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Process Parameter Selection for Optimizing the Weld Pool Geometry of Stainless Steel (SS 202 & SS 316) of the TIG Welding using Taguchi Method

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Abstract: Tungsten Inert Gas welding is one of the widely used techniques for joining ferrous and non-ferrous metals. The TIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. In this study, SS 202 and SS 316 types of austenitic stainless steels were welded by GTAW (Gas Tungsten Arc Welding) using SS 202 and SS 316 (ER 316L) filler metals, respectively. The present study aims to search out the optimization of process parameters for Gas Tungsten Arc Welding (GTAW).The process parameters like welding current, wire diameter, shielding gas, and groove angle were varied at three different levels to find out the influence of parameters on weld bead geometry, i.e., weld bead width and weld bead height. To consider these quality characteristics together in the selection of process parameters, Taguchi method has been adopted to analyze the effect of each welding process parameter on the weld pool geometry and then to determine the process parameters with the optimal weld pool geometry. From the results, it observed that 'bead width for SS 202 and SS 316 tends to increase significantly with the increase in groove angle from 60^0 to 90^0. Welding current and shielding gas were found to be the most significant factors leading to change in bead height for SS 202 and SS 316.
Keywords: GTAW; Austenitic Stainless Steels; Weld Bead Geometry; Taguchi Method

I. INTRODUCTION

Tungsten Inert Gas (TIG) welding which uses a non-consumable tungsten electrode and an inert gas for arc shielding, is a highly significant arc welding process. It is commonly used for welding hard-to-weld metals such as aluminum, stainless steel, magnesium and titanium [1]. TIG welding is a multi-objective and multi-factor metal fabrication technique, where Argon or Helium is used for shielding purpose. TIG weld quality is strongly characterized by the weld pool geometry because it plays a major role in determining the mechanical properties of the weld. Therefore, it becomes necessary to select the welding process parameters for obtaining an optimal weld pool geometry[2].Optimization of weld pool geometry has been attained by using TIG welding on a stainless steel plate by varying welding parameters, and results showed that 'smaller the better' quality characteristics are better utilized in the analysis of Signal-to-Noise ratio (S/N) and analysis of variance (ANOVA) [3]. A mathematical model has been developed to study the effects of process parameters on weld pool geometry in GTAW using ANOVA and found that wire feed rate, travel speed, and wire diameter are the main parameters that influence bead geometry in GTAW [4]. Investigation of Weldments obtained in stainless steel (304L and 316L) by GTAW yields better mechanical properties than by GMAW, i.e., yield strength, tensile strength, hardness and impact energy values of 304L and 316L stainless steels welded by GTAW are higher than that welded by GMAW [5]. It optimized SS 316L stainless steel and observed that Gas flow has a major impact and Bevel angle has the least impact in affecting the tensile strength [6]. Use of active flux, TiO_2 in GTAW increases the depth of penetration [7]. Peak current has the highest contribution in affecting the weld microhardness; grain size and HAZ width in the GTA Welded Aluminium Alloy 7039 [8]. Non-pulsed current weldments yield higher tensile strength values than pulsed current during GTAW for SS 304 metal [9]. The microstructure of weld metal structure shows the delta ferrite in a matrix of austenite steel 202 grade during GTAW [10].

II. EXPERIMENTAL DESIGN

Since the last four decades, there have been limitations in applying conventional experimental design techniques for industrial experimentation. Dr. Genichi Taguchi, a Japanese Engineer, established a new method known as orthogonal array design, which adds a new dimension to the conventional experimental design. Taguchi's DOEs are denoted by 'Labc' where 'La' refers to the orthogonal arrays of variables or design matrix, 'b' refers to the levels of variables and 'c' to the number of variables. Taguchi's method is a broadly accepted method of DOE which has proven in producing high-quality products at a subsequently low cost [11].

An advantage of the Taguchi's method is that it emphasizes on mean performance characteristic value close to the target value rather than a value within certain specific limits, thus improving the product quality. Results obtained from Taguchi's method are only relative, and it does not exactly indicate which parameter has the highest effect on the characteristic performance value [12]. Also, Taguchi's method is an off-line quality control method, where off-line refers to the fact that it is practiced away from or parallel to the production process. It is not intended to be applied while actual production is in progress [13]. The statistical tool Minitab is used for the construction of the array. With such an arrangement, completely randomized experiments can be performed [14]. Orthogonal Arrays provide a set of well-balanced minimum experiments, and Dr. Taguchi's S/N ratios help in data analysis and prediction of optimum results.

III. EXPERIMENTAL SETUP

Experiments were conducted on TIG welding Lincoln Electric Invertec 350V pro machine as shown in figure 1. The machine setup consists of the power source, machining base, welding torch, shielding gas cylinder, and filler rod. Direct Current Straight Polarity, i.e., the tungsten electrode and the workpiece are taken as cathode and anode respectively. Argon, Helium and their mixture are used to protect the weld pool from contaminants. A constant gas flow rate of 10 lit/min is maintained throughout the experimental runs.

