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Optimization of TIG Welding Process Parameters With SS316 Material Using Taguchi Design

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Abstract - *Tungsten Inert Gas welding is a popular method for connecting ferrous and nonferrous metals. In which a non-consumable tungsten electrode and workpiece form an arc, while argon shields the molten metal from the atmosphere. TIG welding will use to join 3 mm-thick SS316 sheets. Welding current, gas flow rate, and front/back width are the input/output parameters. The Taguchi method recommended orthogonal array design to assign experiment factors. 9 Taguchi L9 orthogonal array experiments will design. ANOVA and S/N ratio will use to optimize welding parameters. After analysis, front and back width control factors are most significant.*

Keywords: **Tig welding, Anova, Taguchi method, Minitab, Stainless Steel.**

1. INTRODUCTION

Welding fuses metals or thermoplastics, unlike brazing and soldering, which do not melt the base metal. This method is employed in sculpture and manufacture. The weld pool is formed by melting the base metal with filler material. The pool cools and produces a connection that may be stronger than the parent metal depending on the weld configuration (butt, complete penetration, fillet, etc.). Pressure alone or with heat can weld. Welding requires a barrier to prevent filler metal or molten metal contamination or oxidation. A welding junction is any point or edge that joins metal or plastic parts. Their shape depends on the geometry soldered between metal or plastic work pieces. The American Welding Society classifies joints as butt, corner, edge, lap, and tee. These layouts can vary at the welding spot.

2. OBJECTIVE

1. 1. For this experiment, I have chosen a 3mm thick SS316 sheet material.
2. Using a L9 orthogonal array, the Taguchi method was chosen.
3. Arrange for L9-Based Tig Welding Task
4. Locate the Welding Job's Output Parameters (Front Width, Back Width)
5. Use this study to optimise the process parameters by analysing their effect on the weld bead geometry.

3. TAGUCHI DESIGN

To improve process and product design, Taguchi is looking for easily controllable factors and their settings that reduce product response variability while maintaining a desired mean response. By adjusting those parameters to their sweet spots, we may make the product more resistant to variations in both operating and environmental circumstances. Removing the bed effect rather than the cause of the bed effect allows for more stable and high-quality goods to be obtained during the Taguchi parameter design stage. In addition, the method can save money and eliminate wasted goods by systematically applying it at the pre-production stage (off line), which means fewer tests are needed to determine cost-effective process conditions.

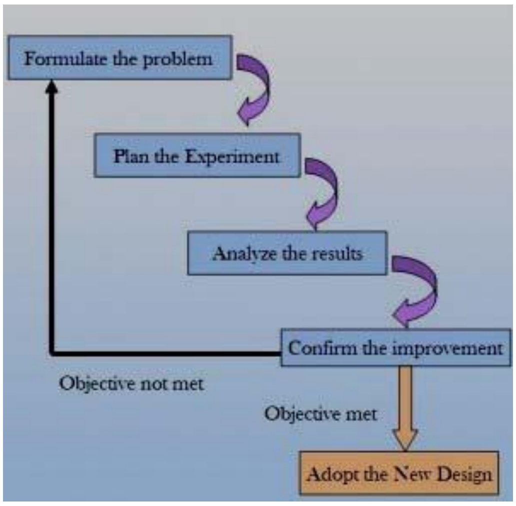

Fig-1: Pictorial views of Taguchi steps

4. SELECTION OF PROCESS PARAMETERS

After study the various research paper and we decide the

Input parameters

Factor A : Welding Current (A)
Factor B : Gas flow rate (LPM)

Parameter that remains constant

Work Piece Thickness

Output Parameter

Front width & Back width

Table-1: Process Parameter Level

Thickness	Parameters	L-1	L-2	L-3
3mm	Welding Current	70	80	90
	Gas Flow Rate	4	6	8

Table-2: Levels of the orthogonal array L9

Ex. No.	Welding Current	Gas Flow Rate	Plate Thick Ness
1.	70	4	3
2.	70	6	3
3.	70	8	3
4.	80	4	3
5.	80	6	3
6.	80	8	3
7.	90	4	3
8.	90	6	3
9.	90	8	3

5. EXPERIMENTAL WORK

5.1 Specimen Preparation

- The plates are prepared and then set on the workstation. They are made of stainless steel SS316 alloy and have dimensions of 60x40 mm and a thickness of 3 mm.
- The welding electrode must be held at a right angle to the surface being welded.
- The welding of the plates began with a single pass. The samples are fused together while maintaining the different parameters.

