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Optimization Of Process Parameter in Arc Welding Process On Dissimilar Material By Using ANOVA Method

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Abstract

Welding is widely used by manufacturing engineers and production personnel to quickly and effectively set up manufacturing processes for new products**.** In this research work, bead on plate welds were carried out on AISI 409 & Mild Steel plates using gas metal arc welding (GMAW) process.Full factorial is used to formulate the experimental design.The input process variables considered here include welding current, welding voltage & gas flow rate.A total no of 27 experiment runswere conducted using full factorial method using.The analysis for signal-to-noise ratio was done using MINITAB-17 software for higher-the-better quality characteristics.The significance of each parameter was studied by using the ANOVA (Analysis of variance).Finally the confirmation tests were performed to compare the predicted values with the experimental values which confirm its effectiveness in the analysis of tensile strength of the joint.

Keywords- Tensile strength,Stainless steel AISI 409,Mild steel,Anova,GMAW.

I. INTRODUCTION

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. Metal inert gas arc welding (MIG) or more appropriately called as gas metal arc welding (GMAW) utilizes a consumable electrode and hence, the term metal appears in the title. The schematic diagram of GMAW or MIG welding process is shown in Figure 1.

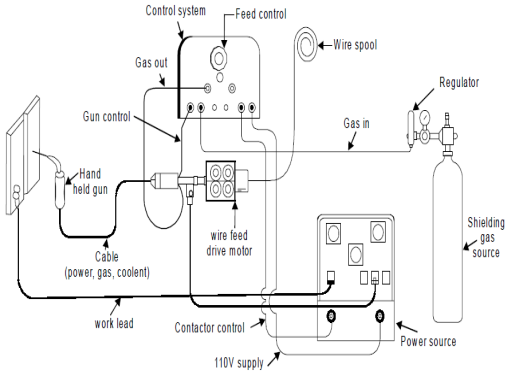

Figure1.

The current from the welding machine is changed by the rate of feeding of the electrode wire. Normally DC arc welding machines are used for GMAW with electrode positive (DCRP). In the GMAW process, the filler metal is transferred from the electrode to the joint. Depending on the current and voltage used for a given electrode, the metal transfer is done in different ways.

A. WORKING PRINCIPLE OF MIG WELDING :

The electrode in this process is in the form of coil and continuously fed towards the work during the process. At the same time inert gas (e.g. argon, helium,co_2) is passed around electrode from the same torch. Inert gas usually argon, helium, or a suitable mixture of these is used to prevent the atmosphere from contacting the molten metal and HAZ. When gas is supplied, it gets ionized and an arc is initiated in between electrode and work piece. Heat is therefore produced. Electrode melts due to the heat and molten filler metal falls on the heated joint.

The arc may be produced between a continuously fed wire and the work. Continuous welding with coiled wire helps high metal depositions rate and high welding speed. The filler wire is generally connected to the positive polarity of DC source forming one of the electrodes. The workpiece is connected to the negative polarity. The power source could be constant voltage DC power source, with electrode positive and it yields a stable arc and smooth metal transfer with least spatter for the entire current range.

B. GMAW / MIG welding applications :

MIG may be operated in semiautomatic, machine, or automatic modes. All commercially important applicable metals such as carbon steel, high-strength, low-alloy steel, and stainless steel, aluminum, copper, titanium, and nickel alloys can be welded in all positions with this process by choosing the appropriate shielding gas, electrode, and welding variables.

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D. MIG Welding Effecting parameters :

Weld quality and weld deposition rate both are influenced very much by the various welding parameters and joint geometry. Essentially a welded joint can be produced by various combinations of welding parameters as well as joint geometries. These parameters are the process variables which control the weld deposition rate and weld quality. The weld bead geometry, depth of penetration and overall weld quality depends on the following operating variables.

- Electrode size, Welding current, Arc voltage
- Arc travel speed, Welding position
- Gas Flow rate, Shielding Gas composition
- Electrode extension (length of stick out)

II. LITERATURE REVIEW

Abdul wahab H.Khuder et al. [1], have studied the effect of welding process parameter in welding joint of dissimilar metal by using MIG spot welding. In this research the base material selected for welding are austenitic stainless steel-type AISI 316L and carbon steel. The filler metal use for welding this dissimilar metal is E80S-G and CO_2 is used as shielding gas. The experiment was carried out by considering feed of wire, time of feed and weld current as input parameter. The effect of these parameters on diameter of the spot and shear force was predicted by doing the experiment. From the result they conclude that the size of spot weld and shear force is increase with increasing welding current while the shear force is decrease with increase of welding time. Also they found that the increasing welding current and time of welding will also increase diameter of weld zone and decreases the shear force.

