INVESTIGATION OF DISSIMILAR MATERIAL TIG WELD FOR BOILER PANELS

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ABSTRACT

Super heater is an inevitable component of any boiler system and failure of super heater leads to breakdown of whole plant. The integration of efficient quality welding technologies for dissimilar metals will be a key component in the successful weld quality for power plant components. In this investigation, an attempt has been made to study the dissimilar material AISI304 and SA213T22 tungsten inert gas welding is performed under different welding conditions current (80, 100, 120 Amps), gas flow rate (5, 7, 9 ltr/min), speed (1.5, 2, 2.5 mm/sec) and micro structure analysis performed to find influence of fusion heat. The Taguchi analysis is implemented to obtain single response optimization used to attain the best yield strength, the ultimate strength and the elongation of the metals.

Keywords: AISI304; SA213T22, TIG Welding, Taguchi method, Grey Analysis

INTRODUCTION

Boilers are the key parts in control plants which create steam by productive consuming of accessible energizes. The productive and inconvenience free task of kettle is exceptionally pivotal to keep up. Lessened execution, monotonous disappointments in evaporator parts are regular issues identified with a kettle framework. Super radiator tube disappointment is extremely basic issue in boilers. Super warmer is essentially a warmth exchanger in which warm is exchanged from heater gas to the steam. These curls are comprised of composite steel SA213T22 which has consumption protection and it can't withstand persistent high temperature. The super-warmer curls are comprised of SA213T22 which can withstand up to 540°C metal temperatures and last stage super-radiator stream temperature of more than 565°C with the expansion in steam weight with their required disparate materials. AISI304 has better properties, for example, protection than flame side erosion and a stream temperature of 650°C for conclusive super-radiator (Halil 2013). Henceforth, the disparate materials are acquainted with decrease the harm and an exchange material AISI304 is endeavored to supplant this super warmed loop. The unique material welding isn't conceivable to influence a combination to weld and welding parameters are influencing the welding quality. The disparate materials welding have been consistently investigated and the related important examinations introduced by the past specialists are given underneath.

Ehsan Gharibshahiyan (2011) has examined the impact of welding parameters and warmth contribution on the HAZ and grain development, the part of grain estimate on hardness and sturdiness of low carbon steel has likewise been contemplated, it was watched that, at high warmth input, coarse grains show up in the HAZ which brings about lower hardness esteems in this zone. For instance raising the voltage from 20 to 30 V diminished the grain measure number from 12.4 to 9.8 and hardness diminished from 160 to 148 HBN. High warmth info and low cooling rates delivered fine austenite grains, bringing about the development of fine grained polygonal ferrites at encompassing temperature. Renping Wang et al (2011) numerically reproduced the transient temperature field amid laser welding of 304 stainless steels by utilizing FLUENT programming. A volumetric warmth source with gaussian dispersion was accepted. Wenchao Dong et al (2011) were explored the oxygen content is high, the weld shape is thin and profound as a result of the internal convection actuated by both the Marangoni compel and the electromagnetic power for various welding parameters. At the point when the welding rate or cathode hole builds, the temperature angle on the pool surface is diminished and the internal Marangoni convection is debilitated, which makes the weld D/W proportion diminish. Under the higher welding current, the internal convection incited by the electromagnetic power is reinforced and the higher weld D/W proportion is acquired. Under low oxygen content, the outward Marangoni convection is the principle convection mode in the weld pool and influences the weld to shape wide and shallow. The internal convection instigated by the electromagnetic power is contributive to the expansion of the weld profundity. The weld width feebly increments contrasted and the weld profundity. Accordingly, the weld D/W proportion marginally diminishes with the expanding welding parameters. Dongjie Li et al (2012) were researched the impact of two run of the mill weld pool shapes, wide-shallow and limited profound. Marangoni convection was thought to be the primary figure controlling liquid stream the fluid pool. Internal Marangoni convection drives the warmth motion to exchange from the edges of the weld pool to the middle and frame a profound and restricted weld pool shape. Changes in the welding parameters straightforwardly change the warmth input and the example of the Marangoni convection, along these lines controlling the state of the liquid pool. For the unadulterated Heshie lded TIG process, the outward Marangoni convection was debilitated with expanding oxygen content; in this way, theD/W proportion expanded somewhat. For the twofold protected TIG process, the convection was improved with expanding oxygen content over a specific range, up until the point that a lot of oxide was framed. The overwhelming oxide layer on the pool surface debilitates the inward bearing of Marangoni convection in order to influence the warmth stream liquid from the external part to the internal piece of weld pool surface, and mischief the welding proficiency. The twofold protected TIG process is a suitable strategy for including a dynamic component, for example, oxygen, into the weld pool in order to change the outward stream of Marangoni convection into an internal stream. This technique takes into consideration a more extensive scope of welding parameters to get a limited and profound weld pool. Ahmad et al (2012) explore the crawl harm plausibility was checked utilizing Larsan-Miller parameter related with essential super-warmer container of a power plant. Raghuvir Singh et al (2013) were completed explored the impact of TIG welding parameters like welding rate, current and transition on profundity of entrance and width in welding of 304L stainless steel has been contemplated. From the examination it was watched that motion utilized has the most huge impact on profundity of entrance took after by welding current. However Sio2 motion has more critical impact on profundity. Advancement was done to amplify entrance and having less globule width. A large portion of the scientists focus on the distinctive bearings however AISI304 over SA213T22 unique materials weld was not performed yet and henceforth it is critical to think about for the power plant segments. Considering every one of the focuses, in the present work, AISI304 to SA213T22 disparate materials, TIG welding is performed under various welding conditions.

