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# Effect of Different Process Parameters & Analysis of Mechanical Properties of HVOF Sprayed Coatings on Stainless Steel Substrates

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*Abstract*— The advance in the field of materials science and particularly the development of functional coatings by different techniques of deposition in the solid state, has improved the efficiency and safety of components and equipment that are subject of extreme conditions involving high temperatures and pressures of operation such as: heat exchangers, boilers, furnaces, as well as (Aeronautics) gas turbines blades. Steam turbines represent an area of interest for the development of coatings that not only can resist high temperatures, but would also be capable of withstanding exposure to corrosive environments and wear. Hardness is also the main important property which important for the service life of coating. This upcoming dissertation will give us the mechanical properties of material with & without coated surface also this dissertation includes micro hardness test & erosion behaviour of coated material by fluctuating input parameters viz. Powder feed rate, stand-off distance, Fuel flow rate etc.

***Key words:*** HVOF Coating, Coating Thickness, Operating Parameters

## I. INTRODUCTION

Surface Coating is in use since long back is rapidly increasing with the development of civilization. There has been considerable impact in this field. Surface coating process used in finding out engineering solutions to all the critical production problems related to coating the products on a continuous and consistent basis in your production plant. Surface coating can be defined as a process in which a substance is applied to other materials to change the surface properties, such as mechanical properties, colour, gloss, resistance to wear or chemical attack, or permeability, without changing the bulk properties. Production of surface coating by any method depends primarily on two factors: the cohesion between the film forming substances and the adhesion between the film and the substrate. The development of science and technology revolutionized the surface coating industry in the progressive countries of the world. Surface coating technology involves the use of various types of products such as resins, oils, pigments, polymers, varnishes, plasticizers, emulsions, etc. Improvement in functionality of object is the main aim of surface coating process.

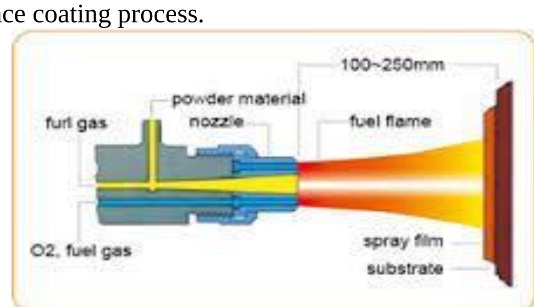


Fig. : HVOF spray

## II. LITERATURE REVIEW

HVOF sprayed WC–Co coatings: Microstructure, mechanical properties and friction moment prediction by Tahar Sahraoui, Sofiane Guessasma, M. Ali Jeridane (2009-Algeria) studied the design of HVOF WC–12Co coatings results in different phase compositions depending on the spray conditions. For all studied conditions, the porosity content is less than 1%, which is a typical result obtained using HVOF technique; improvement of coating hardness can be obtained using the smallest stand-off distance and fuel flow rate. For all studied conditions, the porosity content is less than 1%, which is a typical result obtained using HVOF technique.

Slurry erosion–corrosion behaviour of high-velocity oxy-fuel (HVOF) sprayed Fe-based amorphous metallic coatings for marine pump in sand-containing NaCl solutions by Y. Wang, Y.G. Zheng, W.Ke,W.H. Sun, W.L. Hou , X.C. Chang, J.Q. Wang (2011-China) studied The AMCs exhibit good resistance to localised corrosion and relatively low uniform corrosion resistance due to porosity. in contrast, 304 stainless steel exhibits very low pitting resistance and relatively high uniform corrosion resistance. The Erosion–Corrosion rate of 304 stainless steel increases rapidly with flow velocity, sand size and sand content, whereas AMCs increases mildly. The AMCs with better slurry E–C resistance may be good candidates to solve the E–C problems of marine pump in sand-containing seawater.

Study on stainless steel 316L coatings sprayed by a novel high pressure HVOF by Bo Sun, Hirotaka Fukanuma, Naoyuki Ohno (2014- Japan) The researchers tried to adjust deposition pressure w.r.t. particle velocity at lower temperature, temperature is the dominant factor to check particle melting state, researchers achieved 90% deposition efficiency. Dense Stainless Steel 316L coatings composed of unmolten or partially molten particles can be obtained at different oxygen/fuel ratios λ. It is possible to obtain high deposition efficiency of 90% with optimizing spray conditions.

Developing Empirical Relationship to Predict Hardness in WC-10Co-4Cr HVOF Sprayed Coatings. K.Murugan, A.Raghupathy, V. Balasubramanian, K.ShridharIn ) also used to decide optimum deposition conditions , stand-off distance ,powder feed rate, gas flow rate are the most important parameters influencing hardness. Oxygen flow rate is also important factor for the important parameter for rate & powder feed rate. Researchers have fixed the following parameters as stated in table.

 

| No | Factor | Units | Levels | | | | |
|---|---|---|---|---|---|---|---|
| | | | -2 | -1 | 0 | 1 | 2 |
| 1 | Oxygen Flow Rate | lpm | 242 | 246 | 250 | 254 | 258 |
| 2 | LPG Flow Rate | lpm | 52 | 56 | 60 | 64 | 68 |
| 3 | Powder Feed Rate | g/min | 28 | 33 | 38 | 43 | 48 |
| 4 | Spray Distance | mm | 216 | 222 | 228 | 234 | 240 |

Fig. 1: Process Parameters for HVOF Coating

Erosion Behaviour of WC-10Co-4Cr Coating on 23-8-N Nitronic Steel by HVOF Thermal Spraying by Avnish Kumar, Ashok Sharma, S.K. Goel (2016-India) have made result that The high amount of WC retention and good coating microstructure solution treated 23-8-N nitronic steel substrate resulted in higher fracture toughness with a marginal loss in hardness of the coating. Coated solution treated 23-8-N nitronic steel showed better erosion resistance at both impact angles.

