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Microstructure, Mechanical Properties & Corrosion Behavior of Duplex 2209 in Electro-Slag Strip Cladding over low carbon steel substrate: a Review Paper

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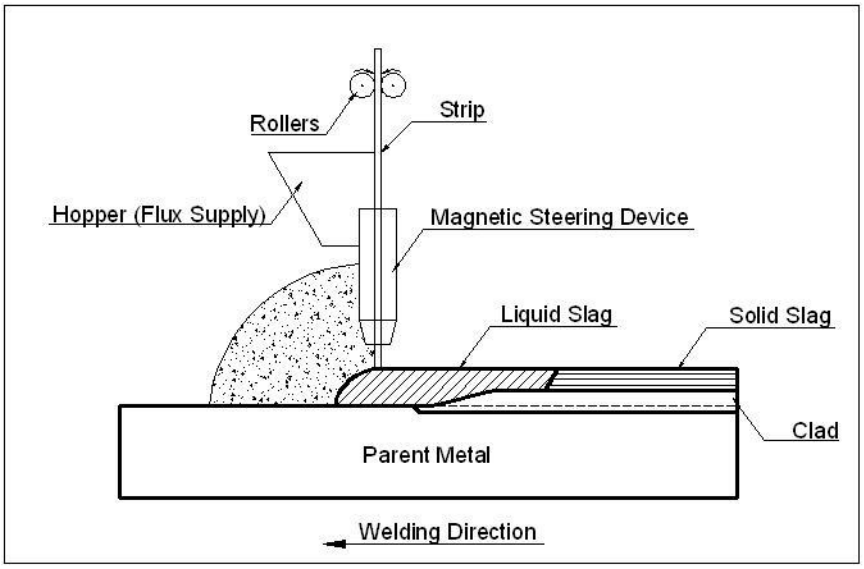
ABSTRACT
The purpose of this research work is todetermine the microstructure and mechanical properties of Stainless steel (Duplex 2209 and S.S 309) weld overlay on Low carbon steel plate (SA 516 Grade 70) developing multilayers. The buffer layer is done by using S.S 309 L strip electrode of 60mm width following by top layers of Duplex 2209.The Process used is Electro Slag Strip Cladding due to its unique properties like high deposition rate and low dilution level.The Microstructure characterization will be examinedby the use of SEM/EDS. In mechanical properties Micro hardnesswill be examined. Residual stress analysis will be done by XRD. The intergranular stress corrosion study will also be carried out as per ASTM G-5 standards.
Keywords–Electro-Slag Strip Cladding, Scanning Electrode Microscope,Duplex steel.

I. INTRODUCTION

In the Modern world of industrialization the wear is eating the assets worth millions of dollars per year. The wear is in the form of corrosion, erosion, Abrasionetc. which occur in the process industries like oil & gas, refineries, Cement plants, steel plants and dockyards. The pressure vessels or reactors which often work at elevated temperatures face corrosion in their internal diameter.



From last many decades CRA (Corrosion resistant alloys) are being used for overlaying a protective layer over base metal by various techniques like explosion welding, SAW, Submerged arc Strip Cladding (SASC) and Electro-Slag Strip Cladding.The most efficient and widely used technique these days is Electro-Slag Strip cladding due to its unique properties like high deposition rate, Low dilution and high quality defect free weld.

Electro-Slag Strip Cladding Process–

In ESSC the strip electrode is continuously fed into molten pool of electrically conductive flux. The principle is based on resistance heating by which the electric current flows through flux and melt it. The flux contains fluorides like CaF2 and NaF which increase electrical conductivity. Electro-Slag Strip Cladding process is identical to SASC. The basic difference is that in ESSC there is no arc while

welding. The arc is strike just to start the weld. Due to unavailability of arc there is no ultraviolet radiation but only infra-red rays.The basic problem in this process is undercut. The problem arise due to electromagnetic pinch effect. The electromagnetic forces due to high current passing through the metal strip tends the flow of molten metal from sides to the center of the weld bead. To overcome this problem we apply an external magnetic field by using magnetic steering device in the opposite direction. The metal deposition rate is up to 52kg/hour which is highest among other processes. The dilution level is recorded as low as 10-15% among all processes. A straight polarity is used in ESSC. Arc voltage is kept low at 24-26V and current is high 400-2400 A depending on strip size

Chemical Composition of Base Material and Strip electrode –

This grade of steel is as per the standard specification of Pressure vessel plate, carbon steel for moderate and low temperature service. Its composition is as follows

Elements	Base Metal	S.S 309 L	Duplex 2209
Carbon, C	0.27 under ½", 0.28 between ½" to 2"	0.009	0.008
Silicon, Si	0.15 - 0.40	0.13	0.43
Sulfur, S	0.035	0.0015	<0.0005
Phosphorous, P	0.035	0.015	0.018
Manganese	0.85 - 1.20	1.68	1.51
Chromium	-	20.34	22.95
Nickel	-	13.45	8.59
Molybdenum	-	2.84	3.02
Cobalt		0.023	0.11
Copper		0.078	0.12
Nitrogen		0.031	0.15

The strip electrode will be 60 mm X 0.5 mm dimension.

The flux used consist of following by %

SiO2	6
Al2O3	24
CaO + MgO	48
K2O + Na2O	2
F	32

II. Experimental Procedure -

The base plate of SA 516 Grade 70 low carbon steel of 50 mm received in normalized, accelerated cooled and tempered condition. In first case the buffer layer with SS 309 L will be performed followed by second and third layer of Duplex 2209.The overlays then will be tested under SEM/EDX. Micro hardness will also be tested along with residual stress analysis by XRD. Welding parameters used in performing ESSC

Parameters	Range
Welding current (I)	1200-1400 A
Voltage (V)	22-26V
Travel Speed	170 mm/min
Pre heat	130 degree Celsius
Interpass	Max 200
Electrode extension (Stick Out)	12-15 mm
Height of Flux	15mm
Polarity	DCEP

III. CONCLUSION

The analysis in this area over past few decades reveals that in ESSC generally Austenitic grades of Stainless Steel is used like 304, 309, 316 L etc. The review paper evaluates the new grade of Stainless steel i.e. Duplex 2209 which exhibits different mechanical and chemical properties as compared to conventional Austenitic Stainless steel. The mechanical properties along with corrosion behavior of the clad overlay will be evaluated.

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