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Original Research Article

PREDICTION OF TIG AND MIG WELDING PARAMETER BY COMPARISON OF HARDNESS

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ABSTRACT

The choice of the welding depends on several factors; primarily among them are the compositional range of the material to be welded, the thickness of the base materials and type of current. TIG and MIG welding has several advantages like joining of dissimilar metals, the absence of slag, low heat affected zone and etc. Since input parameters play a major role in determining the quality of a welded sample. A plan of experiments based on Taguchi technique has been used to design of experiment, acquire the data and to predict the welding parameters as well as the process parameter in terms of hardness. An Orthogonal array and analysis of variance (ANOVA) are employed to investigate the welding characteristics of alloy Steel material and predict the welding parameters also compare it in between the TIG and MIG welding Hardness responses.

KEYWORDS: - Alloy steel; design of experiment; hardness.

1. INTRODUCTION

TIG welding offers several advantages i.e. joining of dissimilar metals, low heat affected zone, absence of slag etc. In TIG welding operation, weld quality mainly depends on features of bead geometry, mechanical-metallurgical characteristics of the weld and various aspects of weld chemistry. These features are greatly influenced by the welding parameters such includes current, voltage, gas flow rate, electrode stick-out, edge preparation, position of welding, weld speed [4]. Selection of filler rod material also has significant effect on weld quality. Selection of optimum parametric setting is essential for obtaining desired weld quality. Now-a-days, determination of optimum values of process parameters in

manufacturing are the areas of great interest for researchers and manufacturing engineers. The input parameters play a very significant role in determining the quality of a welded joint. The welding parameters are current, arc voltage and welding speed. These parameters will affect the weld characteristics to a great extent. Because these factors can be varied over a large range, they are considered the primary adjustments in any welding operation. MIG welding is a versatile technique suitable for both thin sheet and thick section components.

2. BACKGROUND WORK

In welding process, there are parameters need to be consider in concern to obtain the objective characteristic of weld bead. To develop 3-D welding technology, two characteristics of weld bead need to be improve, quality and mechanical strength. The shape and dimensions of the weld bead are very important in the use of 3-D welding as a Rapid Prototyping system, these will determine the strength of wall and shape produced product and this characteristic will influence the quality of the surface finish. To obtain this, comparison parameter in this TIG and MIG welding need to be study. These parameters affecting the arc and welding bath should be estimated and their changing conditions during process must be determine in order to obtain optimum results. A perfect arc can be achieved when all the parameters are in conformity. In MIG welding process, there is several important parameters need to concern. These parameters are arc voltage welding current, amperage, travel speed, wire feed speed, torch angle, free wire length, nozzle distance, welding direction, electrode extension, welding position and the flow rate of gas. However, wire electrode diameter and its composition, type of protective gas are the defined parameters before starting welding and cannot be changed during the process.

3. OBJECTIVE

The good quality of welding bead will lead to reduction of finishing process of the product by means the process of the milling process can be skip. The present work aim is to determine the input–output relationships of a TIG & MIG welding process. To investigate prediction of parameter in TIG & MIG welding technology for hardness quality of welding.

4. METHODOLOGY

Design of Experiments (DOE) is a powerful statistical technique introduced by R. A. Fisher in England in the 1920's to study the effect of multiple variables simultaneously. The DOE using Taguchi approach can economically satisfy the needs of problem solving and product/process design optimization projects. By learning and applying this technique, engineers, scientists, and researchers can significantly reduce the time required for experimental investigations. DOE is a technique of defining and investing all possible

combinations in an experiment involving multiple factors and to identify the best combination. In this, different factors and their levels are identified.

The cause-effect diagram was constructed to identify process parameters which may affect the desired quantity characteristics of the final job. These parameters can be listed in categories as follows:

(i) Power source

(ii) Current

(iii)Speed of welding

The choice and the selection of the parameter were decided by considering the objective of present study. Before selecting a particular OA to be used as a matrix for conducting the experiments.

The parameter is their best of three result are taken as level which is shown in table 1.

Table 1 Levels and Parameters

Factors	Level 1	Level 2	Level 3
Voltage in KV (V)	30	35	40
Current in Ampere (A)	240	245	250
Speed of welding in m/min (S)	2.5	2.8	3.1

This basic design uses up to three control factors, each with three levels. A total of nine runs must be carried out, using the combination of levels for each control factor. In this case the DOE will generate the experiment design and then allow that design to both welding experiment to obtain responses. Taguchi orthogonal design uses a special set of predefined arrays called orthogonal arrays (OA) to design the plan of experiment. These standard arrays stipulate the way of full information of all the factors that affects the process performance as shown in table 2.

