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Erosion Behaviour of Chromium Based Hardfacing Alloy

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Abstract **- In the present study commercial available chromium based hardfacing alloy (CPET 071) was deposited on SS304 steel by manual metal arc welding process to investigate the erosion behaviour. Solid particle erosion study was carried out using air jet erosion tester rig. Erosion testing was done at room and 400°C temperature at different impingement angles i.e. 30° and 90°. Optical microscopy technique is used to analyse the microstructure. Microstructure of the deposited hardfacing alloy has been formed to be free from defect such as crakes and porosity, with typical dendritic structure. Erosion rate of the base and hardfaced steel has been found to be higher at 400 °C temperatures with 30° impingement angle.**

Keywords: **Microstructure, Hardfacing, Microhardness, Erosion**

I. Introduction

Hardfaced welding method is commonly used for functionalizing surfaces subjected to severe wear, corrosion or oxidation, which has transformed itself into a field of broad applications. This process is generally used to deposit a wear resistant alloy on either a worn component or new item of plant which is to be subjected to wear in service (Gregory, 1978). To overcome the various types of wear problems of the steel, hardfacing has emerged as an important process that improves the surface properties like hardness and wear resistance of the component. It can also be used for upgrading the inferior quality steel/material, which encounters severe wear and to restore the components for further use (Kumar et al.,1999). The systematic study of various consumables and welding processes applied to hard facing is of great interest for the optimization of the design of the consumables and for the evaluation and fine tuning of the welding procedures (Gualcoa1 *et al.,* 2010).

Hardfacing can be applied by a number of welding processes. Selection of the most suitable welding process for a given job depends on factors like: nature of work to be hardfaced, function of the component, base metal composition, size and shape of the component, accessibility of weld equipment, state of repair of weld components, number of same or similar items to be hard faced etc (Balasubramanian *et al.,* 2009). Everything that man makes wears out, usually, as a result of sliding between contacting and rubbing solids. Wear of materials is an every-day experience and has been observed and studied for a very long time. Nevertheless, it is difficult to predict and to control wear of rubbing elements. According to Davies and Bolton referring to a British report, the local industry would be able to save significant amount of resources if appropriate measures for reducing wear should be taken. The present paper aims at investigating the microstructure and erosion behaviour of SS304 steel hardfaced by commercial available chromium based alloy CPET 071 deposited by manual arc welding process.

II. Experimental Procedure

A.Substrate Material

SS304 steel has been used as a substrate material in the present study. Specimens with dimensions of 300mm × 50mm × 5 mm were prepared. Before welding, these specimens were ground and cleaned with acetone. The chemical composition of the substrate material is given in Table I.

Table 1 Chemical Composition of The Substrate Material (Wt %)

Element	Wt %
C	0.08
Mn	2.0
Si	0.75
P	0.045
S	0.030
Cr	20.0
Al	0.10
Ni	10.50
Fe	Balance

B. Hardfacing

Commercially available hardfacing tubular coated electrode (CPET 071) is used for deposing single layer on the flats and without any buffer electrode. CPET 071 alloy is a tubular cored of chromium carbide type, reinforced with alloying additives. Chemical composition of the hardfaced electrode is given in Table II.

C. Characterization

Microstructure of the samples has been studied with the help optical microscope. For metallographic studies specimens were prepared by cutting the samples along the cross-section and subsequently polishing. The polishing was carried out with alumna slurry to obtain a surface finish on polishing machine. The polished specimens were subsequently etched with picral etching reagent. Microhardness of the samples was measured using Vickers microhardness tester (Mytutoyo) with 1kg load and 15 sec indentation time.

Table II Chemical Composition Of Hardfacing Electrode

Elements	Hardfacing Alloy A
Cr	27.73%
SiO2	7.97%
Co	.12%
Ni	.21%
Mn	0.18%
S	5.16%
P	0.48%
Fe	58.45%

D. Erosion Testing

The erosion experiments were performed on air jet type erosion test rig. The specimens for erosion testing were rectangular blocks measuring 20 mm long, 15 mm wide. The specimens were mounted directly below the nozzle with a stand off distance of 10 mm between the end of the nozzle and the test surface. The particle feed rate was kept constant throughout the erosion studies. The erosion experiments were conducted at room and 400°C temperature with impingement angles of 30° and 90°. After each erosion test the specimens were removed and cleaned with dry compressed air. Erosion rate of the specimens is calculated by measuring the weight loss of the specimens after experimentation. Each experiment is of 3 hrs.

III. Result and Discussion

A. Microstructure and Microhardness

It is well known that the microstructure plays a predominant role in determining the behaviour of materials in several applications. Therefore control and optimization of microstructure is very important for materials in hardfacing in the form of deposited material for any of their mechanical properties. According to the observations by Chatterjee et al (2006) the microstructure proved to be more important than hardness in determining abrasion resistance.

Optical microstructure for the cross-section of hardfaced alloy deposited on SS304 steel substrate has been shown in Fig. 1. Microstructure reveals the formation of fine lines of austenite uniformly distributed into the eutectic matrix. Island of chromium carbide are randomly distributed into the matrix, having two principal shapes in the plane of polish; a hexagonal platelet morphology and long spine like form. As observed by Chang *et al* (2010), hardness of hardfacing alloy increases with the increase in carbon contents, while the chromium carbide accompanied to refine the structure of the weldmeant. It is apparent from Fig no.1 that the interface between the substrate and the hardfacing material shows good bounding.

