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Experimental Investigation of Tungsten Inert Gas Arc Welding Process Parameter of Mild Steel

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A B S T R A C T

In the present analysis, the investigation was carried out on the 10 mm thick mild steel plate having length 200 mm and width 70 mm. The input process parameter for TIG welding of mild steel plate were modelled for achieving acceptable welds. The process variables such as welding current, voltage and welding speed has been selected as the most effective process parameters. Also these process parameters has been selected to studied for the interaction effects on weld width, weld penetration, width of HAZ, depth of HAZ, weld cross-sectional area and arc spread.

Keywords: TIG Welding; Weld Width; Weld Penetration; Depth of HAZ

1. Introduction

In the 1920's, the first time welding arc and the weld pool was shielded by the helium gas as a shielding gas. However, nothing was done with this method until the beginning of World War I1 when a great need developed in the aircraft industry to replace riveting for joining reactive materials such as aluminum and magnesium. Using a tungsten electrode and direct current arc power with the electrode negative, a stable, efficient heat source was produced with whichexcellent welds could be made. Helium was elected to provide the necessary shield because, at the time, it was the only readily available inert gasThis process is also known as non-consumable electrode welding process. But, the AWS terminology for this process is gas tungsten arc welding (GTAW), because shielding gas mixtures which are not inert can be used for certain applications,

Since the early days of the invention, numerous improvements have been made to the process and equipment. Welding power sources have been developed specifically for the process. Some provide pulsed dc and variable polarity ac welding power. Water-cooled and gas-cooled torches were developed. The tungsten electrode has been alloyed with small amounts of active elements to increase its emissivity; this has improved arc starting, arc stability, and electrode life. Shielding gas mixtures have been identified for improved welding performance. Researchers are presently pursuing further improvements, in such areas as automatic controls, vision and penetration sensors, and arc length controls. The primary process parameters in GTAW are arc voltage (arc length), welding current, travel speed, and shielding gas. The amount of energy produced by the arc is proportional to the current and voltage. The amount transferred per unit length of weld is inversely proportional to the travel speed. The arc in helium is more penetrating than that in argon. However, because all of these variables interact strongly, it is impossible to treat them as truly independent variables when establishing welding procedures for fabricating specific joints[1-3].Datta et al. [4] developed a statistical model for predicting bead volume of submerged arc butt welds in mild steel plates. Experiments based on a 33 full factorial design, without replication, were conducted with 3 levels of 3 process parameters namely welding current, welding voltage, and electrode extension. The ANOVA was employed to evaluate quantitatively the significant of the main and interaction effects of 3 process parameters on bead volume. Three empirical models: linear, curvilinear, and a second degree response surface model have been developed. The effects of 3 process parameters were also represented graphically and it is shown that these process parameters are to represent significant effects on bead volume.

Also, Gunaraj et al. [5] developed empirical models using the five-level factorial design for prediction and optimization of weld bead for the SAW process of 6- mm-thick structural steel plates. The second degree response surface models were developed to have relationships between the important control process parameters: welding voltage; wire feed rate; welding speed; and nozzle-to-plate distance; and 5 bead-quality parameters: penetration; reinforcement; bead width; total volume of the weld bead; and dilution. ANOVA analysis was used to check the adequacy of all the empirical models. The main and interaction effects of the process parameters on bead geometry were determined quantitatively and presented graphically.

Furthermore, Gunarajet al. [6] highlighted the use of RSM by designing a central composite rotatable design matrix to develop empirical models for predicting weld bead quality in SAW for pipelines. The experiment was designed based on a four factor five level factorial central composite rotatable design. The second degree response surface models, which relate the important process parameters such as the open-circuit voltage, the wire feed rate, the welding speed and the nozzle-to-plate distance, to the penetration, the reinforcement, the width and the percentage dilution of the bead geometry, were developed. ANOVA analysis was effectively used to test the adequacy of the all the developed models.

