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CHARACTERISTICS STUDIES OF STAINLESS STEEL (AISI TYPE 304L) WELDED BY ER310L FILLER USING TIG WELDING

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ABSTRACT

In aerospace, automotive, manufacturing industries, welding has been widely used for engineering applications. Welding requires properties like corrosion resistance, wear resistance and hardness. The corrosion and wear rate depends on the atmospheric conditions and engineering applications. The welded AISI type 304L stainless steel is subjected to post weld heat treatment during welding process. This welding process suffers by ferrite and carbon contents. The filler ER310L is selected and welded with stainless steel (AISI type 304L) by Gas tungsten Arc welding (TIG welding) method. Satisfactory results are obtained from tensile test, hardness test, impact strength and microstructures, which makes it eligible for engineering applications. This research work elevates the corrosion resistance and mechanical properties of stainless steel (AISI type 304L) economically for the engineering applications.

Key words: Stainless steel, AISI Type 304L, ER310L filler, Tig welding.

INTRODUCTION

The major factor considered in the selection of different components of 500 MWe sodium cooled fast breeder reactor (PFBR) includes operating condition availability design data code ease of fabrication, international experience and cost. To avoid mix up of material development and characterisation attempt has been made to number of material and welding consumables[1,8]. This paper deals with material irradiation effect on material properties for 304L Stainless steel base metal and welds[2,10].

In this paper, we will discuss about the TIG welding process, equipments, power sources, type of electrode shielding gases types of current gas flow rate. Ferrous and non

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ferrous materials to themselves or to very similar alloy composition for welding dissimilar metals can be practically welded by TIG welding process. TIG is process of permitting carbon steel to be joined to stainless or to copper alloys before opting for such designs. However consequent effect such as galvanic corrosion and difference in expansion coefficients and conductivity should be considered[3].

Numerical simulation of transient temperature under residual stress in friction stirs welding of 304L stainless steel. Specifically for welding Three dimensional nonlinear thermal and thermo mechanical numerical simulation or conducted for the friction stir welding (FSW) Of 304L stainless steel the finite elements analysis WELDSIM is developed by author. Simulation was used to base on the experimental record of transient temperature at several locations. During the friction stir welding process for 304L stainless steel inverse analysis method for thermal numerical simulation is developed after the transient temperature field determined the residual stress in the welded plate are then calculated using a three dimensional-elastic-plastic thermo mechanical simulation[4,9].

Selection of filler wire for and effect of auto tempering on mechanical properties of dissimilar metal joined between 403 and 304L (N) stainless steel. The weld ability of dissimilar weld joint between austenitic 304L (N) stainless steel (SS) and martensitic 403 ss made by cast tungsten arc welding process has been checked. 12 mm thick plate of two material were joined using K type weld groove joint with straight edge on the 403ss side butter using ERNICr-3 filler wire for this study[5].

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as argon or helium and a filler metal is normally used. The foremost advantages of shielding gas: (i) gases prevent the weld area from atmosphere, (ii) the heat is transmit from electrode to metal, (iii) it is a steady process[6]. Gas Tungsten Arc Welding Process gives the strong weld pool geometry that plays an important role to describe the chemical and mechanical properties of the weld[7].

EXPERIMENTAL

Stainless steel (AISI type 304L) weld plates were prepared with the dimension of 250 x 240 by x 10 mm. Edge preparation was carried out provided bevel angle of 35°C. The plate were butted (Tacked) together to form a single V groove with a include angle of 75 degree. A root gap was maintained 1.6 to 2 mm a land was provided 0.5 to 1 mm. The plate was rigidly fixed into the welding table by suitable fixtures, since the thickness of plate is 6 mm, to prevent the distortion of the plate during welding due to residual stress. The plates were welded with Gas tungsten arc welding (GTAW) process. The arc current of 50 and 80 Amps, maximum voltage of 12v were used in the present case. AWS ER308L filler wire of 1.6 and 2 mm diameter were used for the root pass and subsequent pass. Welding was in carried out 1G interpass temperature was maintained less or equal to 120°C. To avoid the inter granular corrosion, controlled travelling speed and heat input was maintained.