Amit Kumar et al. [2], have done work on optimization of MIG welding parameters using Artificial Neural Network (ANN) and Genetic Algorithm (GA). In this research work they make mathematical model by using ANN method for prediction effect of welding parameter such as welding voltage, welding speed and welding current on ultimate tensile stress during the welding of dissimilar material such as stainless steel grade 304 and grade 316. The argon gas was taken as shielding gas and experiment was done on full factorial. The Genetic Algorithm (GA) used to optimize the value of output parameter. From the analysis it is concluded that the maximum ultimate tensile strength is meet at 110 A welding current, 18 V welding voltage and 43.362 cm/min travel speed. Also they have shown that the Artificial Neural Network (ANN) successfully integrated as other regression model.

M. Aghakhani et al. [3], have done work on optimization of gas metal arc welding process parameter for increase quality and productivity of weldment. In this research work for increasing quality and productivity of weldment they have considered weld dilution as output parameter and effect of input parameter wire feed rate (W), welding voltage (V), nozzle-to-plate distance (N), welding speed (S) and gas flow rate (G) was found on it. The base material use for experiment is ST-37 steel plate and the mixture of 80% argon and 20% CO2 is use as shielding gas. The experiment was designed by Taguchi's L25 orthogonal array and analysis was carried out by ANOVA method also they develop mathematical model for weld dilution. From the experimental result they found that the wire feed rate has the most significant effect on the weld dilution while gas flow rate has no effect on weld dilution.

Ajit Hooda et al. [4], have developed a response surface model to predict tensile strength of inert gas metal arc welding of AISI 1040 medium carbon steel joint. In this research the welding voltage, current, wire speed and gas flow rate are considered as input parameter. The experiment was designed by face centered composite design matrix. From the experiment they conclude that the optimum values of process parameter such as welding voltage 22.5 V, wire speed 2.4 m/min and gas flow rate 12 l/min for maximum yield strength both transverse and longitudinal are remain same but the current value is 190 A and 210 A respectively.

Pradip D. Chaudhari et al. [5], have investigate the effects of welding process parameters of Gas Metal Arc Welding (GMAW) on tensile strengths of SS 3Cr12 steel material specimen. In this research work the welding voltage, wire feed rate, welding speed and gas flow rate were considered as inflating input parameter. The experiment was designed by central composite design matrix and the analysis was done by using Minitab-17 software. From the analysis they found that the tensile strength was increasing with increasing with increase the value of welding speed and gas flow rate whereas the increasing with decrease the value of wire feed rate and welding voltage.

III. EXPERIMENTAL DETAILS

A. Experimental setup:

A number of experiment were conducted to study the effect of various machining parameter on welding process.These studies have been undertaken to investigate the effects of current,voltage,pressure.Argon and Carbon gas is used in welding.Esab Auto K400 Synergic welding machine is use.Three levels take all process parameters.

Levels of process parameters

Levels	Pressure	Current	Voltage
1	12	150	15
2	15	170	20
3	18	190	25

Table-1.

IV. TAGUCHI METHOD

Genichi Taguchi was a leader in the growth of quality consciousness. One of Taguchi's technical contributions to the field of quality control was a new approach to industrial experimentation. The purpose of the Taguchi method was to develop products that worked well in spite of natural variation in materials, operations, suppliers, and environmental change. This is robust engineering.

The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varies.

A. Signal -to- Noise (S/N) ratio:

The signal to noise (S/N) ratios has obtained using Taguchi's methodology. The 'signal' is the desirable value (mean) and the 'noise' is the undesirable value (standard deviation). Thus the S/N ratio represents the amount of variation present in the performance characteristic. Depending upon the objective of the performance characteristic, there can be various types of S/N ratios. There are 3 Signal-to-Noise ratios of common interest for optimization.

