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Use of DC Motor Control in Development of Pipe Welding Technology by Using the GMAW Process for Variation of Welding Nozzle Movement

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Abstract: Gas Metal Arc Welding (GMAW) welding technology is a welding method that is widely used in industry. A problem that often occurs is that it is difficult for a welder to control the speed of movement of the welding nozzle, which can affect the quality of the welding results. With welding tools that can control the movement of the welding nozzle, this problem can be overcome and increase the efficiency and productivity of the welding manufacturing process. The method for testing the quality of welding results is analyzed visually using the visual test and penetrant test methods. The use of GMAW welding tools for pipe butt joints using DC motor control to vary the movement of the welding nozzle is effective, making it easier for the welder and good welding results. Good welding results were obtained for setting the welding nozzle movement time in 1.4 seconds and 1 second for one left and right the movement cycle on a pipe joint rotating at a constant speed of 24 rpm. Setting the time for the welding nozzle movement in 0.6 seconds for one cycle of left and right movement produces poor welding in pipe joints that rotate at the same speed.

Keywords: DC Motor Control, GMAW Welding, Welding Nozzle Movement

1. Introduction

Gas Metal Arc Welding (GMAW) welding technology is a welding method that is widely used in industry. The GMAW welding process uses solid wire as a filler metal which is fed continuously and the resulting arc is protected by inert gases such as argon or helium [3][8]. The characteristics of the welding process are greatly influenced by the shielding gas. Inert gases such as argon and helium cause a more stable arc with fewer spatters and produce high quality welds. However, a problem that often occurs in the pipe welding process using the GMAW welding process is that it is difficult for a welder to control the speed of the welding handle around the pipe and the movement of the welding nozzle which can affect the quality of the welding results. Previous research on GMAW welding showed that variations in current and voltage with 1mm diameter filler affected the mechanical properties of hardness and tensile strength of commercial steel and it was found that changes in physical properties resulted in changes in the strength of the welded product [1][4]. It was also found that welding speed as a process parameter influenced the optimization of welding results [9] by deposition of a cladding layer with ER 309L metal core wire in GMAW welding [6]. In

addition, GMAW welding speed parameters using the Taguchi method are used to optimize the tensile strength of the welding results [11]. Stability in the pipe welding process also influences the welding results which produce minimal defects [10]In research on the influence of the stability Welding aids are one solution to overcome and facilitate the welding process, with the aim of increasing efficiency and productivity. For pipe welding, for example, developing pipe welding tools is the first step to producing quality welded joints. Pipe welding tools that are easy to move are a necessity for the user community. Therefore, designing and manufacturing tools that are easy, cheap and easy for high mobility need to be done. Previous research products related to pipe welding aids that currently exist use gearboxes to regulate the rotational speed of the pipe to be welded so that it is difficult to change the rotational speed during welding without stopping the welding process [10]

This research aims to develop and improve pipe welding tools using the existing GMAW process using DC motor control for varying welding nozzle movements to improve the quality of welding results. The benefit of this research is to obtain a GMAW welding tool for pipe butt joints using DC motor control to vary the movement of the welding nozzle.

2. Research Method

The method used in this research is a design method by analyzing the results of butt joint welding tests on the pipe. The parameters of this research consist of free parameters in the form of a welding nozzle movement time variable in one left and right movement cycle, namely 0.6 seconds, 1 second, and 1.4 seconds. The dependent variable is the welding results at each welding nozzle movement time setting. The method for testing the quality of welding results is analyzed visually using the visual test and penetrant test methods. There will be 2 (two) DC motor rotation speed controls, which will be used to rotate the pipe to be welded and move the welding nozzle. The rotational speed control system block for AC motors and DC motors realized in this research can be seen in Figure 1.

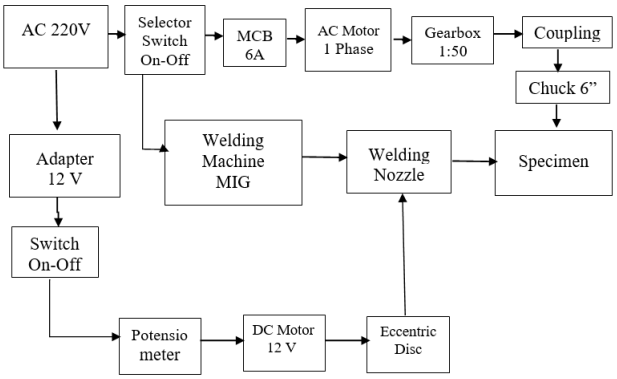

Figure 1. The Control system block of AC motor and DC motor rotational speed.