I. EXPERIMENTAL DETAILS

The paper aims to investigate and identify key improvements in weld mechanical properties and the microstructural compounds of dissimilar metals. This information helps lay a baseline for TIG welding process specifications and also demonstrates the significant factors affecting the TIG welding processes on dissimilar metals. The materials selected for dissimilar welding are AISI304 and SA213T22 and the chemical composition is given in Table 1..

TABLE I

Chemical composition of the AISI304 and SA213T22

AISI304								
C	Cr	Fe	Mn	Ni	P	S	Si	Mo
0.08	19	70	2	10	0.045	0.03	1	-
SA213T22								
0.15	2.60	-	0.60	-	0.025	0.025	0.50	1.13

The electrode selected for similar welding is E309L whose dimension is 2.4m in length. The argon is used as gas and its pressure is 3.5 kg/cm^2 during welding. The affecting factors and level selected for dissimilar welding AISI304 and SA213T22 is given in Table 2 and the experimental results of yield strength, the ultimate strength, Vickers hardness and the elongation of the metals is given in Table 3

TABLE II

Factors and levels for similar and dissimilar welding

Factor/ Levels	Level 1	Level 2	Level 3
Current (Amps)	80	100	120
Gas Flow Rate (ltr/min)	5	7	9
Speed (mm/sec)	1.5	2	2.5

TABLE III

Experimental result for AISI304 to SA213T22

Trials	A	B	C	YS (MPa)	US (MPa)	EL (%)
1	1	1	1	573.20	625.80	17.50
2	1	2	2	447.50	635.32	27
3	1	3	3	365	569.45	14.50
4	2	1	2	429.90	660.60	20
5	2	2	3	314	511.62	29.50
6	2	3	1	370.20	594.65	13.50
7	3	1	3	433	655.81	30
8	3	2	1	396.80	571.96	17
9	3	3	2	400.10	599.47	18

II. TAGUCHI METHODOLOGY

Taguchi proposed that the engineering optimization of a process or product should be carried out in a three-step approach, that is, system design, parameter design, and tolerance design. In the system design, the engineer applies scientific and engineering knowledge to produce a basic functional prototype design. This prototype design includes the product design stage and the process design stage. The objective of the parameter design is to optimize the settings of the process parameter values to improve quality characteristics and to identify the product parameter values under the optimal process parameter values. In addition, it is intended that the optimal process parameter values obtained from the parameter design are insensitive to the variation of environmental conditions and other noise factors. Since the quality characteristic is to be maximization, the larger the better category is used to calculate the S/N ratio for responses Equation 1 shows the larger the better characteristic.

$$\text{S/N ratio } (\eta) = -10 \log_{10}\left(\frac{1}{n}\right)\sum_{i=1}^{n}\frac{1}{y_{ij}^{2}} \qquad (1)$$

Taguchi technique is used to find the optimum setting of dissimilar materials weld and experiments are conducted based on the L_9 orthogonal array. The aim function is maximization of the yield strength, ultimate strength and Elongation, so experimental results are converted to signal to noise ratio for reduction of variance using Eq.1. The signal to noise ratio yield strength, ultimate strength, and elongation is presented in Table 4. The Taguchi analysis for yield strength and ultimate strength is given Table 5,