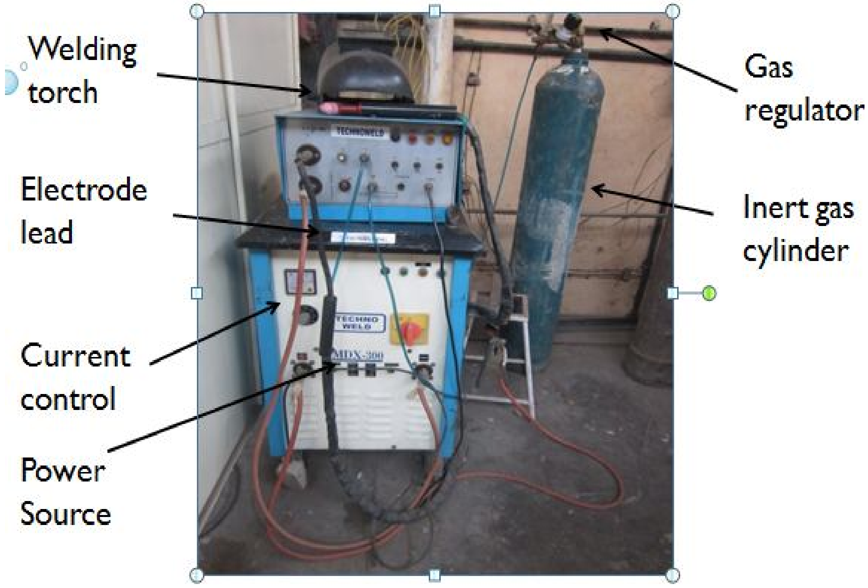

Figure 1: GTAW Setup (Courtesy: Paanchal Weld Workshop, Faridabad)

A. *Work Material*

SS 202 and SS 316 austenitic stainless steel with a chemical composition presented in Table 1 used in the experiment.

Table 1: Chemical Composition of Base Metals

Metal	Main Chemical Compositions									
	Fe	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
SS 202	73.182	0.065	0.35	9.54	0.05	0.008	14.99	0.035	0.38	1.4
SS 316	68.304	0.045	0.477	1.26	0.032	0.002	17.4	2.1	10.2	0.18

To evaluate the weld bead geometry of the austenitic stainless steel weldments, test specimens having dimensions of 100 x 50 x 6 mm^3 with a V-shaped groove (having different angles) is used.

B. *Filler Wire*

Filler wires chosen for welding the two grades of stainless steel SS 202 and SS 316 are same as that of base metal, i.e., SS 202 and SS 316 (ER 316L) respectively. However, filler metals melt at a temperature lower than that of the base metal. Therefore it yields during cooling since it remains more plastic than the base metal and relieves the contraction stresses that might cause cracking. The chemical composition of filler metals is listed in Table 2.

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Table 2: Chemical Composition of Filler Metals

Metal	Main Chemical Compositions									
	Fe	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
SS 202	Bal.	0.12	0.9	9.0	0.06	0.008	16.0	0.2	1.0	0.70
SS 316 (ER 316L)	Bal.	0.008	0.7	1.75	0.03	0.03	18.5	2.7	12	0.20

C. *Process parameters*

In this study, the Experimental plan has four variables namely current, groove angle, filler wire diameter and shielding gas and they vary in range as:

Current (100A-200A), Groove angle (60°-90°), Filler diameter (1.6mm-2.4mm) with Shielding gas. Selected parameters in levels during the study, are listed in Table 3.

Table 3: Process Parameters and three levels for the TIG Welding

S.No.	Parameter	Units	Symbol	Levels		
				1	2	3
1.	Welding current	Ampere	I	100	150	200
2.	Grove Angle	Degree	ϴ	60^0	75^0	90^0
3.	Electrode diameter	mm	E	1.6	2	2.4
4.	Shielding Gas	--------	G	Pure Argon	Pure Helium	50% Ar + 50%He

IV. EXPERIMENTAL PROCEDURE

In the present work, weld pool width and height of the specimen SS 202 and SS 316 grade steel welded by TIG welding method are evaluated. The number of factors chosen for study is 4, each at three levels. An L9 orthogonal Array TIG welding has been performed on SS 202 and SS 316 grade steel to complete the experiment. In welding process, the cut and v-grooved samples were welded at different values of current, gas flow rate and welding speed as per array to finish the nine experiments. The matrix of L9 with the actual value of parameters are shown in Table 4.

Table 4: Orthogonal array for experimentation on both SS202 and SS316 grade stainless steel

S. No.	Welding Current	Groove Angle	Electrode Diameter	Shielding Gas
1	100	60	1.6	1
2	100	75	2	2
3	100	90	2.4	3
4	150	60	2	3
5	150	75	2.4	1
6	150	90	1.6	2
7	200	60	2.4	2
8	200	75	1.6	3
9	200	90	2	1

