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Research Paper

WEAR CHARACTERISTICS OF CHROMIUM CARBIDE HARDFACED LAYER MADE BY PASTE TECHNIQUE USING E-7014 SMAW ELECTRODE

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In the present work a detailed study was done to study the effect of different compositions of chromium powder on mild steel, deposited by paste coating process. On coating weld metal AWS E7014 SMAW electrode was deposited with SMAW Process. Three different compositions of metal powder had been chosen for hardfacing material. The investigation was done on three categories of samples prepared by these compositions. Various rigorous tests were carried out on the batch of 3 samples per category i.e. total nine samples. Wear test and micro-hardness test were done to record the observations. Wear test was performed on dry wear and friction testing machine. [Model: Wear and Friction Monitor Tester TR-20], supplied by M/S DUCOM, Bangalore (INDIA) wear using different loads.

Keywords: Hardfacing, SMAW, Wear testing, Microhardness

INTRODUCTION

Hardfacing is a process of depositing the filler metal on to a compatible surface for the enhancement of wear properties. Hardfacing is one of the most useful and economical way to improve the wear performance of a component. Shielded metal arc welding is most commonly used process for hardfacing due to its easy availability and versatility of operation. Low carbon steel (Mild Steel) is selected for the present work as substrate material due to its low cost, easy availability and variety of applications. Parts of agriculture and earth moving equipment like support roll of tractor, dipper teeth, Plough shares, Knives and cutter like feed chopper, grader blades, are recognized as severe problems, resulting in failure by wear (Stringer J, 1998; Kumar S *et al*., 1999). As the resistant elements (Cr) increases, carbide formation gets increased, which results in enhanced wear resistance. One possible way to solve these problems applying a hardfaced layer (Pandey S and Kumar M, 2010; Rathod D *et al*., 2012). This process is one of the most popular and has

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been widely adopted in many industries due to its flexibility, cost effectiveness and superior quality of the wear resistance and hardness is obtained (Parmar R S, 2008). High heat input resulted larger carbide precipitation, lowers the hardness, low heat input resulted higher hardness (Gualco A *et al*., 2010).

In this presented study, the Shielded Metal Arc Welding (SMAW) method of making surface modification to improve the wear properties of mild steel materials has been used. Wear resistance is less for mild steel for oblique impact (Crespo A C and Scotti A, 2008). Higher mass losses were measured in mild steel versus carbides (Selvi S *et al*., 2008). The mild steel is hardfaced with different compositions of chromium. The mild steel is frequently used material due to its low cost, which at same time soft material with poor wear properties.

To reduce this wear problem, the hard-facing was done by welding coating (welding of Cr and sodium silicate) using SMAW on the mild steel plate and were investigated with regard to their wear and micro hardness characteristics. Hardfacing leads to hard surfaces, higher hardness gives the high wear resistance (Gulenc B and Kahraman N, 2003).

MATERIALS AND METHODS

The material used in the current investigation is mild steel with hardfaced layer made by paste technique USING E-7014 SMAW ELECTRODE. Three levels had been chosen for current, chromium percentage and coded as upper level (H), medium level (I), lower level (L). The decided values of process parameters with their notations and units are given in the table.

Table 1: Process Parameters

Sl. No.	PARA METRES	UNITS	H	I	L
1.	Cr %	-	90	80	70
2.	Current	ampere	150	130	110

A three level factorial design of (3^2=9) nine trials has been selected for determining the effect of two independent parameters. The selection of three level factorial design helps in reducing experimental runs to the minimum possible (Douglas C, 2001).

The rectangular mild steel specimens having dimensions 100mm × 30mm × 10mm were prepared.

Beads on the mild steel plates have been deposited as per the design matrix with the SMAW E-7014 electrode. The response parameter (wear) is recorded by conducting experiments as per the design matrix. The software *Design -for-experts(DX8)* version used to implement factorial design consisting of nine experiments and to develop a model showing the relationships between the response wear and process parameters (welding current and % of Cr) for coded values of (H), (I), (L) for each of the process parameters.

The microhardness of the coatings on the surface was measured with a load of 2 kg using the Digital Micro Vickers Hardness tester (SHV-1000, Chennai Metco, Pvt., Ltd, and Chennai, India). The test was conducted for 9 specimens.

Wear tests were conducted using a pin-on -disc machine [Model: Wear and Friction Monitor Tester TR-20], supplied by M/S DUCOM, Bangalore (INDIA).

RESULTS AND DISCUSSION

a) Microhardness

All the ten samples were first polished on disc polishing machine and after that the microhardness was checked. The microhardness was checked on middle position. At every sample one reading was taken. Hardness readings are shown in Table 5.1. Microhardness of base metal is 208 VHN.

Table 2: Microhardness Result (All Samples)

Sample No.	Sample Name	Hardness in VHN
1.	HH	556
2.	HI	587
3.	HL	637
4.	IH	562
5.	II	589
6.	IL	615
7.	LH	282
8.	LI	321
9.	LL	365

Comparison of microhardness of 90%, 80% and 70% Cr using three current as shown in Figure 5.1 to Figure 5.3.