Recently, some researches have been concentrated on using these traditional models with AI techniques to solve the problem [7-11].Kimet al. [7] developed a linear, a curvilinear model and an intelligent system for GMA welding process based on factorial experimental design. Three process parameters namely arc current, welding voltage and welding speed, are considered as the main parameters influencing bead geometry and each process parameter take on three levels. ANOVA was employed to determine the significance of each factor on the optimization parameter and to detect whether there were any interaction effects among the factors themselves. The intelligent system was established by using a BPNN.In this article the effect of tungsten inert gas welding input process parameters of weld joint structure of mild steel plate.

2. Experimental Procedure

Four Welding parameters values were used for the experiment of the TIG welding process as shown in Table 1. The argon gas flow rate was not as influential on weld width, welds penetration and so could be set easily. However, the other four parameters had a significant influence on the weld width, penetration and HAZ differed depending on the particular steel plat used and its thickness.

Table 1 Input process parameters of TIG welding

S. No	Input process parameters	Unit
1	Current (I)	I ampear
2	Voltage (V)	V Voltage
3	Travelling speed	(m/mm)
4	Arc length	(mm)

2.1 Material Selection

Mild steel has been identified as suitable engineering materials for application in many industries fields such as automotive industries, aerospace industries, defense and nuclear science.

Table 2 Chemical Composition of the mild steel

Elements	C%	Si%	Mn%	P%	S%	Ni%	Cr%	Fe%
Composition	0.15	0.17	0.46	0.18	0.066	0.14	0.014	98.8

Specimen for Tungsten welding process was developed by following steps:

A Mild steel plate were cut in to (180 mm × 65 mm ×8.0 mm) test specimen.Corner and edge preparation with use of the file to assure proper surface contact between the specimens.Cleaning of the abraded specimens using acetone to remove oil and grease. Marking of the specimen at required overlap then identify the center to generate the weld .

2.2 Experiments to identify the process parameters level and their range

Pilot experiment was conducted in order to determine the appropriate range of input process parameters. The working range is decided by their bead width and penetration of the weld joint and also inspecting the weld joints for a smooth appearance and the absence of any visible defects. Weld joints for pilot experiment developed by varying one of the process parameter at a time while keeping the rest of them at a constant value. Table 3 shown the range and level of the TIG process parameters for the mild steel.

Table 3 Range and level of process parameters

S.N	Parameter	Low	Medium	High
1	Current (I)	50	70	90
2	Voltage (V)	10	10.5	11
3	Travelling speed (m/mm)	14	29	44

The methodical investigation has been started in regard to study the effect of the input process parameters on the weld bead structure of the mild steel by using the tungsten inert gas welding processor.

.Experimental setup of tungsten inert gas welding has arc image magnifying system, work piece base system, setup for speed control, TIG welding machine and LVDT for arc length measurement. The arc image magnifying system is used to calculate and measure the arc length and arc spread during TIG/GMA welding process. The arc image magnifying system contains input and output lens to magnify the welding arc. The input lens captures the arc image and output lens magnify this image to required extent. For the movement of image magnifier in X,Y,Z direction there is provision in setup by which movement of magnifier can be easily controlled in required direction. The speed control unit control the movement of work piece base system by which speed of work piece can be easily controlled.

3. Results and Discussion

3.1 Effect of welding current on weld bead width

As shown in Figure 1 the effect of welding current (A) on the weld bead width. As increasing the welding current the weld bead with is also increase. The 4.16 mm minimum beat width has been measured at 50 A welding current, welding speed 44 mm/min and arc voltage 10 V. 7.64 mm maximum bead width has been measured at 90 A welding current, welding speed 14 mm/min and arc voltage 11 V. In TIG welding process it has been observed that the increasing the welding current from 50 A to 90 A, the bead width also increases.

Figure 2 shown the effect of the welding current on the joint penetration. The 1.04 mm minimum penetration has been measured at 50 A welding current, welding speed 44 mm/min and arc voltage 10 V. 2.54 mm maximum penetration has been measured at 90 A welding current, welding speed 14 mm/min and arc voltage 11 V. In TIG welding process it has been observed that the increasing the welding current from 50 A to 90 A, penetration also increases.

