RESEARCH ARTICLE OPEN ACCESS

Process Parameter Optimization for Tensile Strength for Plasma Arc Welding of SS304

Harshal M. Pargaonkar*, S. R. Kulkarni**
**(PG student, Government Engineering College Aurangabad, Maharashtra*
*** Professor, Mechanical Engineering, Government Engineering College Aurangabad, Maharashtra, India*
Corresponding auther : Harshal M. Pargaonkar

ABSTRACT
The Joining of the Austenitic Stainless Steels is often used in the pressure vessels, chemicals and processing industries. The mechanical properties at the weld bead should also fulfill requirement of applicable code. Several process parameters interact in the complex manner resulting in direct or indirect influence on the mechanical properties. It is necessary to find out the optimum process conditions which are capable of producing desired weld quality. Therefore to achieve the typical tensile strength in Plasma Arc Welding (PAW) is the primary objective of this study. The parameters Current (I), Voltage (V), Wire feed (Wf) were optimized using Taguchi Orthogonal Array and Analysis of Variance (ANOVA) is used for the analysis. The optimum parameters observed are Current: 230A; Voltage: 28V; Wire feed: 740mm/min resulting UTS of 687.35 MPa for SS304 of 6mm thickness..

Keywords - Taguchi, ANOVA, PAW

Date of Submission: 20-05-2018 Date of acceptance:05-06-2018

I. INTRODUCTION

between a non-consumable electrode and the work piece (transferred arc) or between the electrode and the constricting nozzle (non-transferred arc).

Plasma arc welding (PAW) is an arc welding process similar to gas tungsten arc welding. The electric arc is formed between an electrode (which is usually but not always made of sintered tungsten) and the work piece. The key difference from GTAW is that in PAW, by positioning the electrode within the body of the torch, the plasma arc can be separated from the shielding gas envelope. The plasma is then forced through a fine-bore copper nozzle which constricts the arc and the plasma exits the orifice at high velocities (approaching the speed of sound) and a temperature approaching 28,000 °C (50,000 °F) or higher..

II. EXPERIMENTAL DESIGN

In order to optimize the tensile strength levels of parameter Current, Voltage and Gas flow are decided after pre experimentation done for various levels of these process parameters.

Parameter	Level 1	Level 2	Level 3
Current (A)	210	220	230
Voltage (V)	24	26	28
Wire feed (mm/min)	700	740	780

Table 1: Level of Process parameters

The experimentation was conducted for L9 orthogonal array. The plates were tacked first and then the sample number identification was done by itching sample number on the plate. The process parameters were written on the plate by means a permanent marker.

III. MATERIAL SPECIFICATIONS

Flat plates of SS 304 with dimension 300x150x6 mm are taken. The chemical composition is verified with the Material Test Certificate received with the material. Additionally PMI testing is done.

Figure 1: Raw material

BASE METAL	Chemical Composition								
	%C	%Mn	%Cr	%Ni	%Mo	%S	%P	%Si	%Fe
	0.061	0.83	18.14	8.02	-	0.002	0.041	0.43	Remaining

Table 2: Chemical composition of SS 304

IV. TESTING AND ANALYSIS OF RESULTS

The samples were tested for non destructive testing such as Visual Inspection, Dye Penetration Testing and Radiographic Testing> The reports are examined certified Level-II inspector and all the results are found satisfactory.

The tensile test was conducted with reference to standard ASTM A370-2017. Following are the obtained resultsFigure captions appear below the figure, are flush left, and are in lower case letters. When referring to a figure in the body of the text, the abbreviation "Fig." is used. Figures should be numbered in the order they appear in the text.

Sample no	Ultimate Tensile Strength in MPa
1	650.14
2	616.16
3	684.09
4	645.11
5	653.08
6	642.19
7	654.44
8	640.35
9	667.53

Table 3: Results of Tensile Test

Table captions appear centered above the table in upper and lower case letters. When referring to a table in the text, no abbreviation is used and "Table" is capitalized.

