Experimental Investigation of Welding Parameters for A MIG Welding With SS304 By Using Taguchi Method

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Abstract - *Many different types of industrial processes make use of the Metal Inert Gas (MIG) welding technique. All three of these metrics—weld quality, productivity, and cost—are heavily dependent on the GMA welding parameters. The characteristics of the welded metal were assessed using the MIG technique. Using SS304 as my material of choice, I will study how changing the current, voltage, and wire speed impacts the width and height of the beads. With three distinct values for each input parameter, the experiment follows the architecture of a Taguchi L9 orthogonal array. In order to evaluate the results, we will run an analysis of variance (ANOVA) and choose the best settings based on the signal-to-noise ratio. This will validate the experimental outcome. Determine the input parameter's most significant impact on the output parameter.*

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

1. INTRODUCTION

When standard fabrication methods like casting, forging, rolling, extrusion, etc., are unable to produce the necessary component, joining the metal is the next best option.Although bolting is the most prevalent method of fastening, welding can sometimes make an item lighter. The following design parameters are being considered by all partner designers. Joining materials, typically metals or thermoplastics, is the goal of the industrial process known as welding. To achieve this, the work components are melted together with or without filler material to create a pool of molten material called the weld pool. As the pool cools, it solidifies into a strong joint. Pressure, either alone or in combination with heat, is occasionally employed to create the weld.

Gas flames, electric arcs, lasers, electron beams, friction, and ultrasonic are some of the energy sources that can be utilised in welding. Despite welding's association with industry, it can take place in a variety of settings, including the open air, underwater, and even space. Burns, electric shock, eye damage, inhalation of toxic fumes and gases, and exposure to high UV radiation are all possible outcomes of welding without proper safety measures.

2. OBJECTIVE

I chose to conduct the experiment on SS304 sheet material, which has a thickness of 3 mm.

The Taguchi Method With the L9 Orthogonal Array That Was Selected
In order to analyse the experimental data, Minitab software is utilised.

Figure out the MIG welding job's bead width and bead height before you start.

Determine the optimal welding process parameters by analysing their effects on the shape of the weld bead.

3. DESIGN OF EXPERIMENT

The goal of a DOE experiment is to determine the optimal combination of variables by defining and exploring all of the possible combinations. In this, many elements are stated along with their respective levels. Combining elements at suitable levels, each within its own acceptable range, to generate the greatest results while exhibiting minimal fluctuation around the optimal results is another valuable application of design of experiments. The various conditions to be researched are laid out using the design of experiment. First, the number of trails has to be defined; second, the circumstances for each trail need to be stated; these two objectives must be met by an experiment design. Having a good understanding of the product or process being studied is crucial before coming up with an experiment design. This will help you discover the aspects that could potentially impact the result. An approach to finding and fixing process problems, determining which process factors are significant, and discovering the likelihood of estimating interactions is the Design of Experiments (DOE).

3.1Taguchi design

Using an orthogonal array to organise the process parameters and the levels at which they should be varied, Taguchi proposes an experimental design that saves time and resources by collecting the necessary data to determine which factor most affects product quality with a minimum amount of experimentation.

- Process Parameters

Input Parameter:

Factor A : Welding Current (Amp)
Factor B : Voltage (V)
Factor C : Gas flow rate (LPM)

Constant parameter:
Work Piece Thickness

Output Parameter:

Bead Width

Bead Height

Table-1: Process Parameter Level

Thickness	Parameters	Level1	Level2	Level3
3mm	Welding Current	150	170	190
	Voltage	23	25	27
	Gas Flow Rate	12	15	18

Table-2: Taguchi Design Factor

EX.NO.	WELDING CURRENT (A)	VOLTAGE (V)	GAS FLOW RATE (LPM)
1	150	23	12
2	150	25	15
3	150	27	18
4	170	23	15
5	170	25	18
6	170	27	12
7	190	23	18
8	190	25	12
9	190	27	15

4. EXPERIMENTAL WORK

4.1 Working procedure

- Material selection
- Material testing

Specimen preparation

- Experiment work
- Testing result

Fig-1: MIG Welding Machine set-up

4.2 Work piece detail

Because of its widespread use in the process industry, SS304 is the material chosen for this investigation. The chosen thickness for the material is 3 mm.According to ASTM guidelines, the specimen size that was chosen is 60 mm x 40 mm.

Fig-2: The SS304 material thicknesses used for the work piece

Welding performance of tig welding machine

Fig-3: welded work

Visual examinations verify work part penetration after welding. Insufficient penetration specimens are rejected. To explore how welding settings affect bead geometry, a travelling microscope measures bead width and height.

Table-3: Experiment Work

Ex. No.	Welding Current	Voltage	Gas Flow Rate	Bead Width	Bead Height
1	40	23	2.4	5.12	4.17
2	40	25	3.2	4.53	4.30
3	40	27	4.0	4.95	4.14
4	40	23	4.8	4.55	4.12
5	60	25	2.4	5.21	4.62
6	60	27	3.2	4.64	4.56
7	60	23	4.0	5.08	5.03
8	60	25	4.8	5.22	4.92
9	70	27	2.4	5.88	5.00

Table-4: A ratio of SN for the width and height of beads

EX.NO.	BEAD WIDTH (mm)	S/N RATIO B.W.	BEAD HEIGHT (mm)	S/N RATIO B.H.
1	4.00	-12.0412	2.01	-6.06392
2	3.57	-11.0534	1.71	-4.65992
3	3.93	-11.8879	1.82	-5.20143
4	4.19	-12.4443	3.03	-9.62885
5	3.62	-11.1742	1.57	-3.91799
6	3.94	-11.9099	1.75	-4.86076
7	4.86	-13.7327	1.51	-3.57954
8	4.35	-12.7698	1.15	-1.21396
9	4.20	-12.4650	1.47	-3.34635

5. CONCLUSION

- For this investigation, we used minitab and anova to determine the bead width and bead height on SS304 material with a 3mm plate thickness.
- Welding current and gas flow rate are used in the experiments carried out utilising the L9 orthogonal array. The experimental data was analysed using Minitab 16.
- Following conclusion have been drawn after analysis. Process parameter do not have same effect for every response. Significant parameter and its percentage contribution changes as per the behaviour of the parameter with objective response.
- As per experimental data minimum bead width (3.57 mm) obtained at welding current 150 AMP, voltage 25 V & gas flow rate 15 LPM and maximum bead width (4.86 mm) obtained at welding current 190 AMP, voltage 23 V & gas flow rate 18 LPM. And minimum bead height (1.15 mm) obtained at welding current 190 AMP, voltage 25 V & gas flow rate 12 LPM and maximum bead height (3.03 mm) obtained at welding current 170 AMP, voltage 23 V & gas flow rate 15 LPM.
- From Anova analysis and experimental data i have conclude that most significant parameter is welding current on output parameters. Voltage & Gas flow rate is minmum effect on output parameters compare to welding current but voltage is more effect compare to gas flow rate.

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