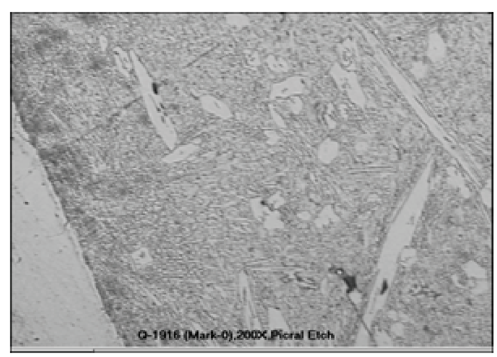

Fig. 1 Optical microstructure for the cross-section of hardfacing alloy deposited on SS304 stee

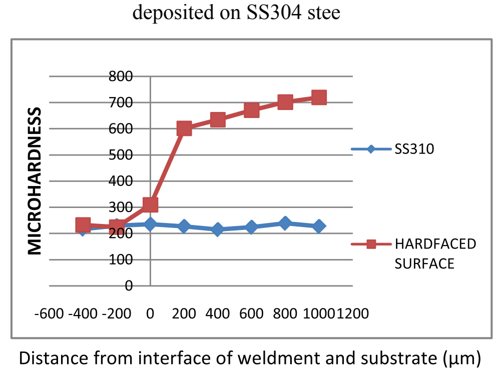

Fig 2 Microhardness profile for hardfaced SS304 steel

The microhardness values of the hardfacing alloy on the SS304 steel have been measured across the hardfacing-substrate interface and plotted in Fig. 2 as a function of distance from the hardfacing-substrate interface. At each distance from hardfacing-substrate interface, four readings are taken and each point in the Fig. 2 shows the average of four readings. The microhardness values for the hardfaced steel lies in the range of 610-710 Hv, while the substrate steel has an average microhardness of 236 Hv. Furthermore, a slight decrease in the microhardness of the hardfacing has been observed near the hardfacing-substrate, which may be attributed to dilution of substrate steel elements towards hardfacing. Hardfacing improved the microhardness of substrate steel significantly. According to Kumar et al (1999) hardness of the materials plays an important role in determining the wear characteristics. Generally wear is inversely proportional to the hardness of hardfacing material. The hardfacing alloys shows uniformity in the value of microhardness, which may be attributed to fine and uniform microstructure along the depth of weldment.

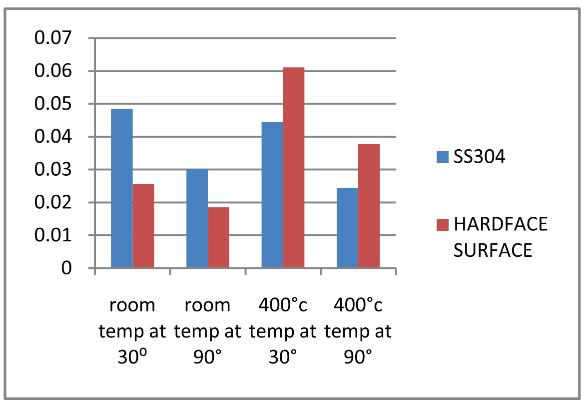

Fig. 3 Bar chart showing weight loss for bare and hardfaced SS304 steel exposed to an erosion test at two different temperatures (room temperature and 400°C) and at 30° and 90° impingement angles.

B. Erosion

The erosion rate of SS304 steel with and without hardfaced alloy at two temperatures (i.e. room and 400°C) is shown in Fig 3. Form the Fig.3 it has been observed that at room temperature with 90 ° impingement angle, hardfacing has provided maximum resistance to erosion with minimum weight loss. However, at higher temperature (400°C) hardfaced steel experienced high erosion rate as compared to bare steel at both the impingement angles i.e. 30° and 90°.

IV. Conclusion

Microstructure of the hardfacing alloy revealed the formation of fine lines of austenite uniformly distributed into the eutectic matrix. Island of chromium carbide are randomly distributed into the matrix, having two principal shapes in the plane of polish; a hexagonal platelet morphology and long spine like form.

- Microhardness of the hardfaced steel has been found to be significantly higher than the bare steel.
- At room temperature bare experienced higher erosion rate, whereas at higher temperature hardfaced steel experienced higher erosion rate at both the impingement angles under study.

Acknowledgement

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References

[1] Balasubramanian V., Varahamoorthy R., Ramachandran C.S. and Muralidharan C., (2009), "Selection of welding process for hardfacing on carbon steels based on quantitative and qualitative factors," *Adv Manuf Technol,* Vol. 40, pp. 887–897.

[2] Chang C.M., Chen Y.C., Wu W., (2010), "Microstructural and abrasive characteristics of high carbon Fe–Cr–C hardfacing alloy," *Tribology International,* Vol. 43, pp. 929–934.

[3] Chatterjee S., Pal T.K., (2003), "Wear behaviour of hardfacing deposits on cast iron" *Wear,* Vol. 255, pp. 417–425

[4] Gregory. E.N., (1978), *"Hardfacing,"* Tribology international pp. 129-134.

[5] Gualco A., Svoboda H.G., Suriana E.S. and Vedia L.A., (2010), "Effect of post-weld heat treatment on the wear resistance of hardfacing martensitic steel deposits," *Welding International,* Vol. 24, pp. 258-265.

[6] Kumar S., Mondal D.P., Khaira H.K. and Jha A.K., (1999), "Improvement in High Stress Abrasive Wear Property of Steel by hardfacing," *Materials Engineering and Performance,* Vol-8, pp. 711-715.