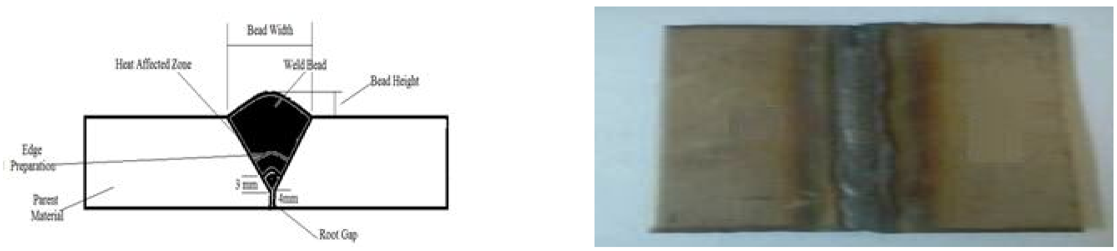

Figure 2 (a) schematic of bead geometry (b) Sample representation of weld bead on plate (with trial 1st conditions)

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After welding, the values of weld bead width and bead height is measured using Vernier caliper and height gauge, and these values are processed in ANOVA using Minitab software to optimize the results.

V. RESULTS AND DISCUSSION

In the present study weld bead width and weld bead height of the weld specimens were identified as the responses, therefore, "smaller the better" (SB) characteristic is chosen for analysis purpose. The response parameters, weld bead width, and bead height is a 'Smaller the better' (SB) case of SS 202 and SS 316 material respectively.
The S/N ratio with a lower-the-better characteristic can be expressed as:

$$\eta_{ij} = -10 \log\left(\frac{1}{n}\sum_{j=1}^{n} y_{ij}^2\right)$$

A. For SS 202

1) *Weld Bead width* :Table 5 drawn ahead shows the different observations made for calculating the average bead width and height. On trial, four reading for bead width and height were considered, and a find the average value for optimal value.

Table 5. Results of Bead Geometry for SS 202 material specimen

Exp. No.	Parameters	Bead width observations	Bead height observations	Avg. Bead width (mm)	Avg. Bead Height (mm)
1	I_1, Θ_1, D_1, G_1	8.10, 7.90, 7.70, 8.00	0.82, 0.90, 0.88, 1.22	7.925	0.955
2	I_1, Θ_2, D_2, G_2	8.84, 9.80, 8.80, 9.40	1.16, 0.70, 0.08, 0.80	9.21	0.685
3	I_1, Θ_3, D_3, G_3	11.8, 10.9, 11.38, 11.70	0.66, 0.56, 0.20, 0.15	11.445	0.3925
4	I_2, Θ_1, D_2, G_3	9.30, 9.00, 9.20, 9.60	0.92, 0.40, 0.50, 0.56	9.275	0.595
5	I_2, Θ_2, D_3, G_1	9.80, 8.70, 8.70, 8.70	0.78, 0.80, 0.66, 0.90	8.975	0.785
6	I_2, Θ_3, D_1, G_2	10.40, 10.60, 10.20, 10.60	0.77, 1.22, 0.82, 1.22	10.45	1.0075
7	I_3, Θ_1, D_3, G_2	9.90, 8.90, 8.20, 10.00	2.66, 2.48, 1.62, 1.42	9.25	2.045
8	I_3, Θ_2, D_1, G_3	11.58, 9.90, 10.90, 10.00	0.78, 0.32, 0.32, 0.42	10.595	0.46
9	I_3, Θ_3, D_2, G_1	11.60, 10.20, 11.70, 11.30	2.76, 2.88, 2.70, 2.86	11.2	2.8

Weld bead width of the weld pool belongs to the 'Smaller the Better' characteristics. Taguchi's method is applied, and analysis is done with the help of ANOVA. By data analyzed, graph of mean and Signal-to-Noise ratio
(S/N) is formed as shown in Figure 2 and calculated the value of analysis of variance and response table for mean and Signal-to-Noise Ratio are mentioned.

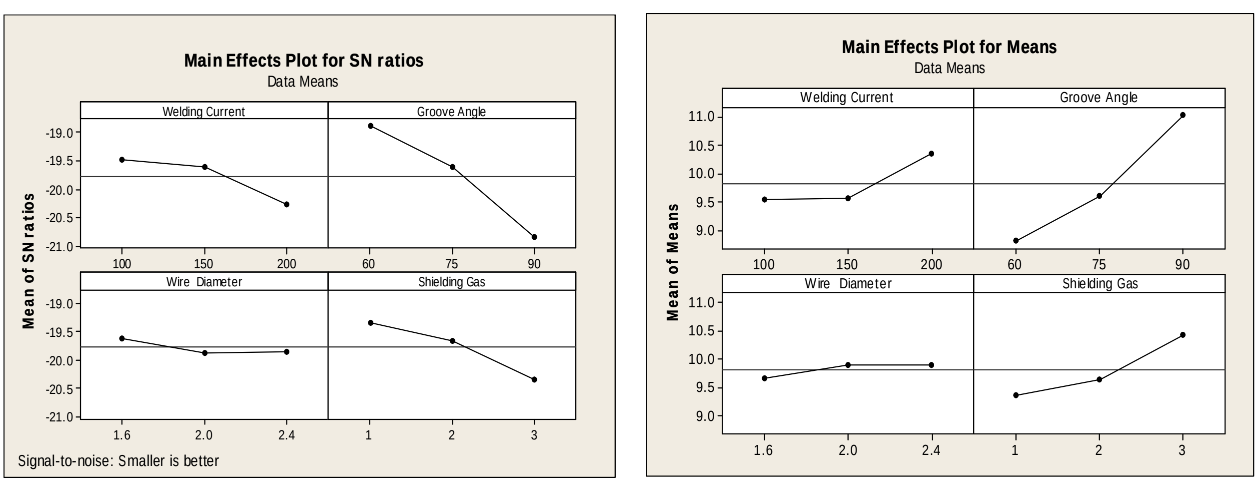

Figure 2: Main effects plot for S/N ratios and means for Weld Bead Width of SS 202 steel