Fig-2: The SS316 material thicknesses used for the work piece

Test results for tig welding machine

Fig-3: welded work

Visual inspections are used to verify penetration after welding the work parts. Rejected specimens are those with inadequate penetration. By utilising a travelling microscope to measure the front and back widths, the impact of welding settings on bead geometry may be examined.

Table-3: Experiment

Ex. No.	Welding Current	Gas Flow Rate	Plate Thick Ness	Front Width	Back Width
1	70	4	3	5.10	4.42
2	70	6	3	5.06	4.66
3	70	8	3	4.31	4.77
4	80	4	3	5.83	5.98
5	80	6	3	5.45	4.52
6	80	8	3	4.81	4.33
7	90	4	3	8.49	4.46
8	90	6	3	8.20	4.00
9	90	8	3	6.14	4.41

6. RESULTS & DISCUSSION

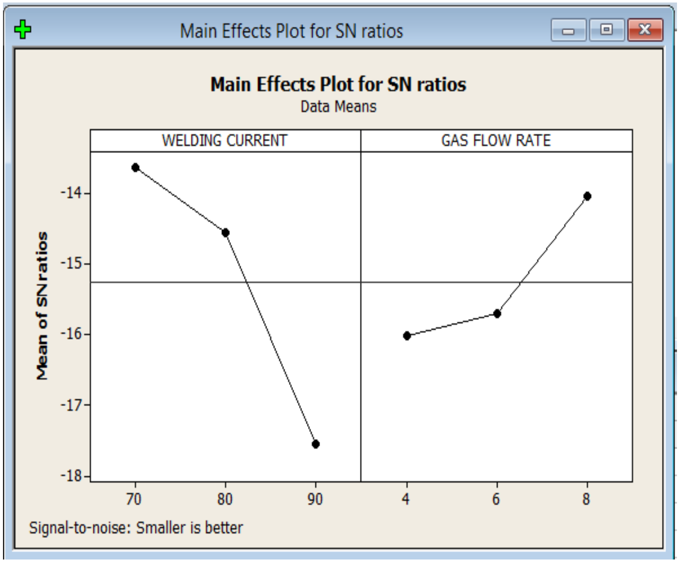

Fig-4: Analysis of the front width's main effect

Main plot effect for front width at 3 mm thickness at varying welding current and gas flow rate is shown above. At welding current 70 AMP and gas flow rate 8 LPM, the front width is minimum and at 90 AMP and gas flow rate 4 LPM, it is maximum.

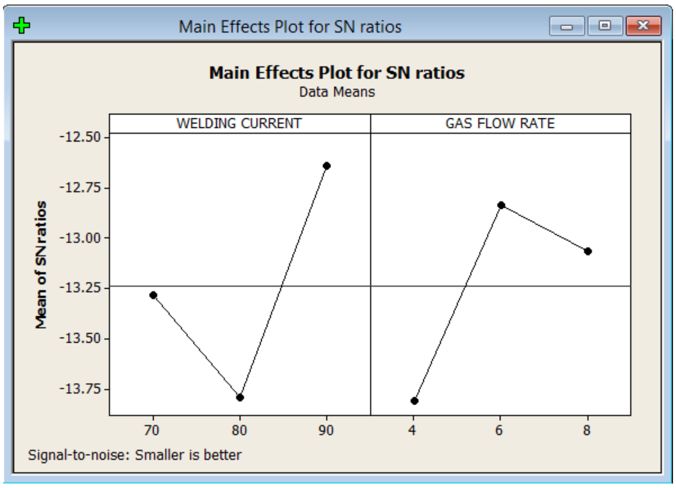

Fig-5: Analysis of the back width's main effect

The above image shows how welding current and gas flow rate affect the main plot for back width at 3 mm thickness. Welding currents of 90 AMP and gas flow rates of 6 LPM result in the narrowest possible back width, while welding currents of 80 AMP and gas flow rates of 4 LPM yield the widest.

7. CONCLUSION

Minitab and anova were used to analyse front and rear widths on 3mm-thick SS316 material. The L9 orthogonal array tests use welding current and gas flow rate.

Experimental data was evaluated with Minitab 16. Analysis yielded the following conclusions. A process parameter's effect depends on the response. A important parameter's percentage contribution and objective metric-induced behaviour modification. The tests showed that the front width can be as narrow as 4.31 mm at 8 LPM gas flow and as wide as 8.49 mm at 90 AMP welding current and 4 LPM gas flow. The maximum back width was 5.98 mm at 80 AMP and 4 LPM gas flow, while the minimum was 4 mm at 90 AMP and 6 LPM.

From Anova analysis and experimental data i have conclude that most significant parameter is welding current on output parameters. Gas flow rate is minmum effect on output parameters compare to welding current.

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