TABLE IV
Signal to noise ratio for AISI304 to SA213T22 dissimilar metal weld

Trials	A	B	C	YS (MPa)	US (MPa)	EL (%)
1	1	1	1	55.1661	55.9287	24.8608
2	1	2	2	53.0159	56.0599	28.6273
3	1	3	3	51.2459	55.1091	23.2274
4	2	1	2	52.6673	56.3988	26.0206
5	2	2	3	49.9386	54.1790	29.3964
6	2	3	1	51.3687	55.4852	22.6067
7	3	1	3	52.7298	56.3356	29.5424
8	3	2	1	51.9714	55.1473	24.6090
9	3	3	2	52.0434	55.5553	25.1055

TABLE V
Taguchi Analysis: YS & US versus A, B, C

Level	YS			US			EL		
	A	B	C	A	B	C	A	B	C
1	53.14	53.52	52.84	55.70	56.22	55.52	25.57	26.81	24.03
2	51.32	51.64	52.58	55.35	55.13	56.00	26.01	27.54	26.58
3	52.25	51.55	51.30	55.68	55.38	55.21	26.42	23.65	27.39
Delta	1.82	1.97	1.53	0.34	1.09	0.80	0.85	3.90	3.36
Rank	2	1	3	3	1	2	3	1	2

TABLE VI
General Linear Model: Analysis of Variance for YS

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	12383.3	12383.3	6191.7	7.98	0.111
B	2	18686.9	18686.9	9343.5	12.05	0.077
C	2	9266.3	9266.3	4633.2	5.97	0.143
Error	2	1551.1	1551.1	775.6		
Total	8	41887.7				
S = 27.8487 R-Sq = 96.30% R-Sq(adj) = 85.19%						

TABLE VII
General Linear Model: Analysis of Variance for US

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	857	857	429	0.23	0.813
B	2	9308	9308	4654	2.51	0.285
C	2	4313	4313	2156	1.16	0.463
Error	2	3714	3714	1857		
Total	8	18192				
S = 43.0931 R-Sq = 79.58% R-Sq(adj) = 18.34%						

TABLE VIII
General Linear Model: Analysis of Variance for EL

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	6.22	6.22	3.11	0.10	0.911
B	2	139.39	139.39	69.69	2.19	0.314
C	2	116.22	116.22	58.11	1.82	0.354
Error	2	63.72	63.72	31.86		
Total	8	325.56				
S = 5.64456 R-Sq = 80.43% R-Sq(adj) = 21.71%						

It clearly shows that the optimal welding parameters for maximization of yield strength is current set as 80 amps, gas flow rate 5 lit/min and welding speed set as 1.5 mm/sec. Optimal welding parameters for maximization of ultimate strength is current set as 80 amps, gas flow rate 5 lit/min and welding speed set as 2 mm/sec. The Taguchi analysis for Elongation is given Table 6, it clearly shows that the optimal welding parameters for maximization of Elongation is current set as 120 amps, gas flow rate 7 lit/min and welding speed set as 2.5 mm/sec. The objective of the dissimilar material weld AISI304 to SA213T22 is maximization of yield strength, ultimate strength and Elongation. This was termed as the larger the better type problem where maximization of the characteristic was intended. S/N Ratio was calculated for the responses using the larger the better formula Equations 1.

In this study, the analysis of variance is used to find the statistically significant welding parameters. The analysis of variance for yield strength is given in Table 9. It clearly shows that the gas flow rate most significantly affects the yield strength with F:P value of 12.05:0.077. The analysis of variance for ultimate strength is given in Table 10. It clearly shows that the gas flow rate most significantly affects the ultimate strength with F:P value of 2.51:0.285. The analysis of variance for elongation is given in Table 11. It clearly shows that the gas flow rate most significantly affects the elongation with F: P value of 2.19:0.314. The analysis of variance for Vickers hardness is given in Table 12. It clearly shows that current most significantly affects the Vickers hardness with F: P value of 5.76:0.148.

III. CONCLUSION

The function of the super heater coil is transfer heat energy, during transfer of high transfer damage happen in weld spot. So aim of the investigation is to study the performance of the dissimilar material AISI304 to SA213 T22 TIG welding the following are the outcomes

- Optimal TIG welding parameters for dissimilar material maximization of yield strength is current set as 80 amps, gas flow rate 5 lit/min and welding speed set as 1.5 mm/sec.
- Optimal TIG welding parameters for dissimilar material maximization of ultimate strength is current set as 80 amps, gas flow rate 5 lit/min and welding speed set as 2 mm/sec.
- Optimal TIG welding parameters for dissimilar material maximization of Elongation is current set as 120 amps, gas flow rate 7 lit/min and welding speed set as 2.5 mm/sec.

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