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The plot for means for weld bead width shows that mean value increased with the increase in groove angle from 60^0 to 90^0 as shown and with the behavior of gas. In the case of S/N ratio, the S/N ratio decreased with the increase of groove angle and nature of gas as shown. The optimal results for means and S/N ratio of weld bead width are at groove angle 60^0, Shielding gas Ar, current at 100 amp, and a wire diameter of 2 mm.

Table 5: Analysis of variance for S/N ratio of Weld Bead Width for SS 202 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Current	Ampere	2	1.13515	0.56758	9.4502	19.0	13.0744
Groove	Degrees	2	5.87250	2.93625	48.8886	19.0	67.6382
Wire	mm	2	0.12011	0.06006	1.0	19.0	1.38340
Shielding Gas	………	2	1.55446	0.77723	12.9409	19.0	17.904
Total		8	8.68222				100
Pooled Error		2	0.12011	0.06006			1.38340

(SS= Sum of Square, F= F factor, PC = percent contribution, factor with least variance value is considered for error pooling)

Table 6: Response table for S/N ratio of Weld Bead Width for SS 202 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	-19.48	-18.89	-19.63	-19.35
2	-19.60	-19.63	-19.88	-19.68
3	-20.29	-20.85	-19.87	-20.35
Delta	0.81	1.96	0.25	1.00
Rank	3	1	4	2

Table 7: Analysis of variance for means of Weld Bead Width for SS 202 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Current	Ampere	2	1.2877	0.64387	11.572	19.0	11.8778
Groove Angle	Degrees -	2	7.5782	3.78912	68.1006	19.0	69.902
Wire Diameter	mm	2	0.1113	0.05564	1.0	19.0	1.0266
Shielding Gas	-------	2	1.8640	0.93202	16.7508	19.0	17.1945
Total		8	10.8413				100
Pooled Error		2	0.1113	0.05564			1.0266

Table 8: Response table for means of Weld Bead Width for SS 202 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	9.527	8.817	9.657	9.367
2	9.567	9.593	9.895	9.637
3	10.348	11.032	9.890	10.438
Delta	0.822	2.215	0.238	1.072
Rank	3	1	4	2

From above tables, It showed that groove angle has maximum effect and wire diameter has minimum effect on bead width. The results revealed that groove angle is a significant factor and an optimal value of (bead width) 8.817 mm is obtained and considered to be desired value.

2) *Weld bead height:* The graph of means for weld bead height shows that weld bead height largely depends upon shielding gas and welding current. Shielding gas with Ar-He mixture has a lower value of bead width. The welding current effect indicates that it increases from 100 A to 200 A as shown in figure 4.

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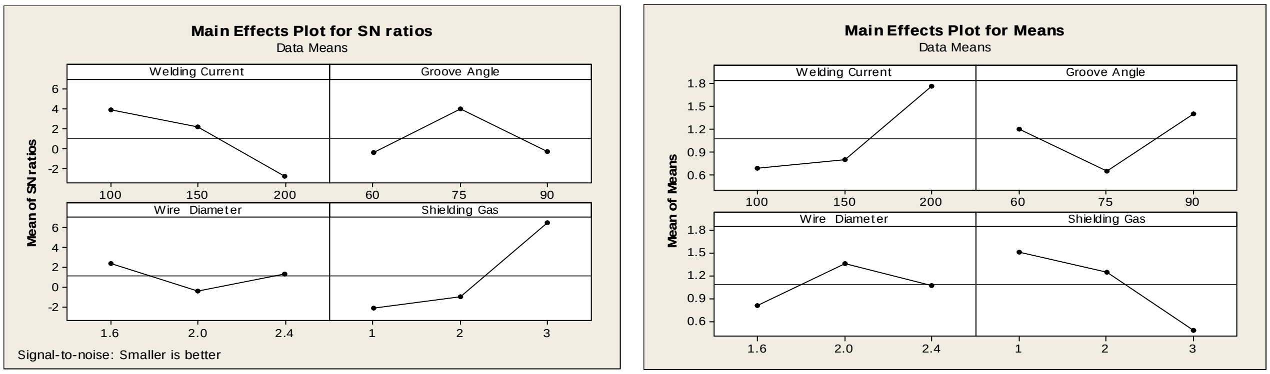

Figure 3: Main effects plot for S/N ratios and means for Weld Bead height of SS 202 steel

Table 9 Analysis of variance for S/N ratio of Weld Bead Height for SS 202 material