(a) Nominal is the best characteristic

$$SNi = 10log\frac{\bar{y}_i^2}{s_i^2}$$

(b) Smaller is batter

$$SNi = -10\log\left(\sum_{u=1}^{Ni}\frac{y_u^2}{N_i}\right)$$

(c) Larger the better characteristics

$$SNi = -10\log\left[\frac{1}{N_i}\sum_{u=1}^{Ni}\frac{1}{y_u^2}\right]$$

Where

$$\bar{y}_i = \frac{1}{N_i}$$

$$s_i^2 = \frac{1}{N_i - 1}\sum_{u=1}^{N_i}(y_{i,u}$$

i = Experiment number

u = Trial number

N_i = Number of trials for experiment i.

If the difference between the minimum and maximum value of a parameter is large, the values being tested can be further apart or more values can be tested. If the range of a parameter is small, then fewer values can be tested or the values tested can be closer together.

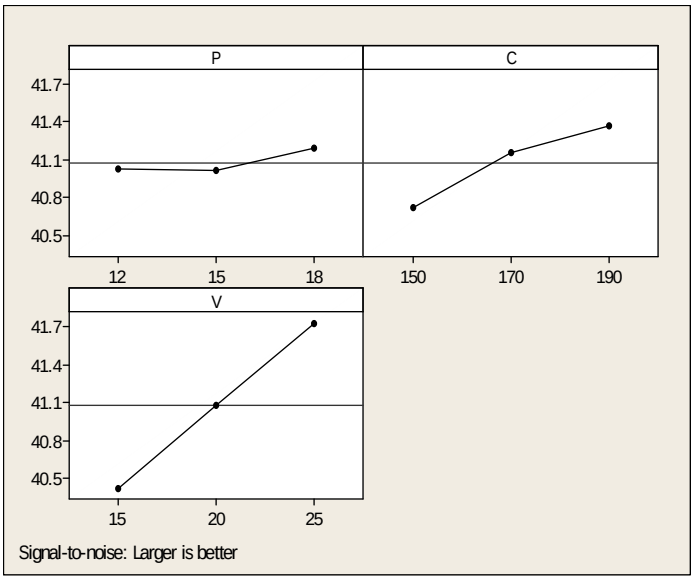

Figure2.Main effect of S/N ratio

(input-p-pressure,c-current,v-voltage,output-load(kn))

S/N Response Table for Ultimate Tensile Strength

Level	p	C	v
1	41.03	40.72	40.42
2	41.02	41.15	41.08
3	41.19	41.36	41.74
Delta	0.18	0.65	1.32
Rank	3	2	1

Table-2.

V. ANALYSIS OF VARIANCE FOR TENSILE STRENGTH

ANOVA is used to estimate the percentage contribution of various process parameters to the selected performance characteristics. This gives the information about how significant the effect of each controlled parameter on the quality characteristics of interest. The total variation in the

result is the sum of variation due to various controlled factors and their interactions and due to experimental error.

Analysis of variance (ANOVA) for raw data and S/N data has been performed to identify the significant parameters and quantifies their effect on the performance characteristics. The ANOVA based on the raw data identifies the factors which affects the average response rather than reducing variation.

Analysis of Variance for Load(kn), using Adjusted SS for Tests

Source	DF	Seq SS	Adj Ss	Adj Ms	F	P
Pressure	2	29.63	29.63	14.81	2.91	0.078
Current	2	324.07	324.07	162.04	31.82	0.000
Voltage	2	1335.19	1335.19	667.59	131.09	0.000
Error	20	101.85	101.85	5.09		
Total	26	1790.74				

S=2.25668	R-Sq=94.31%	R-Seq(adj)=92.61%

Table-3.

SS, sum of squares; DOF, Degree of freedom; P, Percentage contribution;

VI. CONCLUSION

MIG welding is one of the best welding technique by which we can join two similar and dissimilar materials. Analysis of variance (ANOVA) helps to find out the significance level of the each parameter. The optimum value was predicted using MINITAB-17 software. Based on the investigations following conclusions are drawn.

- MIG welding process is very successful to join stainless steel (AISI-409) and Mild steel.
- Based on S/N ratio analysis and ANOVA, the process parameters which significantly affects the ultimate tensile strength was voltage and welding current.
- The effect of parameters on the ultimate tensile strength can be ranked in decreasing order as follows: voltage > current>pressure.

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