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Thermal spraying of mild steel with stainless steel

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Abstract— **Thermal spraying is a group of processes wherein a feedstock material is heated and propelled as individual particles or droplets onto a surface. This process can be successfully used for cladding a surface to make in corrosion resistance. Experiments were carried out on 3mm thick mild steel plates and flame powder process was used to deposit a thin layer of stainless steel to make the surface corrosion resistant. Thermal spraying gun used for the experiment was run using oxygen and acetylene gas. Various parameters like oxygen and fuel gas flow rates, atomization air pressure, powder feed rate, spray-pattern and stand-off distance were varied to obtain defect-free and adherent coating. The properties of the coating and there adherence were tested and found to be appropriate.**

Index Terms— **Thermal spraying, cladding, oxy-fuel welding**

I. INTRODUCTION

Thermal sprayed corrosion resistant coatings are used in a wide variety of industries to enhance the lifetime of engineering components [1]. A number of thermal spraying methods are available including arc spraying, detonation gun spraying, low pressure plasma spraying and high velocity flame spraying [2]. The introduction of high velocity oxygen fuel (HVOF) spraying was one of the most significant developments in thermal spray technology and involves using a supersonic flame-jet to spray a feedstock powder through an expansion nozzle onto a substrate surface [3]. The jet accelerates and melts the powder particles, which deform upon impact with the substrate and adhere by mechanical interlocking. HVOF processes use lower temperatures and higher velocities than other thermal spray processes, which results in more compact and better quality coatings than are obtained using many other thermal spray processes. A range of coatings have been formed using HVOF spraying, including metal carbide [4], cermets [5], ceramic [6] and polymer coatings [7].

II. EXPERIMENTAL PROCEDURE:

2.1Material selection:

A commercial Fe-Ni-Cr based, this micro flow gas atomised power obtained from eutectic company limited, England. This nickel based micro flow powder used for joining or cladding steel, cast iron as well as nickel alloys. Thermal spraying was untaken using a high velocity oxygen acetylene system. Oxygen regulated to 15 - 20 psi of pressure and acetylene regulated at 5-7 psi of pressure. The combustion products flow through a converging-diverging nozzle and powder is injected, downstream of the throat, through two radial ports into the hot gas. powder is then accelerated and heated by the gas stream; in the present work stand out distance is 15-20mm. spray parameter were optimised for proper coating .spray parameter were optimised for both the deposit porosity and degree oxidation of particles during spraying technique.

Table 1. Parameter used in deposition of metal powder using thermal spraying gun

S.No.	Parameter	Value
1	Oxygen flow rate	15- 20 psi
2	Acetylene flow rate	5-7 psi
3	Powder feed rate	50 gm/min
4	Stand out distance	15-20 m

Coating was carried out in flat and smooth mild steel substrate of size 50mm×30mm×5mm. it was cleaned and polished using a 1200 grit sandpaper to remove surface roughness and other defect. The coating technique was carried out in thermal spraying gun using withdrawn speed of 10 mm/min. a broad coating was put in substrate and maintaining substrate temperature of below 300 ◦C using compressed air jet. This coating process performed so many times for getting a good weld bead for further testing.

2.2Sample preparation for hardness:

Sample preparation of coated material was carried out in Brinell hardness testing machine for hardness measurement. For this sample is perfectly grind and polished to drawn into specimen and make it flat. This test done by 3000 kg and 10 mm diameter carbide ball indenter, the indenter was pressed into the sample by an accurately test force . The force is maintained for specific dwell time of 10-20 seconds. After the dwell time is complete, the indenter is removed leaving a round indent in the sample. This round indents impression further check by small microscope for Brinell hardness number.

2.3Sample preparation for microstructure evaluation:

Microstructure evaluation of weld bead performed by cutting a small weld area piece . then perfectly grind and polished the weld piece by using 600, 1000, 1200 and 1500 grit size sand paper. At the last stage we polished it by alumina and water mixture to getting a scratch proof surface. Now we etched the sample with suitable etchant. Then we take some micrograph in different region of clad area and parent metal area.