Figure 1: Comparison of Microhardness of 90% Cr Using Three Current

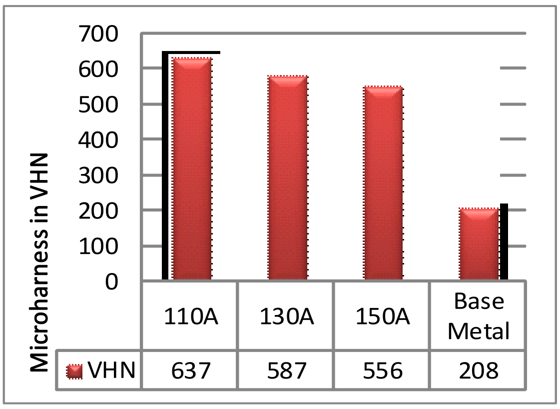


Figure 2: Comparison of Microhardness of 80% Cr Using Three Current

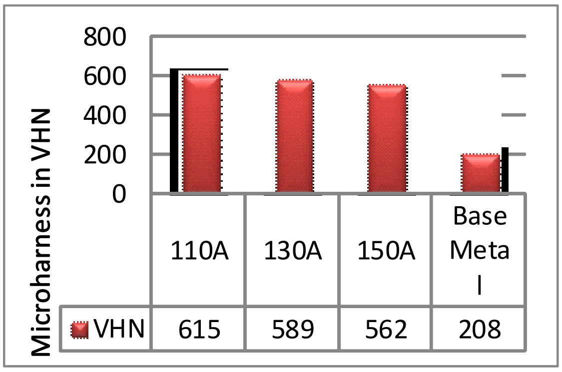
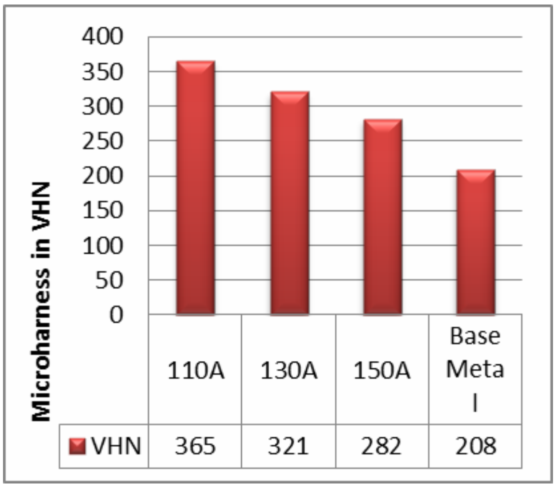


Figure 3: Comparison of Microhardness of 70% Cr Using Three Current



From the above observation it can be easily concluded that at 110A current the micohardness is coming higher as compared to micohardness values at 130A an150 A. The main reason is that with the increase of current hardness decrease for all the three compositions of the paste due to reason that high current results in slower cooling rates resulting in softer matrix having lower hardness. Higher the cooling rate will produce higher micohardness. It has been also observed that the hardness values can be enhanced by approximately 3.10 times using 90% Cr, 3.04 times by using 80% Cr and 1.88 times by using 70% Cr Powder, due to the reason that higher amount of chromium results in increased carbide formation.

b) Wear Study

Wear rate was calculated by measuring initial and final weights of samples.

Table 3: Loss in Weight and Wear Rate

NAME	INITIAL Wt.(g)	LOSS WEIGHT (g)	FINAL Wt.(g)	WEAR RATE (g/hr.)
HH	5.689	0.0051	5.684	0.061
HI	5.682	0.0039	5.678	0.046
HL	5.687	0.0021	5.685	0.025
IH	5.593	0.0051	5.684	0.092
II	5.638	0.0049	5.633	0.058
IL	5.801	0.0046	5.796	0.055
LH	5.589	0.0108	5.578	0.129
LI	5.634	0.0089	5.625	0.106
LL	5.659	0.0081	5.652	0.097
MS	5.561	0.134	5.427	1.608

It has been observed that the (HL), higher chromium percentage (99%) and lower current (110 A) resulted in minimum wear.

CONCLUSION

The hardness values can be enhanced by approximately 3.10 times using 90% Cr, 3.04 times by using 80% Cr and 1.88 times by using 70% Cr Powder. Wear resistance can be increased up to 26 times using 90% Cr, 17 times using 80% Cr and 12 times by using 70% Cr than base metal (mild steel).

Considering all the aspects it may be concluded that paste with 90% Cr gives better wear properties and micro-hardness as compared to paste with 80% and & 70% Cr content. It has been observed that with the increase of current hardness decrease for all the three compositions of the paste due to reason that high current results in slower cooling rates resulting in softer matrix having lower hardness. The wear studies show that as the current is increasing the wear rate also increasing due to decreasing hardness. The same observations have been noticed in all the three compositions of paste.

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