The 220 V AC source is connected to the welding machine via a selector switch to turn it on and off, to the 220 V AC motor to rotate the workpiece via a 6 A MCB and to the 12V DC motor to move the welding nozzle via the On-Off switch. The AC motor is connected to a 1:50 gearbox to produce torque that is able to rotate the workpiece after being directly coupled to a clutch and 6-inch chuck. Rotation of the workpiece in the form of a 4-inch diameter iron pipe is carried out with a clockwise rotation setting of 24 rpm. A 12V DC motor is connected to a potentiometer to regulate the movement of the welding nozzle for 3 (three) time settings in one left and right movement cycle, namely 0.6 seconds, 1 second and 1.4 seconds.

At the tool manufacturing stage, design and analysis of the materials that will be used to make pipe welding aids with varying speeds are carried out. First, the welding tool frame is made with dimensions of 112 cm x 70 cm x 70 cm. The frame is made using hollow iron with a cross section of 4x2 cm. Continue with the installation of a chuck holder with a maximum size of 6-inch, welded handlebar mounts and panel box mounts as well as pipe supports for long pipes. The final stage is testing the pipe welding tool which is integrated with the GMAW welding machine available in the welding laboratory.

3. Result and Analysis

In the manufacturing step, the auxiliary tool system that has been designed is realized using a DC motor, gearbox, clutch, 6-inch chuck to hold the pipe, hollow iron as a frame. The results of the design of the welding aids can be seen in Figure 2. Welding specimens in the form of 6 pieces or 3 pairs of 4-inch pipe butt joints which have been carried out using welding aids that have been designed can be seen in Figure 3.

Figure 2. *The results of welding aids design.*

The test was carried out using variations in the rotation of the welding nozzle, where the 1st sample had a time setting for one movement cycle to the left and right of 0.6 seconds, the 2nd sample was 1 second and the 3rd sample was 1.4 seconds. At the stage of visual analysis of the dimensional results of the weld results and acceptance criteria based on TWI standards, the quality of the weld results were tested, which were

analyzed visually using the visual test and penetrant test methods.

Visual testing is carried out using the TWI standard [2][4], which is the acceptance parameter. The measuring tools used in this test are a welding gauge and an elastic ruler. From the results of this test, it was found that 2 of the three specimens met the standards, while one more specimen was found to be defective in the form of an incompletely filled inter-run groove/lack of inter-run fusion.

(a) *(b)* *(c)*

Figure 3. *Welding specimen with various welding nozzle movement time.(a) 0.6 sec (b) 1 sec (c) 1.4 sec*

Penetrant testing is carried out to look for weld defects that cannot be identified through visual testing. This test uses penetrant test equipment consisting of a cleaner, dye-penetrant, and developer. Before carrying out this test, the specimen is first cleaned with a liquid cleaner with the aim of cleaning solid particles that are still attached to the weld joint. Next, the dye-penetrant is applied using a brush so that the entire weld surface is covered. After waiting for 5 minutes, the welding surface was cleaned again with cleaner until all the dye-penetrant was removed from the welded surface. The final stage is spraying developer fluid to attract dye penetrant trapped on the defective surface. An image of the specimen after being tested using penetrant testing can be seen in Figure 4.

(a) (b) (c)

Figure 4. Specimen tested using penetrant testing with various welding nozzle movement times.

(a) 0.6 sec (b) 1 sec (c) 1.4 sec

The analysis results of this penetration test can be seen in Table 1.

Table 1. *Analysis results from penetrant testing*

Sample Number	Welding Nozzle Movement Time (sec)	Penentrant Testing Inspection Results		Cause Rejected
		Accepted	Rejected	
1	0.6		√	The nozzle movement speed is too fast
2	1	√		
3	1.4	√		

4. Conclusion

Several conclusions can be drawn from this research, namely:

1. Use GMAW welding tools for pipe butt joints using DC motor control to vary the movement of the welding nozzle effectively, making it easier for the welder and good welding results.
2. Good welding results were obtained for setting the welding nozzle movement time in 1.4 seconds and 1 second for one cycle of left and right movement on a pipe joint rotating at a constant speed of 24 rpm.
3. Bad welding results were obtained for setting the welding nozzle movement time in 0.6 seconds for one left and right the movement cycle on a pipe joint rotating at a constant speed of 24 rpm

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