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Parametric Study of the TIG Welding Parameter for SS317L Steel

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Abstract: In this research work the experimental investigation of TIG welding process on ss317 alloy pipe with different process parameter viz. Welding current, voltage, and gas flow rate with L-9 orthogonal array design of experiment. Bending and Tensile test are performed for all 9-test sample as an output parameter. Optimization of process parameter is done via ANOVA and Taguchi method using MINITAB 18 software.
The optimum values of input parameter for tensile strength during TIG welding are 65A current,25V voltage, and 16 lit/s Gas flow rate and for Bending strength the optimum input process parameter are 60A current, 25V voltage, and 16 lit/s Gas flow rate. It has been observed that welding current affects the tensile strength maximum 77.92% followed by voltage 11.18 %. GFR has minimum affect only 7.10% and It can be also observed that voltage affect the Bending strength maximum 37.129% followed by GFR 32.21%. Welding current has minimum affect only 18.06%. The paper ends with a comparison of optimum process parameter of Taguchi and ANOVA method.
Keywords: TIG welding, SS317, optimization, Tensile strength, Taguchi and ANOVA method.

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I. INTRODUCTION

Aluminum composite has good mechanical characteristic (better strength, light weight, etc.) hence they are used in aerospace, automobile industries, defense etc. [1]. Welding is the method of joining of two similar or dissimilar metal or alloy joins together with the application of heat, pressure or both [2].

Tungsten inert gas welding (TIG) was developed by Russel Meredith which was used for the welding of magnesium in year 1941 [3]. In TIG welding process electrode is made of Tungsten which is non consumable one weld is protected by flow of inert gases [4]. A filler rod may be fed to arc zone [5].

A shielding of inert gas most commonly used argon and helium. Inert gas is utilized for the avoid the atmospheric contamination of the weld pool [5]. Heat input parameter play significant role on the cooling rate; bead size and mechanical properties of the weld [6]. TIG weld quality is unequivocally portrayed by the weld pool geometry on the because the weld pool geometry plays a significant role to deciding the mechanical properties of weld [7-8].

Singh et.al 2017 [1] utilized Activated Flux TIG (ATIG) welding process for joining of P91 Steel (Ferritic Steel) plates. Initiating transition (a meager layer) is applied along the line on the outside of the material where the welding is to be completes in this procedure. Jadon et.al 2017 [2] carried out bead on plate welds for Mild Steel and AISI 409 platesutilizing Gas tungsten arc welding (GTAW) technique.

Sharma et.al 2017 [3] In this paper optimization of TIG welding process parameters on Stainless Steel 347, 321 Stainless Steel by using various optimization methods like analysis of variance (ANOVA). Kanaiya et.al 2017 [4] this paper gives an overall view of the TIG welding process and its equipment. Hussein et.al 2016 [5] This exploration researches the procedure properties relationship of welded tube of mild steel (MS) with unique thickness by utilizing TIG welding.

II. EXPERIMENTAL STUDY

The raw material for this experiment is SS317L pipe. Table 1 describes the dimension of the selected plates. For this research work TIG welding machine TORNADO TIG 315 (figure 1) setup available at Rungtacollege of Engineering and Technology, Bhilai workshop. After the cutting the plates into 18 numbers of pieces the edge of plates is grinded. The input process parameters Welding current, voltage, and gas flow rate is set to the selected machine according to design of experiment table. The measured bending and tensile strength of sets of 9 welded plates is sown in table 2.

Table 1. Dimension of selected pipe

Outer diameter(mm)	13
Inner diameter (mm)	12.5
Thickness(mm)	0.5
Length of pipe (mm)	203.2
Number of pipes	18

Table 2.Chemical composition of SS317

Material	C	Mn	Si	Cr	Ni	Mo	P	S	N	Fe
SS316L Stainless steel	0.030	2.00	0.75	16.00-18.00	10.00-14.00	2.00-3.00	0.045	0.030	0.10	69.045

Fig. 1.Complete TIG welding set up

III. ANOVA

ANOVA is a statistically based, objective decision-making tool for detecting any differences in the average performance of groups of items tested. ANOVA helps in formally testing the significance of all main factors and their interactions by comparing the mean square against an estimate of the experimental errors at specific confidence levels.

IV. OPTIMIZATION OF TIG WELDING PROCESS PARAMETERS

TIG welding experimental values are optimized using Taguchi orthogonal array and ANOVA and the effects of individual TIG welding process parameters on the selected quality characteristics are calculated separately

A. Effect on Tensile strength

To describe the effect of various input parameters (current, welding speed, GFR) on tensile strength the experiment is conducted using L-9 orthogonal array. S/N ratio of optimized tensile strength value is shown in table 3.

