Effects of Bevel Pipe Welding Parameters on Dye Penetration Using Factorial Design Method

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ABSTRACT

Pipe welding is a process of the mixing one material with another pipe using a special material. The main objective of this research is to find best process of parameters for good quality weld in MIG pipe welding. Welding perfection with the same strength as the good metal can be produced by applying the correct process. Welded connections should be free of any defects. As a result, according to an ANOVA analysis, high voltage and medium speed are the most significant factor influencing the response variables investigated. The Factorial Design Method enabled the determination of best operating conditions for obtaining bevel cutting and welding pipe production. The welding speed parameter were use in range 2 – 3 mm/s, current use in range 80 – 90 Ampere and voltage use in range 180 – 200 V. ANOVA reveals that sample no.7 gives a better result with desirability of good dye penetration, which hardness is 270.98 HV for welding speed, voltage and current of 2.5 mm/s, 215 V and 70 Ampere, respectively.

INTRODUCTION

MIG (Metal Innert Gas Welding) known as Inert Gas Welding, is a process that electrode will melt and mix with two or more metal melt to form a welding shape. Therefore, the electrode must be provided with constant flow throughout the welding process. For continuous supply, the electrodes are made of wire that can be pushed out of the welding nozzle automatically at the specified speed [1]. Protective gas is supplied through the weld nozzle as done in the TIG welding, this process can be done automatically or semi-automatically. however, MIG equipment is more complex as the process requires continuous and uniform sleeve retraction. MIG is widely used for welds that require high production rates, for example in manufacturing plants. Generally, the machine for MIG welding is a motor generator or successor of a constant-voltage power supply that supplies a constant current of up to 25 amps. Fig. 1 show the illustration of MIG. The voltage will automatically change according to the distance between the ends of the electrode wire with the work, while the current will change inversely as the work is done [2, 5]. Welding torch are usually used to produce electrode wire and protective gases.

LITERATURE RIVIEW

TIG welding is carried out in a controlled atmosphere using a tungsten electrode that functions to produce an arc to melt the metal. Direct current or high frequency flow is used to enable the arc to be continuous and stable without the need for electrodes to touch the metal surface. The arc is lit by pressing the switch on the ignition holder. The fill rod needs to be fed and inserted into the melting area as a metal additive. When welding an inert gas passed from a gas cylinder through a chute acts as a shield to protect the melting crater from the atmospheric air trapped

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inside it [3, 7]. The preparation of pipes is an important part of the pipe welding process, to produce a quality welding connection whose results are influenced by the perfect welding process. Fig. 2 show the schematic of bevel cutting process. One of the reasons why the quality of welding connection quality is due to failure in material preparation [4, 6]. Piping welders must be knowledgeable and skilled to provide the right tools to begin the welding process. This is the first step in successful and quality pipe welding work.

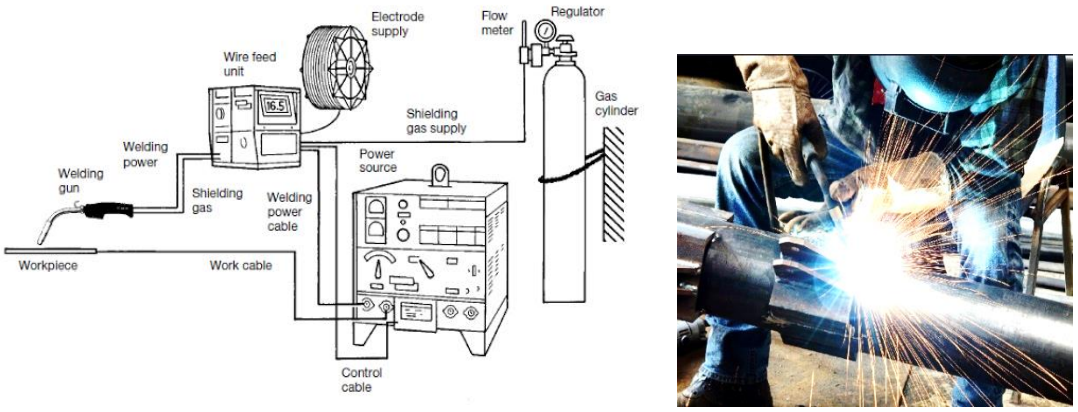


Figure 1. Illustration MIG setup machine and pipe welding.