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III. RESULT AND DISCUSSION:

3.1 Cladding result:

The coating behaviour on the substrate mild steel was found to be satisfactory. The coating bead was observed to be uniform good and free from any visual defects. With the high velocity spray process shows the dense coating. The coating found to be deposited at the place of exploitation of part to be sprayed so its show a good portability. The temperature at substrate and coating interface kept below 300^0C, shows that the molten or partly coating particles do not melt the substrate material on impact. The spray coating shows overall low porosity.

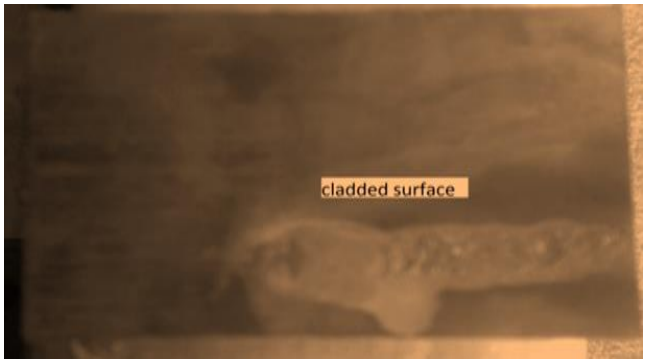

Figure 1 : coating surface on substrate

3.2 hardness result:

For harness perfectly grind flat work piece put in brinell hardness test machine. Then the test load of 2000kg applied by 10mm diameter carbide ball and these work piece drawn after 15 seconds. Then according to indentation corresponding value of hardness load is calculated. The hardness result was carried out by Brinell hardness testing machine. It's found to be increases strength coated material compare as parent material.

figure 2: hardness tested work piece

Table 2: Brinell hardness conversion table

S. No.	Description	Impression Diameter (mm)	hardness no. (kg)	Tensile strength (*1000 psi)
1	Coated material	5.2	131	65
2	Adjacent to coated material	5.5	116	58
3	Parent material	5.9	99.2	50

From table it shows that the strength of coated material is higher than parent material and due to thermal process adjacent to coated material also possesses comparatively high strength than parent material. So by thermal spraying process provides good overall strength of material.

3.3 microstructure result:

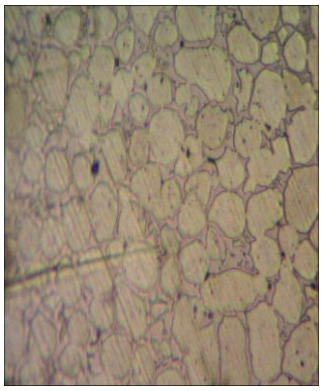

Figure3: clad region on 400X on 200 X magnification

Figure 4: fusion boundary magnification

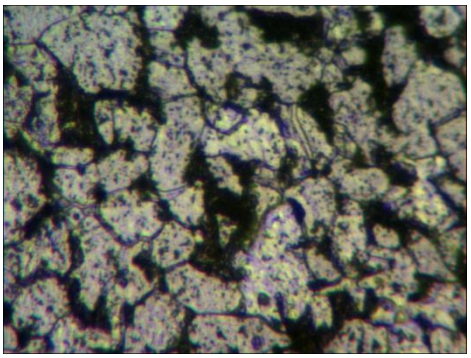

Figure 4: parent metal on 400X Magnification

IV. CONCLUSION:

The coating process successfully carried using Ni-Cr based powder. The work aimed to
Utilizing thermal spraying for good coating characteristic. It was a good procedure for corrosive resistive coating techniques as it could provide good overall strength and hardness than parent material. The Ni-Cr layers were sprayed in molten form and it would expect to provide good corrosion resistance.