V. ANALYSIS OF RESULTS

Taguchi method uses a statistical measure of performance, called as signal-to-noise (S/N) ratio. The S/N ratio is a logarithmic function of desired output serves as objective functions for optimization. The S/N ratio is the ratio of the mean (signal) to the standard deviation (noise). This ratio is a measure of robustness used to identify control factors that reduce variability in a product or process by minimizing the effects of uncontrollable factors. The standard S/N ratios generally used are categorized as Nominal the best (NB), Lower the better (LB) and Higher the better (HB). The S/N ratio for each quality characteristic can be computed independently and regardless of the category of the performance characteristics, a larger S/N ratio corresponds to better quality characteristics

The analysis of the result was done by using Minitab17 software.

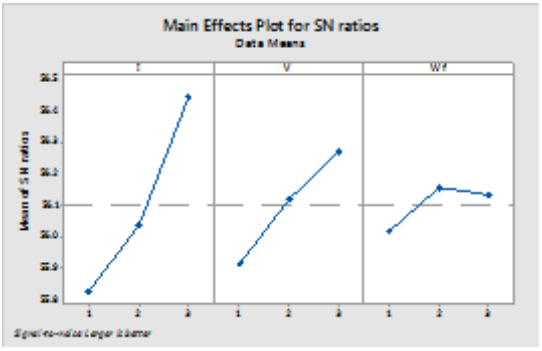

Figure 2: Means Plot for Tensile Test from MINITAB 17

Shows the variation of a particular factor away from the mean value. The more the deviation the greater is the effect of the factor on the response. Here current at level 3,Voltage at level 3,wire feed at level 2 observed to be most effective with the response Ultimate Tensile Strength.

ANOVA calculation for ultimate tensile strength

The analysis of variants was done using Minitab 17 software. Following results are obtained.

Source	DF	SS	Mean of Squares	F	% Contribution
Current	2	3247.4	1623.72	10.35	67.825
Voltage	2	1049.7	524.83	3.35	21.92
Wire feed	2	177	88.49	0.56	3.69
Error	2	313.8	156.89		
Total	8	4787.9			

Table 4: ANOVA results

From the above results It can be seen that the Current being most dominant factor with percentage contribution of 67.825%, followed by Voltage with 21.92% and Wire feed with 3.69% contribution on ultimate tensile strength.

Regression Analysis

The regression model for the tensile strength is calculated from software MINITAB 17.

UTS = -109 + 2.282 I + 6.59 V + 0.100 W_f

The calculations are done for Predicted values of Ultimate Tensile stress are done and observed against the actual values of UTS. We could get following graphical relation

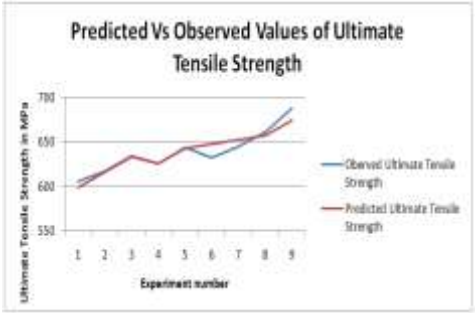

Figure 3: Predicted Vs Observed values of UTS

Confirmation of Experiments

The confirmation of experiment is done with the process parameters Current:230A, Voltage 28V and wire feed 740 mm/min.

Three samples were welded on the same parameter setting and the samples were tested.
The testing results were as follows.

	Sample 1	Sample 2	Sample 3
Observed Value of UTS(MPa)	686.14	680.33	682.68
Predicted Value UTS(MPa)	674.38		

Table 5: Confirmation Test Results

VI. CONCLUSION

The present work is concerned determining the optimum parameters for tensile strength for Plasma Arc Welding.

After the experimentation it was observed that the maximum tensile strength is achieved 687.53 MPa for the current as 230A, voltage as 28V and wire feed as 740 mm/min.

These results are confirmed by confirmation test taken on three samples for which tensile strength was found to be 686.14, 680.33, 682.68 MPa

The ANOVA analysis gives result that the current is the most dominant factor for tensile strength with 67.825% contribution followed by voltage with 21.92% contribution.

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to my guide Prof. S. R. Kulkarni for her valuable guidance and constructive suggestions for the completion of this work

I am also grateful to our Principal Dr. P. B. Murnal and Head of Department of Mechanical Engineering Dr. S. B. Chikalthankar for their constant encouragement and motivations..