Source	Units	DOF	SS	Variance	F	F(critical)	PC
Welding Current	Ampere	2	65.814	32.9071	4.797	19.0	28.800
Groove Angle	--------	2	34.192	17.0961	2.555	19.0	14.964
Wire Diameter	L/min.	2	13.383	6.6913	1.0	19.0	5.856
Shielding Gas	Degrees	2	115.126	57.5628	8.603	19.0	50.380
Total		8	228.515				100
Pooled Error		2	13.383	6.6913			5.856

Table 10 Response table for SN ratio of Weld Bead Height for SS 202 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	3.0950	-0.7175	2.0322	-2.2029
2	1.9527	3.3967	-0.9373	-1.5608
3	-3.1267	-0.7582	0.8261	5.6848
Delta	6.2217	4.1550	2.9695	7.8876
Rank	2	3	4	1

Table 11 Analysis of variance for means of Weld Bead Height for SS 202 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Welding	Ampere	2	2.14968	1.07484	4.693	19.0	40.979
Groove Angle	--------	2	0.92124	0.46062	2.011	19.0	17.561
Wire Diameter	L/min.	2	0.45807	0.22903	1.0	19.0	8.732
Shielding Gas	Degrees	2	1.71685	0.85843	3.748	19.0	32.728
Total		8	5.24583				100
Pooled Error		2	0.45807	0.22903			8.732

Table 12 Response table for means of Weld Bead Height for SS 202 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	0.6775	1.1983	0.8075	1.5133
2	0.7958	0.6433	1.3600	1.2458
3	1.7683	1.4000	1.0742	0.4825
Delta	1.0908	0.7567	0.5525	1.0308
Rank	1	3	4	2

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Analysis of variance for S/N ratio shows that percentage contribution of shielding gas has a maximum contribution, i.e., 50.38 % and wire diameter has a minimum contribution of 5.85 % is shown in Table 10. Analysis of variance for mean indicates that percentage contribution of welding current has a maximum contribution, i.e., 40.97 % and wire diameter has a minimum contribution of 8.73 % is shown in Table 12. The results demonstrated that an optimal value of 0.48 mm is obtained and is considered to be the more desirable.

B. For SS 316

1) *Weld Bead width:* Table 14 drawn ahead shows the different observations made for calculating the average bead width and height. On an average four reading for bead width and height were taken as explained earlier and find the optimal value.

Table 14**.** Results of Bead Geometry for SS 316 material specimen

Exp. No.	Parameters	Bead width observations	Bead height observations	Avg. Bead width (mm)	Avg. Bead Height (mm)
1	I_1, Θ_1, D_1, G_1	8.30, 7.84, 8.20, 8.00	0.23, 0.31, 0.32, 0.34	8.085	0.30
2	I_1, Θ_2, D_2, G_2	10.60, 10.40, 10.10, 10.90	1.90, 1.26, 1.50, 1.60	10.50	1.565
3	I_1, Θ_3, D_3, G_3	9.40, 10.70, 10.10, 10.60	0.56, 0.54, 0.38, 0.70	10.20	0.545
4	I_2, Θ_1, D_2, G_3	8.30, 8.00, 7.80, 6.50	1.70, 1.80, 1.28, 1.44	7.65	1.555
5	I_2, Θ_2, D_3, G_1	9.90, 8.90, 9.60, 10.00	1.68, 0.84, 0.74, 1.08	9.60	1.085
6	I_2, Θ_3, D_1, G_2	10.20, 10.00, 10.00, 9.40	1.44, 1.84, 2.42, 1.74	9.90	1.86
7	I_3, Θ_1, D_3, G_2	11.80, 9.41, 11.60, 10.00	2.20, 2.60, 1.70, 1.10	10.702	1.9
8	I_3, Θ_2, D_1, G_3	9.40, 8.70, 9.30, 9.00	0.84, 0.94, 1.36, 1.86	12.636	1.25
9	I_3, Θ_3, D_2, G_1	10.90, 11.90, 11.40, 11.30	1.58, 1.41, 1.33, 1.71	10.32	1.507