Table 2.1: Chemical composition and mechanical properties of stainless steel (AISI type 304L)

AISI Type	Cr	Ni	C	Si	Mn	P	S
304L	18-20	8-12	<0.03	1.0	2.0	0.045	0.03
UTS (MPa)	0.2% YS (MPa)	Elongation %	Hardness rockwell (HRB)				
586	241	55	B80				

Table 2.2: Chemical composition of filler ER310L

Filler wire	Cr	Ni	C	Si	Mn	P	S	Mo	CU
ER 308L	19.71	9.4	0.018	0.31	1.75	0.024	0.015	0.08	0.11

RESULTS AND DISCUSSION

After the welding process, the welded plates were promoted to post weld heat treatment (PWHT) process. For the duration of the post weld heat treatment procedure, the following successions were chased.

Loading temperature	:	Room temperature
Rate of heating	:	100°C/ hr
Rate of cooling	:	100°C/hr
Soaking temperature	:	680°C
Soaking time	:	1 hr

The main purpose of the post weld heat treatment process (PWHT) is stress relieving that means the homogeneous heating of arrangement to a enough temperature lower the critical array to reduce the main fraction of the residual stress followed by regular cooling. The heat treatment process cycle chart is herewith shown in the Fig. 1.

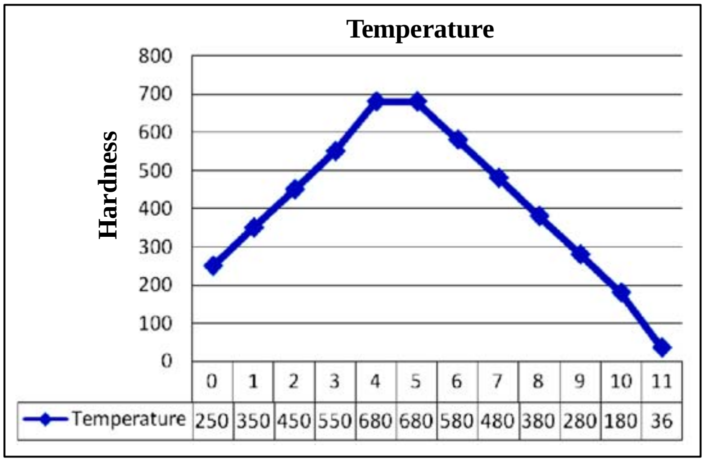

Fig. 1: Post weld heat treatment

Four number of root & face bend specimen are bent around 180° with mandrel diameter of 24 mm (4T) as per ASME section IX and carried out LPE. There was no evidence of defects were found and the same has acceptable. Fig. 2 shows the bent test specimen.

Fig. 2: Bend test specimens

Tensile test under room temperature were done to determine the mechanical properties of SS304L material. Tensile test provide information on the strength and ductility of materials under uniaxial tensile stresses. It may be useful in comparisons of materials; alloy development, quality control and design under certain circumstances.

Tensile strength of one joint was evaluated and selected the defect free region of 2 Numbers of transverse tensile testing specimens with ultimate breaking strength of 501 Mpa and 516 Mpa and found acceptable.

To determine the strength, the Hardness measurements were performed. The hardness profile was carried out were the different main areas of interest were identified such as base metal, fusion zone (FZ), HAZ. Hardness values are observed along the weld interface (weld, HAZ, & BM) are meeting the specification requirement of 92 HRB (maximum) & found acceptable.

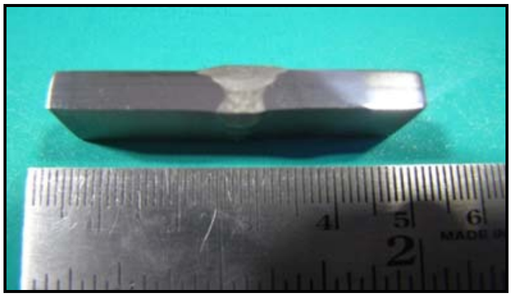

Fig. 3: Cross sectional view of weld specimen for micro structure

The properly solution annealed austenitic structure as per ASTM A 262 is observed in the base metal. Fig. 4 shows the microstructure of the base material.

Fig. 4: Micro structure of base metal

The welded micro structure Fig. 5 reveals dendritic structure with predominantly. Fine diffusion of carbides with austenite is dentrite. These carbides precipitate because the alloy rich austenite can no longer accommodate all the W and Mo left by the pre existing ferrite. This is also because of the reaction that both base metal (304L) and filler metal (ER 308L) are of extra low carbon version with controlled welding parameter.