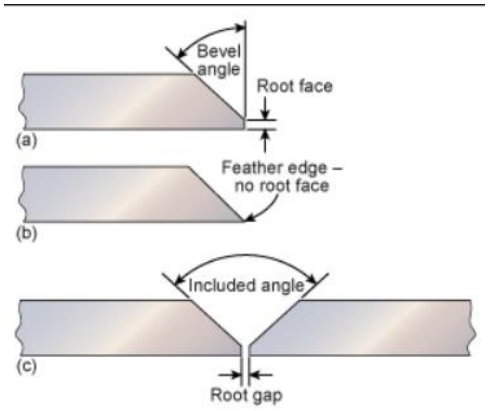


Figure 2. Schematic of bevel cutting.

When preparing for welding, bevel cuts must be made first. Bevel cutting can be done by using bevelling, grinding, or using gas cutting. At work, the welder usually makes a bevel with a gas cutting process. Angular cutting (bevel) pipe usually uses a cutting torch nozzle. Bevels on two pieces of pipe must be carefully made for the pipe connection to connect properly. The first step in making the right bevel cut is to mark the pipe. Beveling of pipes is a process of cutting whereby metal is formed to allow complete mixing and penetration [5]. Proper beveling reduces the amount of filler metal required, while reducing time and expense, it also means less pressure on welding and better design and welding work. Pipe beveling where angles are formed between the edges of the pipe or tube and perpendicular plane with the surface and the beveling pipe are commonly used to provide the ends for welding. Providing a single vee connection pipe is usually used to weld two parts of the pipe connection. Other angles and special shapes such as J-bevels can also be produced at the end of pipes or tubes using an automatic beveling machine.

METHODOLOGY

In order to meet the above objectives, welding of similar stainless steel joints is done by using tungsten gas arc welding method and metal arc welding. Metal fillers and electrodes of similar metal to be welded are used as variables. By specifying specific parameters such as welding speed, power used during welding, welding angle, connection type and thickness of each steel used [6]. Experiments conducted using the welding machine Miller by pulsed DC power supply positive electrode. Test pieces outside diameter 50 mm, length 100 mm with wall thickness of 6mm cut to length every 150 mm at first by supplying excess of 45 degrees and welded. Copper coated mild steel electrode diameter of 1.2 mm is used for welding. Argon gas mixture (85%) and CO_2 (15%) is used to protect. Hardness testing is used to estimate the mechanical properties of a material through hardness testing. This welding process is used to weld different types of metal thicknesses.

RESULTS AND DISCUSSION

There are many factors that influence the quality of welding. The parameter process is the feed rate, current arc, voltage and travel speed filler rod that needed to be controlled because it affects the results of welded joints. The size or depth of penetration is important to determine the quality of welding. It is highly influenced by the penetration depth of other factors. When the penetration depth is too large, the arc burns thin material and at the same time reduces welding quality [7,13]. Input variables or commonly referred to as parameters will affect their bead shape and weldment penetration. Welding current usually controls the speed of electrode burning, fusion depth, and welding geometry. This variable is very important in metal inert gas welding. Another parameter is the welding stress that affects the shape of the fusion zone and the height of welded reinforcement. Table 1 show the running sample parameter and their responses by using Design Expert Factorial Design tool. Welding speed refers to the rate of travel of the material under the electrode. Welding speed also causes a decrease in heat input per unit length of weld. Welding heat input is required to calculate after other parameters are selected. The parameters needed to calculate the heat input are voltage, speed, and welding time.

Table 1 Running sample for bevel pipe cutting and welding with responses

Sample	Run	Parameters			Responses	
		Welding Speed (mm/s)	Voltage (V)	Current (Ampere)	Dye Penetration	Hardness (HV)
a	3	2.00	180.00	80.00	Poor	238.25
b	1	3.00	180.00	80.00	Poor	203.66
c	10	2.00	200.00	80.00	Good	249.45
d	9	3.00	200.00	80.00	Poor	246.33
e	11	2.00	180.00	90.00	Moderate	237.95
f	8	3.00	180.00	90.00	Poor	231.55
g	2	2.50	200.00	90.00	Good	270.98
h	5	3.00	200.00	90.00	Good	265.44
i	6	2.50	190.00	85.00	Moderate	240.35
j	7	2.50	190.00	85.00	Moderate	245.48
k	4	2.50	190.00	85.00	Moderate	241.18

Beveling is the operation for creating a flat angled surface on the end of the pipe. The opening created by the beveling operation gives the welder access to the pipe wall's total thickness, and enables him to make a uniform weld that will guarantee the assembly's mechanical continuity. A root pass is made at the base of the bevels, which forms the base for filling the groove angle formed by the two bevels by successive welding passes.