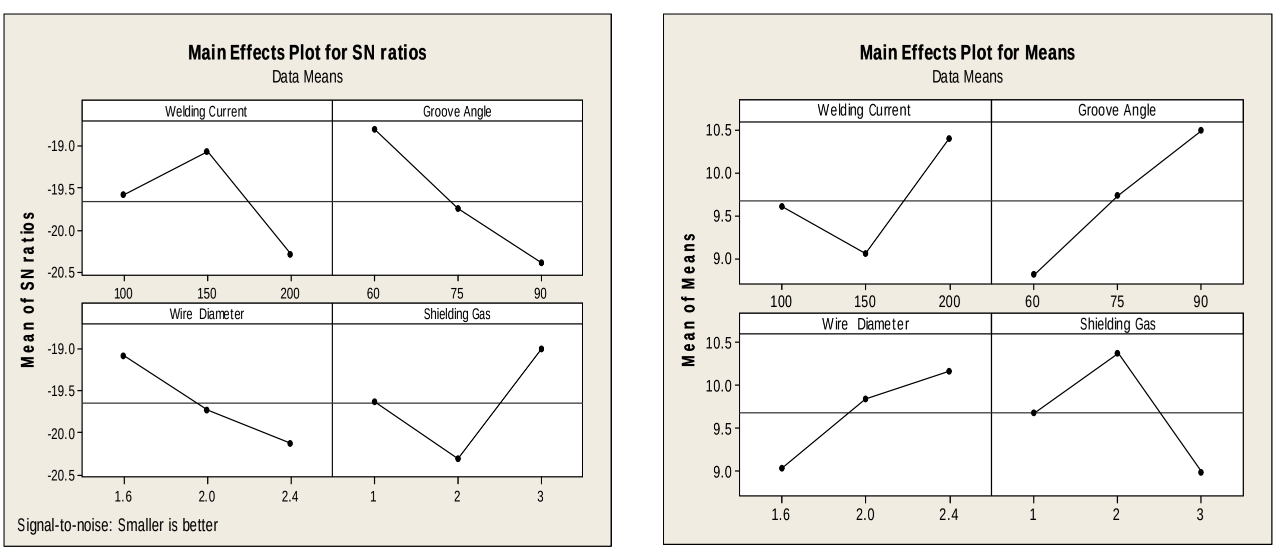

Figure 4 Main effects plot for S/N ratios and means for Weld Bead Width of SS 316 steel

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Plots for means show that bead width decreases with the decreasing groove angle from 90^0 to 60^0 and a minimum value of bead width is obtained at 60^0 groove angle, 1.6 mm diameter, and 150 A current with Ar-He (mixture) shielding gas. Analysis of variance and response table for S/N ratio and means are shown in below Table:

Table 13: Analysis of variance for S/N ratio of Weld Bead Width for SS 316 material

Source	Units	DOF	SS	Variance	F	F(critical)	PC
Current	Ampere	2	2.2564	1.12819	1.288	19.0	21.893
Groove Angle	--------	2	3.7659	1.88297	2.150	19.0	36.539
Wire Diameter	L/min.	2	1.7514	0.87570	1.0	19.0	16.993
Shielding Gas	Degrees	2	2.5329	1.26645	1.446	19.0	24.575
Total		8	10.3066				100
Pooled Error		2	1.7514	0.87570			16.993

Table 14: Response table for S/N ratio of Weld Bead Width for SS 316 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	-19.59	-18.83	-19.09	-19.64
2	-19.09	-19.76	-19.75	-20.32
3	-20.31	-20.41	-20.16	-19.03
Delta	1.22	1.58	1.07	1.30
Rank	3	1	4	2

Table 15: Analysis of variance for means of Weld Bead Width for SS 316 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Welding	Ampere	2	2.7353	1.36767	1.324	19.0	22.952
Groove Angle	--------	2	4.2426	2.12130	2.054	19.0	35.600
Wire Diameter	L/min.	2	2.0654	1.03269	1.0	19.0	17.331
Shielding Gas	Degrees	2	2.8741	1.43706	1.392	19.0	24.117
Total		8	11.9175				100
Pooled Error		2	2.0654	1.03269			17.331

Table 16: Response table for means of Weld Bead Width for SS 316 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	9.595	8.813	9.028	9.687
2	9.050	9.733	9.842	10.368
3	10.393	10.492	10.168	8.983
Delta	1.342	1.679	1.139	1.384
Rank	3	1	4	2

From above tables, It showed that groove angle has maximum effect and wire diameter has minimum effect on bead width.

2) *Weld Bead Height:* From plots of means for weld bead height shows that bead height increases with the increased value of current from 100 A to 200 A and groove angle has negligible effect. With wire diameter bead height first, increases from 1.6 mm to 2mm and then decrease from 2mm to 2.4 mm. The analysis of variance and response tables for S/N ratio and means shows that Welding current and shielding gas has a maximum contribution on weld bead height.

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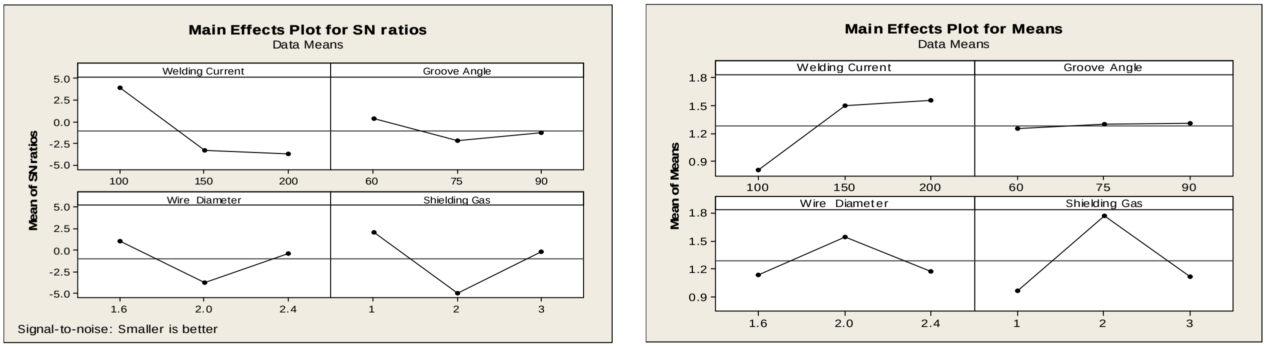