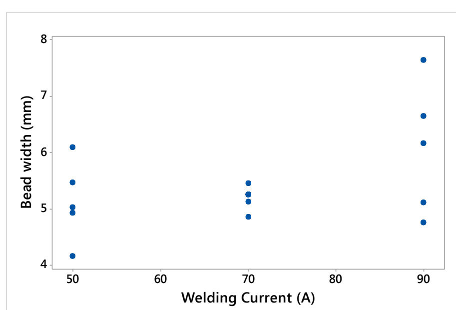

Figure 1 effect of welding current on weld bead width

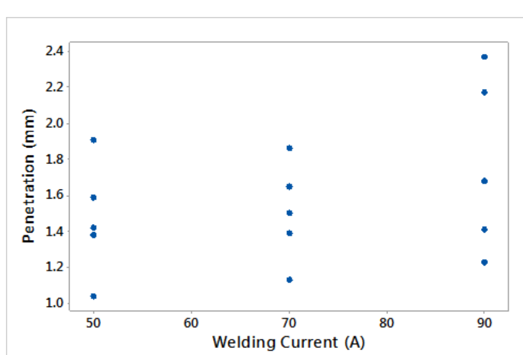

Figure 2 effect of welding current on joint penetration

3. 2 Effect of welding speed on weld bead width

As shown in Figure 3 the effect of welding speed (mm/min) on the weld bead width. As increasing the welding current the weld bead with is also increase. In TIG welding process it has been observed that the increasing the welding speed from 14 mm/min to 44 mm/min, bead width starts to decrease. It is because of the volume of liquid metal is less in high speed.

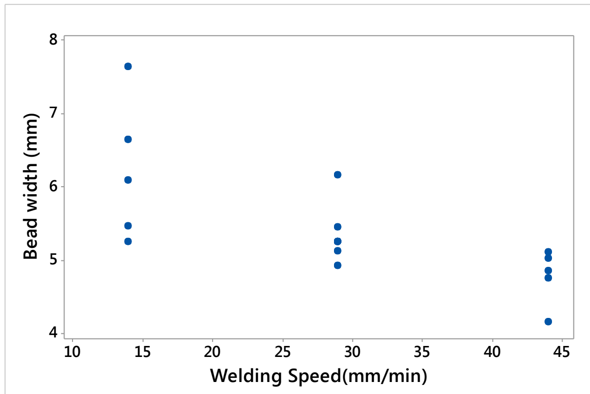

Figure 3 effect of welding speed on bead width

3.3 Effect of welding speed on joint penetration

Figure 4 shown the effect of welding speed on joint penetration. At the lower speed say 14 mm/min the penetration is more in the weld joint and at a higher speed 44 mm/min the penetration is lower as compare to lower speed.

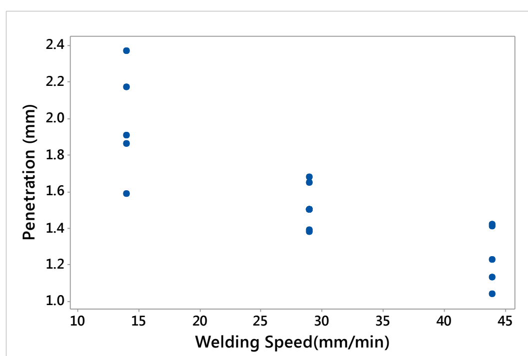

Figure 4 Effect of welding speed on joint penetration

3.4 Effect of welding voltage on weld bead width

As shown in Figure 5 the effect of welding voltage on weld bead width. As increasing the arc voltage 10 V to 11 V, the weld bead starts to increase. The maximum bead width 7.64 mm has been measure at 11 V under the 90 A welding current and 14 mm/min weld speed. The minimum bead width 4.6 mm has been recorded at 10 V along with 50 A welding current and 44 mm/min weld speed.

