unmelted particles present in the at coating was found to be 56% As obtained from the sem analysis. The surface morphology of the wc coatings showed The presence of a large number of fully melted splats, with very Less porosity the porosities of all two coatings. In contrast to the monolayer at coating, the Layers in the bilayered coating were observed to adhere well with Substrate. This was confirmed by the Appearance of the SEM analysis images which is discussed in the following section the detailed analysis of the surface morphology and phases present for all the two coatings have been reported in our earlier work wherein the reasons For the formation of the microstructure and phases have been discussed. it is noteworthy that the bond coat that is Widely used for coating at was considered in our studies.

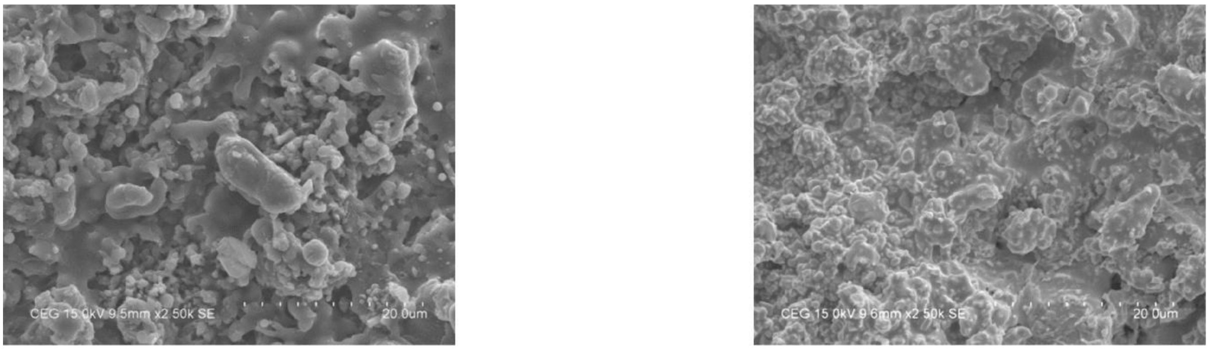

Fig.1. Microstructure of (a) Al_2O_3-13TiO_2 and (b) WC-Co coating

(a) (b)

Fig.2. Cross sectional views of (a) Al_2O_3-13TiO_2 and (b) WC-Co coating

IV. CONCLUSIONS

In the present study, the Al_2O3-40wt%TiO_2 and WC-12wt%Co coatings were prepared on to the EN-8 MILD STEEL substrate using Atmospheric Plasma spraying. The following conclusions were derived.

(1) WC-12wt%Co coating exhibited lowest erosion behaviour when compared with that of the Al_2O_3-40wt%TiO_2.

(2)WC-Co coating is observed as good adhesion strength between coating and substrate even after undergoes to 11 Hrs of Hydraulic process.

(3) Al_2O_3-40wt%TiO_2 coating and this is attributed to the presence of very few pores observed in the coating. In WC-Co very less pores and blow holes appeared.

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