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Investigations on Hard Facing of Inconel on Nuclear Grade SS347 Pipe

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A B S T R A C T

Hardfacing is a low-cost method of depositing wear-resistant surfaces on metal components to extend the service life of the base metal. Hardfacing provides the following benefits: Fewer replacement parts are needed. Operating efficiency is increased by reducing downtime. Less expensive base metals can be used, and overall costs are reduced. This project aims to understand the process of hardfacing, why Inconel is used as the hardfacing agent primarily, and the different kinds of base metals that are used. This project also aims to understand the general techniques used in hardfacing. Apart from that, it aims to improve the hardfacing and wear resistance of stainless steel 347 pipe

Keywords: face hardening, Vickers hardness, microstructure, macrostructure

1. Introduction

Hardfacing, literally speaking, means to harden the surface of the metal. It is a typical surfacing form through which a hard, wear-resistant material is deposited onto the base metal (substrate) by either weld overlay or thermal spray processes. Hardfacing is applied for the purpose of reducing wear or loss of material by abrasion, impact, erosion, galling, or cavitation. Depending on the properties of specific deposited materials, hardfacing may also impart corrosion resistance to the surface that is not intrinsic to the underlying base metal. Hardfacing by weld overlay for an oil drilling pipe (Robotic Arc welding)

2. Experimental Procedure

Hard deposits of Inconel has been made on the nuclear grade SS347 stainless steel pipe using Robotic arc welding machine. The process parameters are Welding Current – 150 Amps; Welding Speed – 200 mm/min; Welding Voltage – 16.5 Volts. Overlap ratio: 30%.Shielding gas environment: 98% Argon + 2% CO_2; 15 l/min and 20 bar. Hard deposits are sectioned along the stainless steel pipe using wire cut EDM process. Sectioned samples are mounted and polished (metallographically prepared samples).Finally, the polished samples are etched with a suitable etchant to reveal the macrograph. The macrographs are presented below process parameters. Micro hardness measurements (load of 500g with a dwell time of 10s) are carried out on the deposits to find out the mechanical integrity.

Table 2.1 Process parameters and their limits

PARAMETER	**Level**		
	-1	0	+1
Welding Current(Amperes)	100	120	140
Wire Feed Rate (mm/min)	60	70	80
Edge Included Angle (Degrees)	30	45	60

Table 2 Welding conditions

Welding process	Robotic Arc Welding
Polarity	DCEN
Mode of operation	Continuous mode
Electrode	INCONEL625
Electrode Diameter	2mm
Shield gas	Argon

Shield gas flow rate	6 Lpm
Shielding gas	Argon
Tip to surface distance	1mm
Welding speed	200mm/min
Torch Position	Vertical
Operation type	Semi-Automatic

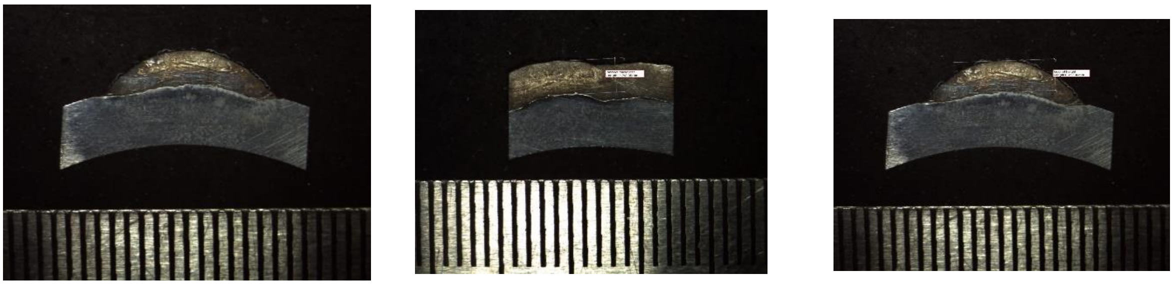


Fig. 1 – Different samples of hard facing

The fig 2.1 shows the picture of hard facing samples of different layers. After the weld the material machined for various test according to the standard measurements.

3. Results & Discussion

Various tests are carried out for the material. The results are compared to get that which Inconel surface have greater hardness value.