Figure 3. Dye panetratian result using solution liquid.

Table 2 Analysis of variance (ANOVA) table

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	3065.91	7	437.99	82.18	0.0020	significant
A-Welding Speed	308.14	1	308.14	57.81	0.0047	
B-Voltage	1823.78	1	1823.78	342.19	0.0003	
C-Current	581.92	1	581.92	109.18	0.0019	
AB	130.65	1	130.65	24.51	0.0158	
AC	83.01	1	83.01	15.58	0.0290	
BC	21.29	1	21.29	3.99	0.1395	
ABC	117.12	1	117.12	21.97	0.0184	
Residual	15.99	3	5.33			
Lack of Fit	0.82	1	0.82	0.11	0.7730	not significant
Pure Error	15.17	2	7.58			
Cor Total	3081.90	10				

Std. Dev.	2.31	R-Squared	0.9948
Mean	242.78	Adj R-Squared	0.9827
C.V. %	0.95	Pred R-Squared	0.9311
PRESS	212.46	Adeq Precision	34.193

The corresponding data on the three response variables were evaluated and recorded as shown on the left-hand column of Table 1. The 11 experiments were conducted in the average value of the dye penetration and hardness (HV). Analysis of variance (ANOVA) was performed for this purpose. The Model F-value of 82.18, which implies the model is significant. The "Model F-Value" at this research large could occur due to noise is only a 0.20% chance. Values of "Prob > F" less than 0.0500 indicates model terms are significant. Analysis shows that A, B and C factor are significant model terms. The model terms are not significant when values indicate greater than 0.1000. If there are many insignificant model terms (not counting those required to support hierarchy), the model reduction may improve that model. It shows interaction between factor AB and AC in this model. The "Lack of Fit F-value" of 0.11 implies that the Lack of Fit is not significantly relative to the pure error. There is an 77.3% chance that a "Lack of Fit F-value" this large could occur due to noise. Non-significant lack of fit is good where it makes the model to fit. The values of R^2 and adjusted R^2 are over 90%. This means that regression model provides an excellent explanation of the relationship between the independent variables (factors) and the hardness (HV). The associated p-value for the model is lower than 0.05 (i.e. α =

0.05, or 95% confidence) which indicates that the model is considered to be statistically significant [10, 11]. The lack-of-fit term is non-significant as it is desired. Furthermore, factor A (welding speed) and factor B (voltage), have a significant effect. Other model terms are said to be non-significant. The 3D surface graphs for hardness are shown in Figure 4.