REFERENCES

[1]. G.Magudeeswaran, Sreehari R. Nair,L.Sundar,N. Harikannan "Optimization of process parameters of the activated tungsten inert gas welding for aspect ratio of UNS S32205 duplex stainless steel welds'' Elsevier 25 July 2014.

[2]. P.Bharatha, V.G. sridharb, M. Senthil Kumar,''Optimization of 316 stainless steel weld joint characteristics using taguchi technique'', 12th Global Congress on Manufacturing and Management, GCMM 2014, Procedia engineering 97 (2014), pp.881 – 891.

[3]. Z.h.Rao,S.M.Liao and H.L.Tsai studied "Effects of shielding gas compositions on arc plasma and metal transfer in gas metal arc welding" journal of applied physics 107,0044902(2010)

[4]. Ugur Esme, Melih Bayramoglu, Yugut Kazancoglu, Sueda Ozgun, ''optimization of weld bead geometry in tig welding process using grey relation analysis and taguchi method", MTAEC9, 43(3)143(2009), ISSN 1580-2949, pp.143-149.

[5]. S.M.Ahir,N.B.Patel,K.A.Patel,''Experimental Investigation of welding distortion of Austenitic Stainless Steel 316 in TIG Welding'', IJARIIE, Vol. 1 Issue 2, 2015, ISSN 2395-4396, pp.123-129

[6]. Vedprakash Singh, Vijay Patel, 'Experimental investigation of GTAW for austenitic stainless steel using DOE'', International Journal for Technological Research in Engineering Vol.1, Issue 9, May 2014, ISSN (Online): 2347-4718, pp.991-995

[7]. Vijay Gohel, Jatin Makwana, Riteshkumar Ranjan, ''Optimization of process parameter for tensile strength and hardness of S.S 304 by TIG welding'', International Journal of Engineering Development and Research, Vol. 4, Issue 2,2016, ISSN: 2321-9939, pp.756-760.

[8]. 8] Prashant S. Lugade, Manish J Deshmukh, ''Optimization of Process Parameters of Activated Tungsten Inert Gas (A-TIG) Welding for Stainless Steel 304L using Taguchi Method'', International Journal of Engineering Research and General Science, Vol. 3, Issue 3, May-June, 2015, ISSN 2091-2730, pp.854-860.

[9]. J.Pasupathy, V.Ravisankar, C. Senthilkumar, "Parametric Optimization of TIG Welding of Galvanized Steel with AA1050 Using Taguchi Method", International Journal of Science and Research(IJSR), Volume 3, Issue 5, May 2014, ISSN 2319-7064, pp.1011-1015

[10]. Mallikarjun Kallimatha, G Rajendrab , S. Sathish, ''TIG Welding Al6061 using Taguchi and Regression analysis methods'', International Journal of Engineering Research ISSN:2319-6890)(online), Volume No.3 Issue No: Special 1, 22nd March 2014 pp.151-154

[11]. J.Pasupathy, V.Ravisankar, C. Senthilkumar, "Parametric Optimization of TIG Welding of Galvanized Steel with AA1050 Using Taguchi Method", International Journal of Science and Research(IJSR), Volume 3, Issue 5, May 2014, ISSN 2319-7064, pp.1011-1015.

[12]. NirmalendhuChoudhury,AsishBandyopadhya y, Ramesh Rudrapati, ‘‘Design optimization of Process Parameters for TIG Welding based on Taguchi Method’’, International Journal of Current Engineering and Technology, February 2014, E-ISSN 2277 – 4106, pp.12-16.

[13]. Arun Kumar, Srirangan, Sathiya Paulraj, ‘‘Multi-response Optimization of Process Parameters for TIG Welding of Incoloy 800HT by Taguchi Grey Relational analysis’’, Engineering Science and Technology, an International Journal (2015),pp.1-7 references are included. Each reference is referred to in the text by a number enclosed in a square bracket

Harshal M. Pargaonkar "Process Parameter Optimization for Tensile Strength for Plasma Arc Welding of SS304 " International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.6, 2018, pp.16-19