Figure 5 Main effects plot for S/N ratios and means for Weld Bead height of SS 316 steel

Table 17 Analysis of variance for means of Weld Bead Height for SS 316 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Welding Current	Ampere	2	115.290	57.6449	10.607	19.0	48.632
Groove Angle	Degrees	2	10.869	5.4347	1.0	19.0	4.585
Wire Diameter	mm	2	33.866	16.9332	3.116	19.0	14.286
Shielding Gas	--------	2	77.041	38.5205	7.088	19.0	32.497
Total		8	237.066				100
Pooled Error		2	10.869	5.4347			4.585

Table 18: Response table for S/N ratio of Weld Bead Height for SS 316 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	3.8263	0.1751	0.8204	1.8643
2	-3.5435	-2.5080	-3.8332	-5.1557
3	-3.9706	-1.3549	-0.6750	-0.3964
Delta	7.7970	2.6831	4.6536	7.0200
Rank	1	4	3	2

Table 19: Analysis of variance for means of Weld Bead Height for SS 316 material

Source	Units	DOF	SS	Variance	F	F (critical)	PC
Welding	Ampere	2	1.04935	0.524676	205.352	19.0	42.506
Groove Angle	--------	2	0.00511	0.002555	1.0	19.0	0.207
Wire Diameter	L/min.	2	0.30013	0.150067	58.735	19.0	12.157
Shielding Gas	Degrees	2	1.11411	0.557055	218.025	19.0	45.130
Total		8	2.46871				100
Pooled Error		2	0.00511	0.002555			

Table 20: Response table for means of Weld Bead Height for SS 316 material

Level	Welding Current	Groove Angle	Wire Diameter	Shielding Gas
1	0.8033	1.2517	1.1367	0.9642
2	1.5000	1.3000	1.5425	1.7750
3	1.5525	1.3042	1.1767	1.1167
Delta	0.7492	0.0525	0.4058	0.8108
Rank	2	4	3	1

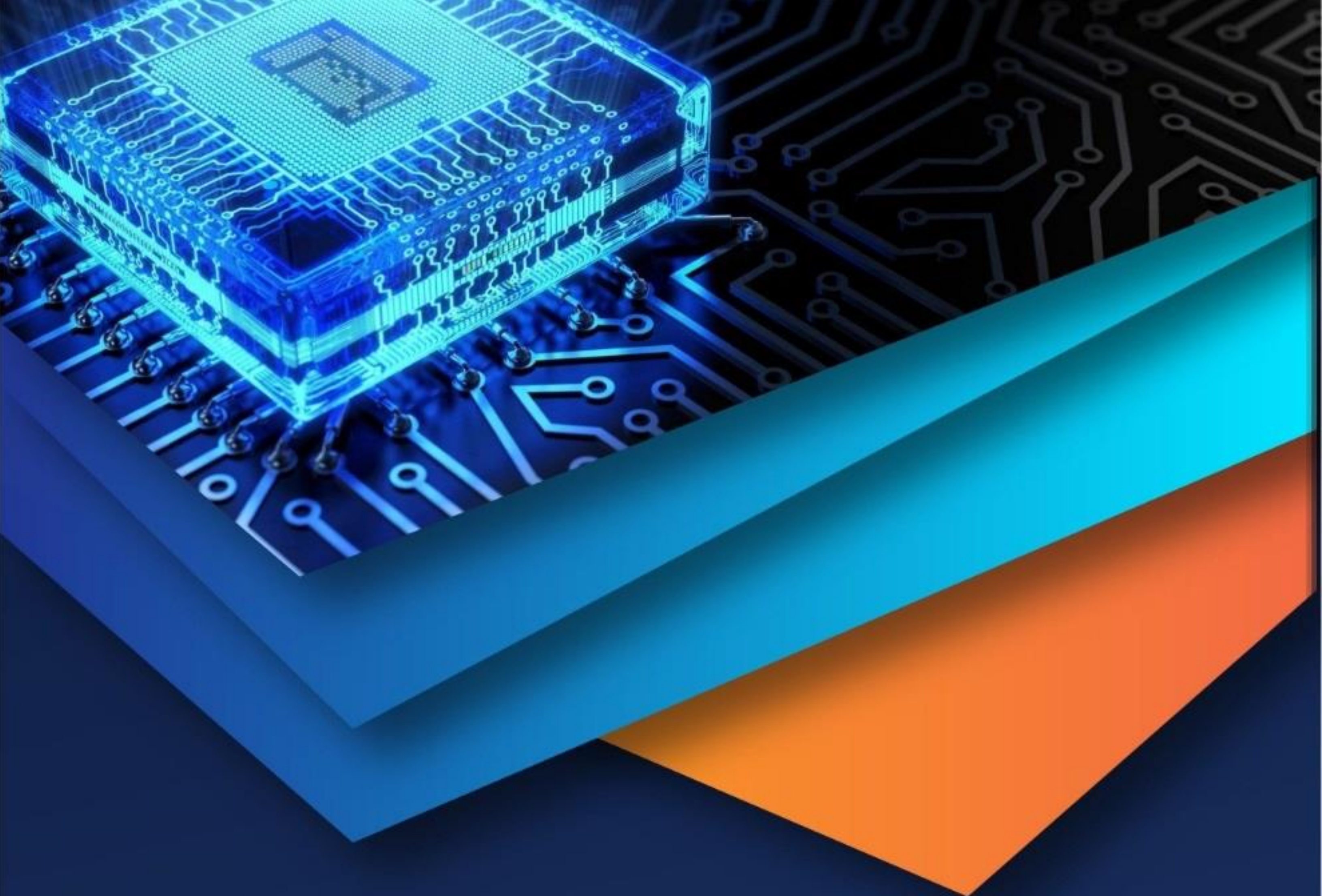
From above tables, It showed that welding current and shielding gas has maximum effect and groove angle has minimum effect on bead height. From response table of means, the optimal value of bead height is 0.8033 mm