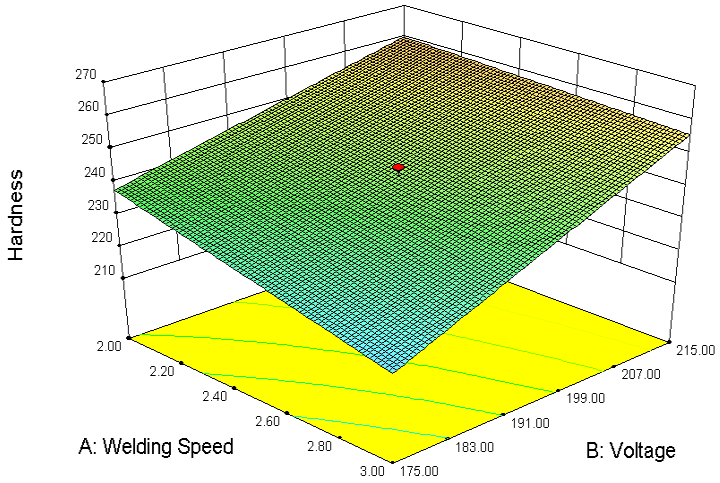
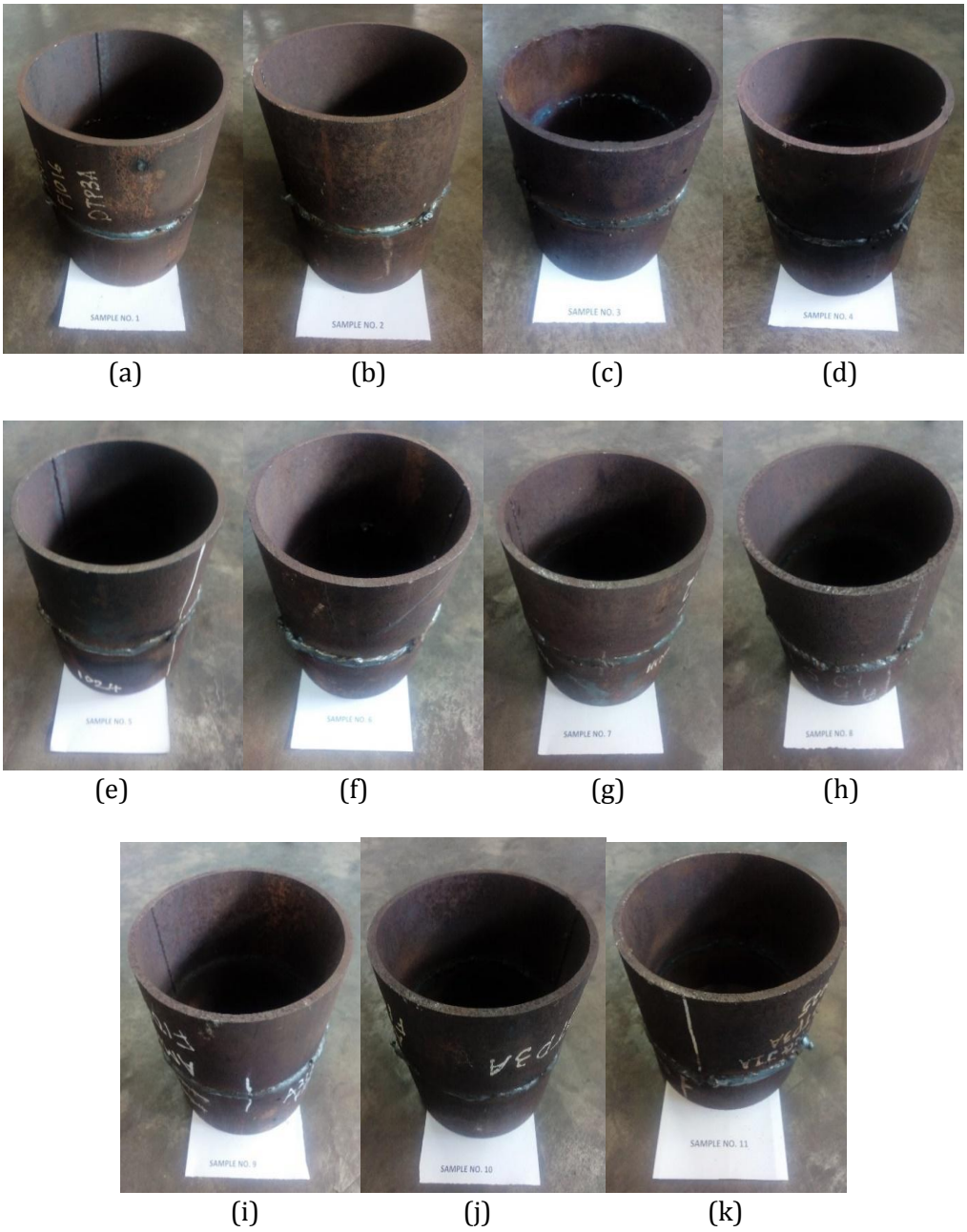


Figure 4. Effect of welding speed and voltage on hardness.

Welding quality can be achieved by meeting the quality requirements such as bead geometry that is strongly influenced by various process parameters involved in the process. Fig. 5 shows the sample no. 1 – no. 11 represents for each testing factor and level. All the connection welding connection should be tested to ensure the strength, durability and leakage [12, 13]. Weld joint that has been welded on base metals actually has more power than the base metal

CONCLUSION

Welding strength or tensile strength of the weld joint depends on the welding parameters such as voltage, current and welding speed. With the increase in current, hardness of the weld joint increases. With the automated welding system uniform welding of stainless steel bevel pipe can be possible. The hardness value at the welded zone taken from the center of the welding zone towards the base material for different samples performed with different welding speed and welding current. Welding penetration is changed by depending on the welding speed and current setting is welding penetration is changed.



(a) (b) (c) (d)

(e) (f) (g) (h)

(i) (j) (k)

Figure 5. Sample No. 1 – No. 11 represents for each testing factor and level.

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