Fig. 5: Micro structure of weld area

Heat affected Zone (HAZ) defined as a part base metal closed to weld fusion zone is metallurgical property affected due to heat of welding. HAZ micro structure with Inter dendritic structure with delta ferrite pool observed in the HAZ so the width of the HAZ is observed as 2-3 mm from weld fusion line. Fig. 6 shows microstructure of HAZ

Fig. 6: Micro structure of HAZ

Delta ferrite is otherwise known as high temperature ferrite with BCC structure in austenitic weld delta ferrite is required to resist hot cracking tendency. So ASME code specified that Delta ferrite should be 3 to 10 FN. If Delta ferrite exist 10 FN it forms a intermetallic compound known as sigma phase when expose to more than 500ºC and if Delta ferrite less than 3 FN which is in adequate to resist hot cracking.

Micro structure study has been carried on base metal, HAZ, WM to find adequacy, oxalic acid electrolytic etching as defined in practice A of ASTM 262 is carried out after properly polishing the Area of interest.

Delta ferrite measurement carried out across the weld interface found to be within the allowable limit of 10 FN (max) and found acceptable.

CONCLUSION

The subsequent conclusions can be drained from the outcomes:

The transformation from liquid to solid of ER308L weld metal is comparable to the principal austenite, and here is a phase arrangement, which holds dendritic. The microstructure of the ER309L weld metal embraces principal ferrite with a little austenite at the last part of transformation from liquid to solid which encloses skeleton ferrite.

Victorious weld of stainless steel (AISI type 304L) might be gained by the TIG welding process employing ER308L.

Ductile fracture with substantial quantities of plastic deformation has been experienced during the tension test in the TIG welding process. By this research work the corrosion resistance and mechanical properties of the welded material have been improved.

REFERENCES

1. G. Lothongkum, E. Viyanit and P. Bhandhubanyong, Study on the Effects of Pulsed TIG Welding Parameters on Delta-Ferrite Content, Shape Factor and Bead Quality in Orbital Welding of AISI 316L Stainless Steel Plate, J. Mater. Process. Technol., **110(2)**, 233-238 (2001).
2. S. C. Juang and Y. S. Tarng, Process Parameter Selection for Optimizing the Weld Pool Geometry in the Tungsten Inert Gas Welding of Stainless Steel, J. Mater. Process. Technol., **122(1)**, 33-37 (2002).
3. J. C. Borland and R. N. Younger, Some Aspects of Cracking in Welled Cr– Ni Austenitic Steels, Br Weld J., **7**, 22-59 (1960).
4. R. G. Baker, Weld Cracking – A Modern Insight, Br Weld J., **47**, 283-295 (1968).
5. Tao Bai and Kaishu Guan, Evaluation of Stress Corrosion Cracking Susceptibility of Nanocrystallized Stainless Steel 304L Welded Joint by Small Punch Test, Mater. Design, **52**, 849-860 (2013).
6. G. Vogt, Comparative Survey of Type of Loading and Specimen Shape for Stress Corrosion Test, Mater. Corros., **29**, 721-725 (1978).
7. R. N. Parkins, Development of Strain-Rate Testing and its Implications, ASTM STP 665: Stress Corrosion Cracking – The Slow Strain-Rate Technique (1979) pp. 5-24.

8. Jeya Jeevahan, G. Britto Joseph, G. Mageshwaran and N. Manikandan, Experimental Investigation of the Effect of Welding Current, Voltage and Gas Flow Rate on Welding Characteristics of Tig Welded s31603 Material, J. Chem. Pharmaceut. Sci., **9(2)**, 734-737 (2016).

9. G. B. Joseph, G. Mageshwaran, Kona Rajesh and Jeya Jeevahan, Study and Analysis of Welding of Dissimilar Metals 409 Stainless Steel and 439 Stainless Steel by TIG Welding, J. Chem. Pharmaceut. Sci., **9**, 1046-1050 (2016).

10. G. Mageshwaran, S. Ramachandran, G. Iyyappan and R. B. Durairaj, Experimental Investigation on Surface Radiation Properties Degradation of Solar Collector Receiver Tube Material, Int. J. Ambient Energy, Doi: 10.1080/01430750.2016.1202139 (2016).

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