VI. CONCLUSIONS

From the analysis of the results using the Signal-to-Noise ratio (S/N) approach and analysis of variance for means, the following points are observed: Bead width for SS 202 steel depends mainly on the Groove angle, and the value increases with increase in angle, and it also increased by using Ar-He gas which is not desirable. Bead height of SS 202 depends mainly on the Shielding Gas and Welding Current, and an Ar-He(50-50) mix with a lower value of current is desirable. The optimal value of bead width for SS 202 is 8.817mm. Bead width for SS 316 steel depends mainly on Groove angle and shielding gas used. It increases with increase in the value of Groove angle and is minimum at 60^0 groove angle. Bead height for SS 316 depends mainly on the Shielding Gas, Welding current and wire diameter used. The minimum value of bead width is for Ar gas at 100 Amp and with wire diameter 1.6 mm. Optimal value of bead height for SS 316 is 0.8033 mm

REFERENCES

[1] Cary, H.B. (1989). Modern Welding Technology. Prentice-Hall, Englewood Cliffs, NJ, fifth edition.
[2] Kumar, Pawan; Kolhe, K.P; Morey, S.J; & Datta, C.K. (2011). Process Parameters Optimization of an Aluminium Alloy with Pulsed Gas Tungsten Arc Welding (GTAW) Using Gas Mixtures. Journal of Material Processing Technology, 2, 2250-2257.
[3] Jaung, S.C; & Tarng, Y.S. (2002). Process parameter selection for optimizing the weld pool geometry in the tungsten inert gas welding of stainless steel. Journal of Material Processing Technology, 122, 33-37.
[4] Kumar, K. Ashok; Satish, G; Narayana, V.Lakshmi; & Rao, N. Srinivasa (2013). Development of Mathematical Model on Gas Tungsten Arc Welding Process Parameters. International Journal of Research in Engineering and Technology, 02,185- 193.
[5] Yilmiz, Ramazan & Uzun, Huseyin (2002). Mechanical Properties of Austenitic Stainless Steels Welded by GMAW and GTAW. Journal of Marmara for Pure and Applied Sciences, 18, 97-113.
[6] Chandrakant, Balaji; Kumar, S.V; A, Kumar; S. Ashwin; & Sathish, R. (2013). Optimization and Non-destructive Test Analysis of SS 316L Weldments Using GTAW. Materials Research.
[7] Randhawa, V.J; & Vikesh, N.M. Suri (2013). Effect of a TIG Welding process parameters on penetration in mild steel plates," International Conference on Mechanical and Industrial Engineering, New Delhi.
[8] C. A., Anoop; & Kumar, P. (2013) Application of Taguchi Methods and ANOVA in GTAW Process Parameters Optimization for Aluminium Alloy 7039, International Journal of Engineering and Innovative Technology (IJEIT), 2, 54-58.
[9] Raveendra, A; & Kumar, B.V.R.R (2013). Experimental study on Pulsed and Non-Pulsed Current TIG Welding of Stainless Steel Sheet (SS304), International Journal of Innovative Research in Science, Engineering, and Technology 2, 2337-2344.
[10] Mukesh; & Sharma, Sanjeev (2013). Study of Mechanical Properties in Austenitic Stainless Steel Using Gas Tungsten Arc Welding (GTAW), International Journal of Engineering Research and Applications, 3, 547-553.
[11] Kondapalli, S. P; Chalamalasetti, S. R; & Damera, N. R. (2013). Application of Taguchi based Design of Experiments to Fusion Arc Weld Processes: A Review. International Journal of Technology and Management ISSN 1927-9000, 2, 1-8
[12] Fraley, S., Oom; M., Terrien, B; & Date, J. Z. (2006). Design of Experiments via Taguchi Methods: Orthogonal Arrays, The Michigan Chemical Process Dynamic and Controls Open Text Book, USA.
[13] Ross, J.P. Taguchi technique for Quality Engineering, (McGraw-Hill, New York).
[14] Kwak, J.S. (2005). Application of Taguchi and response surface methodologies for geometric error in surface grinding process. International Journal of Machine Tools & Manufacture, 45, 327-334.



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