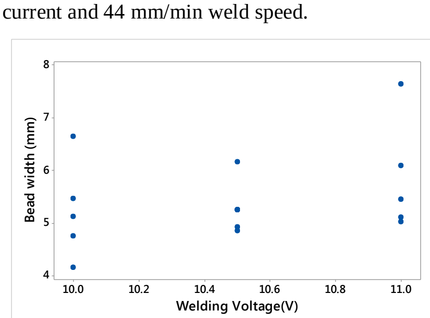

Figure 5 Effect of welding voltage on bead width

4.0 Conclusions

In this study, the effect of input process parameters on bead width and penetration has been investigated. Further the mathematical model has been developed

The following conclusion has been drawn based on results

In TIG welding process it has been observed that the increasing the welding current from 50 A to 90 A, the bead width also increases.

Increasing the welding current from 50 A to 90 A, penetration also increases.

In TIG welding process it has been observed that the increasing the welding speed from 14 mm/min to 44 mm/min, bead width starts to decrease.

At the lower speed say 14 mm/min the penetration is more in the weld joint and at a higher speed 44 mm/min the penetration is lower as compare to lower speed.

References

[1] Kim, D., Kang, M., and Rhee, S., Determination of optimal welding conditions with a controlled random search procedure. Welding J, 84, 125-130, 2002.

[2] Raveendra, J., and Parmar. R. S., Mathematical models to predict weld bead geometry for flux cored arc welding. Metal Construction, 19(2), 31R-35R, 1987.

[3] .Yang, L.J., Chandel, R.S., and Bibby, M.J., The effects of process variables on the weld deposit area of submerged arc welds. Welding. J, 72(1), 11-18, 1993.

[4] Datta, S., Sunder, M., Bandyopadhyay, A., Pal, P., K, Roy., S, C., and Nandi, G., Statistical modeling for predicting bead volume of submerged arc butt welds. Australasian Welding J, 51, Second Quarter, 2006.

[5] Gunaraj, V., and Murugan , N., Prediction and optimization of weld bead volume for the submerged arc process - Part 1. Welding J, 286-294, 2000.

[6] Gunaraj, V., and Murugan, N., Application of response surface methodology for predicting weld bead quality in submerged arc welding of pipes. Journal of Materials Processing Technology, 88(1-3), 266-275, 1999.

[7] Kim, I.S., Son, J.S., Park, C.E., Kim. I.J., and Kim, H., An investigation into an intelligent system for predicting bead geometry in GMA welding process. Journal of Materials Processing Technology, 159(1), 113-118, 2005.

[8] Li, P., Fang, M. T. C., and Lucas, J., Modeling of submerged arc welding bead using self-adaptive offset neural network. Journal of Materials Processing Technology, 71, 288-298, 1997.

[9] Tarng, Y. S., Tsai, H. L., and Yeh, S. S., Modelling, optimization and classification of weld quality in tungsten inert gas welding. International Journal of Machine Tools and Manufacture, 39, 1427-1438, 1999.

[10] Lee, J. I., and Um, K. W., A prediction of welding process parameters by prediction of back-bead geometry. Journal of Materials Processing Technology, 108(1), 106-113, 2000.

[11] Nagesh, D. S., and Datta, G. L., Prediction of weld bead geometry and penetration in shielded metal-arc welding using artificial neural networks. Journal of Materials Processing Technology, 123(2), 303-312, 2002.

[12] Correia, D. S., Gongalves, C. V. Sebastiao., Junior, S. C., and Ferraresi, V. A., GMAW welding optimization using genetic algorithms. Journalof the Brazilian Society of Mechanical Science & Engineering, 26(1), 28-31, 2004.

[13] Gery, D., Long, H., and Maropoulos, P., Effects of welding speed, energy input and heat source distribution on temperature variations in butt joint welding. Journal of Materials Processing Technology, 167, 393-401, 2005.

[14] Deng, D., and Murakawa, H., Prediction of welding distortion and residual stress in a thin plate butt-welded joint. Computational Materials Science, 43, 353-365, 2008.

[15] Malik, A. M., Qureshi, E. M., Dar, N. U., and Khan, I., Analysis of circumferentially arc welded thin-walled cylinders to investigate the residual stress fields. Thin-Walled Structures, 46(12), 1391-1401, 2008.

[16] Wen, H., and Xue. J., Key Techniques on Design of Laser High-speed Video System for Recording Metal Transfer in Arc Welding. The eighth international conference on electronic measurement and instruments, 2007.