Table 2 Design of Experiment

S No.	V	A	S
1	30	240	2.5
2	30	245	2.8
3	30	250	3.1

4	35	240	2.8
5	35	245	3.1
6	35	250	2.5
7	40	240	3.1
8	40	245	2.5
9	40	250	2.8

5. HARDNESS TESTING

The Rockwell scaleis a hardness scale based on indentation hardness of a material. The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. There are different scales, denoted by a single letter, that use different loads or indenters. The result is a dimensionless number noted as HRA, where A is the scale letter. Due to the hardness value of weld bead range, the HRA were chosen to conduct the measurement. A Rockwell scale A (HRA) using load 60 kg to force on ball indenter.

Fig. 1 Rockwell Hardness Tester

The nine experiments were performed based on the L9 OA. The effect of different parameters such as welding current, arc voltage and welding speed of alloy steel 8620 is analyzed by TIG welding. The hardness and tensile strength of all nine-weld specimen were checked carefully and the observed value of hardness and tensile strength are shown in table 3.

Table 3 Observed value by TIG welding

S No.	V	A	S	TIG	MIG
1	30	240	2.5	126	121
2	30	245	2.8	114	118
3	30	250	3.1	116	113
4	35	240	2.8	148	142
5	35	245	3.1	134	131
6	35	250	2.5	116	126
7	40	240	3.1	112	122
8	40	245	2.5	123	133
9	40	250	2.8	137	147

On the base of ANOVA result Analysis of Variance for TIG and MIG Hardness and tensile test has been shown in table 4 and 5 for both welding TIG and MIG welding hardness and tensile strength data individual their factor graph has been made and find out the significant factor for each output responses.

Table 4 ANOVA for Hardness test

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	2	299.56	299.56	149.78	0.52	0.656
A	2	57.56	57.56	28.78	0.10	0.909
S	2	281.56	281.56	140.78	0.49	0.670
Residual Error	2	572.22	572.22	286.11		
Total	8	1210.89				

Table 5 Analysis of Variance for MIG Hardness

S	DF	Seq SS	Adj SS	Adj MS	F	P
V	2	524.22	524.222	262.11	2.79	0.264
A	2	2.89	2.889	1.444	0.02	0.985

S	2	289.56	289.556	144.77	1.54	0.394
RE	2	188.22	188.222	94.11		
Total	8	1004.89				

The ANOVA of the hardness tests shows the P-value for the TIG welding is less that is Voltage and also the response table gives the first rank to voltage which indicates the average hardness is significantly different between the welds material, which requires significant of TIG welding is Voltage. Similarly, ANOVA of the hardness tests shows the P-value for the MIG welding is less that is Voltage and response rank first preferred to voltage as shown in Table 6.

Table 6 Significant Factor Table

	TIG Factor	MIG Factor
Hardness Test	Voltage	Voltage
Tensile Test	Speed of Welding	Voltage

COMPARISON

ANOVA analysis comparing interactions between the two welding TIG versus MIG, for hardness they give the same and equal response of significant parameter is Voltage. The ANOVA tests for mean hardness across the welds show that interactions between TIG versus MIG welds are the same and significantly as shown in Fig 2.

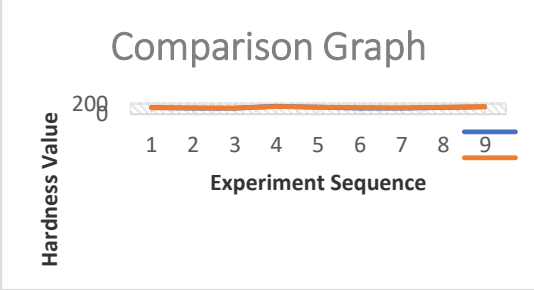

Fig 5.8 Comparison Chart of Hardness

6. CONCLUSION

MIG and TIG Welding process is apply on design of experiment to obtain their responses and analysis with ANOVA, the process parameters which significantly affects the Tensile Strength was speed, current and Voltage will be observed. They affect the weld quality in terms of mechanical properties and weld bead geometry. The value of depth of penetration increased by increasing the value of welding Voltage and welding voltage is the significant value for both welding in terms of Hardness.

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