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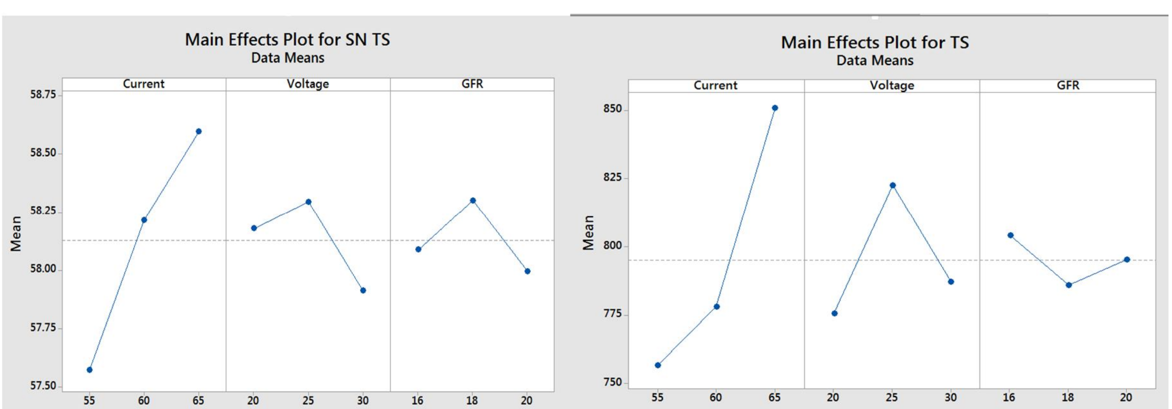
Table 3.Experimental data related to TIG Welding.

Exp No	Input parameter			Output parameter			
	Starting Welding current (A)	Welding speed (mm/s)	Gas flow rate(lit/sec)	Tensile Strength MPa	Bending Strength MPa	S/N ratio TS	S/N ratio BS
1	55	20	16	746.502	101.68	57.4606	40.1447
2	55	25	18	787.478	109.66	57.9247	40.8009
3	55	30	20	735.223	68.33	57.3283	36.6922
4	60	20	18	735.812	76.66	58.5452	37.6913
5	60	25	20	806.245	106.33	58.1293	40.5331
6	60	30	16	791.875	109.89	57.9731	40.8191
7	65	20	20	844.2	70.33	58.5289	36.9428
8	65	25	16	873.89	99.33	58.8291	39.9416
9	65	30	18	834.33	70.68	58.4324	36.9859

Table 4.ANOVA table of Tensile strength (S/N data)

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Current	2	1.61256	0.80628	20.66	0.046
Voltage	2	0.23152	0.11576	2.97	0.252
GFR	2	0.14711	0.07356	1.88	0.347
Error	2	0.07805	0.03903		
Total	8	2.06925			

It can be observed from the table 4 that welding current affect the Tensile strength maximum 77.92% followed by voltage 11.18 %. GFR has minimum affect only 7.10% and graph is shown in figure 3.



(a) (b)

Figure 3. (a)Effect of process parameters on Tensile strength (S/N data) (b) Effect of process parameters on tensile strength (Raw data)

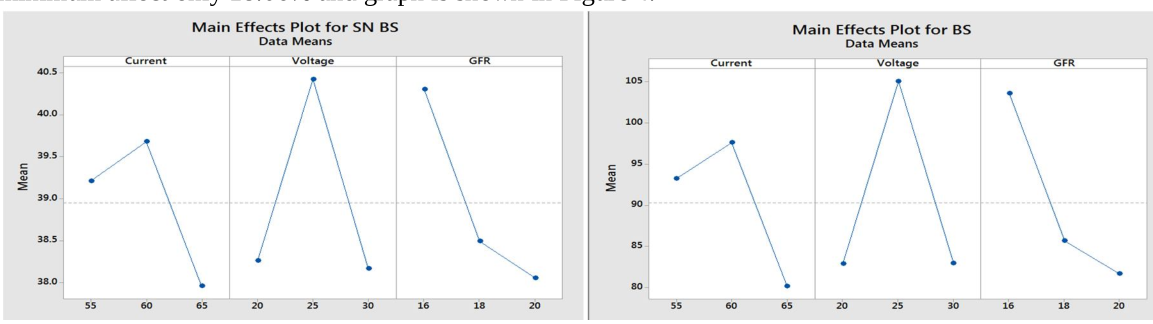
B. Effect on Bending Strength

To describe the effect of various input parameters (current, welding speed, standoff distance) on tensile strength the experiments are conducted using L-9 orthogonal array. S/N ratio of optimized tensile strength value are shown in table 5.