3.1 Vickers hardness test

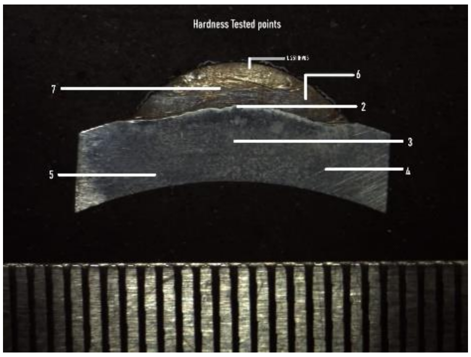
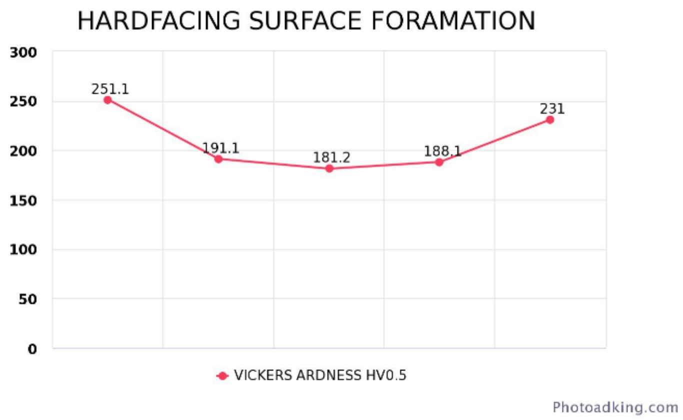


Fig 2 Trail 1 & 2 hardness results samples

3.2 Micro hardness Survey

Table 5 Hardness survey of welded samples

Test point	**range**	**hardness**
1	0.5	**251.1HV05**
2	0.5	191.1HV05
3	0.5	18/1.2HV05
4	0.5	191.2HV05
5	0.5	188.1HV05
6	0.5	231HV05
7	0.5	233.HV05



Graph 1 shows a Rockwell hardness number

3.5 Microstructural Evaluation

The sample are prepared for the microstructural evaluation under metallurgical microscope. The specimen first polished and then etchant is applied on the surface of the specimen for the dwell time of 0.5sec. The etchant used is 10g Oxalic Acid 100ml water with Electrolyte process. The microstructures are carried under 100x magnification. In the weld interdendritic structure formed. In the HAZ microstructure shows complete fusion between weld & base.

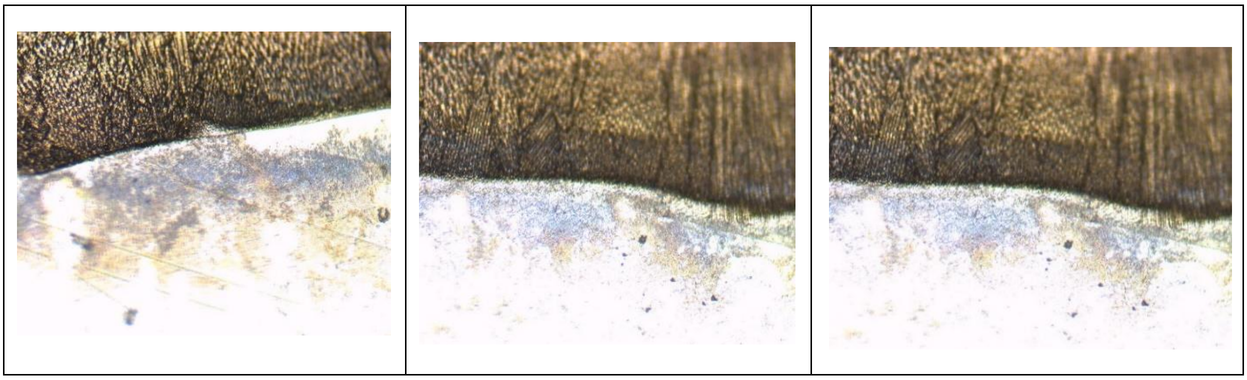


FIG 3 : Shows the layers of weld and macrostructure evaluvation

4. Results & Discussions

Based on the experiments performed the following conclusions are drawn:

Robotic arc welding is used for creating the Inconel 625 face hardening surface over SS347 with process parameters. Proper preparation of metallographic specimens is done by sectioning, mounting, grinding, polishing, and etching. Microstructure is examined in a proper way. The hardness of the Inconel surface formed over SS347 was tested successfully using a Vickers micro hardness machine. The hardness value of the weld zone changes with distance from the Inconel layer to SS347 due to changes in microstructure. The Inconel-welded surface increased the hardness of the SS347 pipe outer surface to withstand higher wear and impact damage

INFERENCE FROM THE RESULTS

The micro hardness investigations on the Inconel deposits on the nuclear grade SS 347 grade steel pipe indicates the higher value is achieved on the overlapped beads (251 HV). The overlapped Inconel deposits are having a higher hardness response.

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