The Wear Resistance of HVOF Sprayed Nickel Chromium and Boron Carbide Coatings by Suresh. R, S.Basavarajappa, M. Prasanna Kumar, Kiran (2017-India) The researchers tried to adjust load of wear at 10N,20N & 50 N With different rpm of coated disc & conclude that HVOF coating produce better wear resistance. During the coating process the particles remained intact and the composition of the powder particles remained unchanged despite the high velocity application. Nickle Chromium and Boron Carbide mixed powders have been successfully deposited by HVOF process to develop coatings of average 200µm thick on Al 6061 MMC composite substrates. The HVOF coatings exhibits better wear resistance by considering different load and speeds.

Dry Sliding Wear Behaviour of WC and Cr-C Coatings on Plain Carbon P/M Steel Substrates Using HVOF Coating Method by D.Shanmugasundarama, K.Gunasekaran 1, R.Chandramouli, N.Natarajan (2017-India) studied the tribological properties of the WC and Cr-C coatings of HVOF coating method were evaluated using pin on Disc dry sliding tester. From the tests it is observed that application of WC and Cr-Coating by HVOF spray technology on low carbon P/M steel substrate has reduced the wear rate significantly. The wear rate is low at low speeds, where as it is very high comparatively at high speeds. From the ANOVA of experiments, it has been observed that both load and sliding velocity is the dominant factor effecting the wear rate and Coefficient

Comparison of tribological properties of HVOF sprayed coatings with different composition by Abdullah Cahit Karaoglanli, Halil Caliskan, Mecit Oge, Kadir Mert Doleker, Mert Hotamis Researchers tried to check all coating mixtures as shown above & compare all wear capabilities & come on coclusion that NiCr base coatings having plastic deformation WC/CoC r>WC/Co >Cr3C2/NiCr >NiCrBSi/WC >NiCr coating wear rate. The most suitable HVOF sprayed coating to prolong the lifetime of components working under wear conditions is WC/CoCr coating owing to its lowest friction coefficient, surface roughness and highest wear resistance. Sliding speed led to an increase in wear volume and its influence is higher at high loads.(15 N)

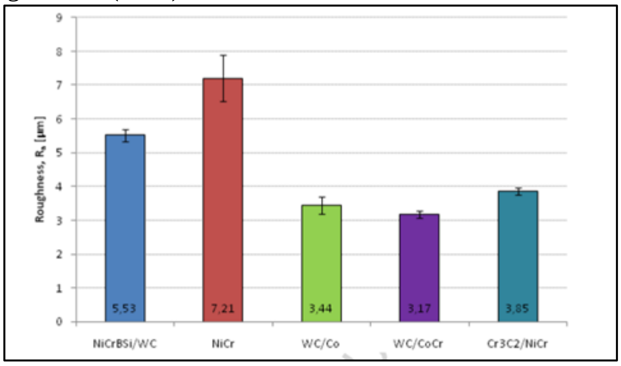


Fig. 2: Comparisons of Surface Roughness by HVOF Coating

The influence of HVOF spraying parameters on the Microstructure, residual stress and cavitation resistance of FeMnCrSi coatings by A.G.M. Pukasiewicz, H.E. de Boer, G.B. Sucharski, R.F. Vaz, L.A.J. Procopiak The use of process parameters is important to increase compressive residual stress , The coatings with higher compressive residual stress had significantly higher Vickers micro hardness, The values of the parameters that produced an increase in particle velocity, i.e., shorter standoff distance, higher fuel flow and lower powder feed rate, also produced an increase in the compressive stress in the coatings. A shorter standoff distance and higher fuel flow resulted in higher particle velocity but did not significantly affect particle temperature. Powder feed rate did not have a significant influence on particle velocity, but a lower powder feed rate resulted in greater compressive residual stress in the coatings.

## III. CONCLUSION

If material is considered, for proper manner like stainless steel, aluminium or Fe based alloys HVOF coating is possibly can provide large number of hardness and wear resistance with corrosion resistance also. Works has been conducted to find the best hardness of materials by HVOF coating. For example, Avnish Kumar, Ashok Sharma, S.K. Goel (2016-India) have made result that The high amount of WC retention and good coating microstructure solution treated 23-8-N nitronic steel substrate and achieved in higher fracture toughness.

Some of the researchers not only worked on material hardness but also varied erosion behaviour of HVOF coated material D.Shanmugasundarama, K.Gunasekaran 1, R.Chandramouli , N.Natarajan includes the comparisons The tribological properties of the WC and Cr-C coatings of HVOF coating method were evaluated using pin on Disc dry sliding tester. A.G.M. Pukasiewicz, H.E. de Boer, G.B. Sucharski, R.F. Vaz, L.A.J. Procopiak checked the influence of HVOF spraying parameters on the Microstructure, residual stress and cavitation resistance of FeMnCrSi coatings.

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