Table 5. ANOVA table for bending strength (S/N data)

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Current	2	4.770	2.385	1.44	0.411
Voltage	2	9.804	4.902	2.95	0.253
GFR	2	8.507	4.253	2.56	0.281
Error	2	3.324	1.662		
Total	8	26.405			

It can be observed from the table 5 that voltage affect the Bending strength maximum 37.129% followed by GFR 32.21%. Welding current has minimum affect only 18.06% and graph is shown in Figure 4.



(a) (b)

Figure 4. (a)Effect of process parameters on bending strength (S/N data) (b) Effect of process parameters on bending strength

V. CONCLUSION

This chapter provides the concluding remarks of the research work. In this research work the TIG welding process for steel 317 was carried out and through the study some important parameters were identified. These parameters are carefully altered through the design of experiment method. After that the optimization technique of ANOVA was implanted in order to get the better result for the output parameters. The change in parameters results in better welding tensile strength and bending strength.

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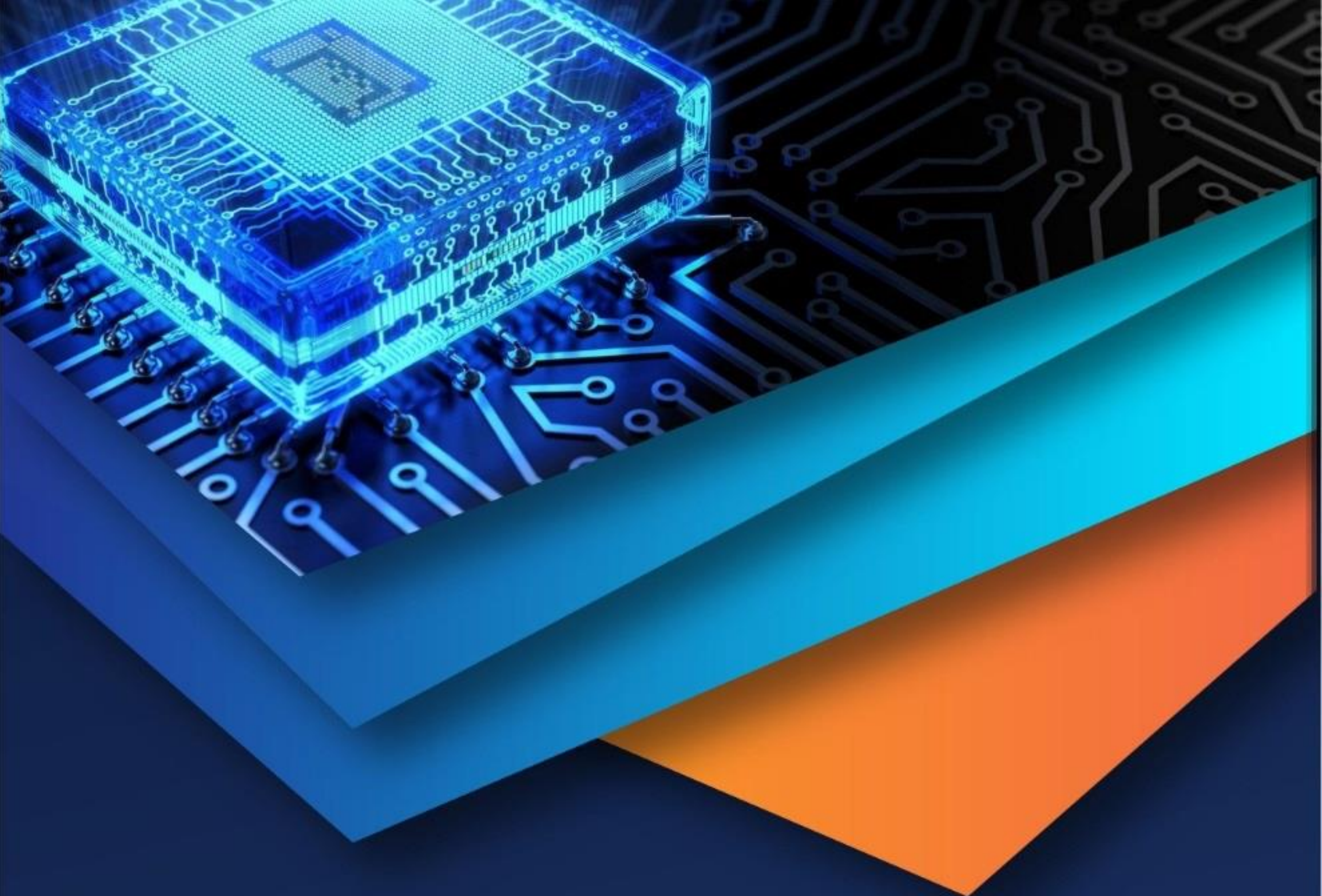

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