REFERENCES:

[1] Davis, Joseph R. *Handbook of thermal spray technology*. ASM international, 2004
[2] He, Jianhong, and Julie M. Schoenung. "Nanostructured coatings." *Materials Science and Engineering: A* 336.1 (2002): 274-319.
[3] Fauchais, P., A. Vardelle, and B. Dussoubs. "Quo vadis thermal spraying?." *Journal of Thermal Spray Technology* 10.1 (2001): 44-66.
[4] Morks, M. F., et al. "Microstructure and hardness properties of cermet coating sprayed by low power plasma." *Materials letters* 60.8 (2006): 1049-1053.

[5] Toma, D., W. Brandl, and G. Marginean. "Wear and corrosion behaviour of thermally sprayed cermet coatings." *Surface and Coatings Technology* 138.2 (2001): 149-158.
[6] Turunen, Erja, et al. "Parameter optimization of HVOF sprayed nanostructured alumina and alumina–nickel composite coatings." *Surface and Coatings Technology* 200.16 (2006): 4987-4994.
[7] Petrovicova, E., et al. "Nylon 11/silica nanocomposite coatings applied by the HVOF process. II. Mechanical and barrier properties." *Journal of Applied Polymer Science* 78.13 (2000): 2272-2289.
[8] Zhao, Lidong, and Erich Lugscheider. "Influence of the spraying processes on the properties of 316L stainless steel coatings." *Surface and coatings technology* 162.1 (2003): 6-10.
[9] Coddet, Christian, ed. *Thermal spray: meeting the challenges of the 21st century: proceedings of the 15th International Thermal Spray Conference, 25-29 May 1998, Nice, France*. Vol. 1. ASM International, 1998.
[10] Westergård, R., et al. "The erosion and abrasion characteristics of alumina coatings plasma sprayed under different spraying conditions." *Tribology international* 31.5 (1998): 271-279.
[11] Coddet, Christian, ed. *Thermal spray: meeting the challenges of the 21st century: proceedings of the 15th International Thermal Spray Conference, 25-29 May 1998, Nice, France*. Vol. 1. ASM International, 1998.
[12] Gorlach, I. A. "Development of the thermal spraying process for anticorrosion surface protection." *Proceedings of the International MultiConference of Engineers and Computer Scientists*. Vol. 2. 2008.
[13] Chokethawai, K., D. G. McCartney, and P. H. Shipway. "Microstructure evolution and thermal stability of an Fe-based amorphous alloy powder and thermally sprayed coatings." *Journal of Alloys and Compounds* 480.2 (2009): 351-359.
[14] Dent, A. H., et al. "Microstructural characterisation of a Ni-Cr-BC based alloy coating produced by high velocity oxy-fuel thermal spraying." *Surface and Coatings Technology* 139.2 (2001): 244-250.
[15] Zhang, D., S. J. Harris, and D. G. McCartney. "Microstructure formation and corrosion behaviour in HVOF-sprayed Inconel 625 coatings." *Materials Science and Engineering: A* 344.1 (2003): 45-56.
[16] Tuominen, J., et al. "Improving corrosion properties of high-velocity oxy-fuel sprayed inconel 625 by using a high-power continuous wave neodymium-doped yttrium aluminum garnet laser." *Journal of thermal spray technology* 9.4 (2000): 513-519.
[17] Lu, Shan-Ping, and Oh-Yang Kwon. "Microstructure and bonding strength of WC reinforced Ni-base alloy brazed composite coating." *Surface and Coatings Technology* 153.1 (2002): 40-48.
[18] Beck, Tilmann, et al. "Modeling of Coating Process, Phase Changes, and Damage of Plasma Sprayed Thermal Barrier Coatings on Ni-Base Superalloys." *Advanced Engineering Materials* 12.3 (2010): 110-126.
[19] Lu, Shan-Ping, and Oh-Yang Kwon. "Microstructure and bonding strength of WC reinforced Ni-base alloy brazed composite coating." *Surface and Coatings Technology* 153.1 (2002): 40-48.
[20] Chidambaram, Devicharan, Clive R. Clayton, and Mitchell R. Dorfman. "Evaluation of the electrochemical behavior of HVOF-sprayed alloy coatings." *Surface and Coatings Technology* 176.3 (2004): 307-317