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Analysis of Electric Current on Aluminum Plate Welding Using MMA (Manual Metal Arc) Method

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***Abstract*—Many industries depend on welding, which joins materials with heat. This research focuses on Manual Metal Arc (MMA) welding aluminum plates due to its adaptability for thin materials and compatibility with aluminum's unique properties. The study investigates how electric current affects aluminum plate MMA welding, improving welding methods. The study examined the effect of electric current on aluminum plates using the MMA method using a qualitative descriptive research design. Sorong Merchant Marine Polytechnic's workshop laboratory conducted the research from February to May 2023 using AWS E 6013 welding electrodes and ASTM A36 plates. Data was collected through observation, documentation, and literature review, then analyzed using data reduction principles. Results show that electric current variation significantly affects welding characteristics. Increased amperage penetrates deeper, but excessive current can melt and weaken joints. Amperage, weld rate, joint quality, and penetration depth must be balanced. The study emphasizes precise welding control, improving welding efficacy. The complex relationship between critical parameters emphasizes the need for careful equilibrium and the importance of following welding guidelines and parameters in the Welding Procedure Specification. As inadequate or excessive current can affect weld quality, this research improves MMA aluminum plate welding results.**

Keywords— Analysis, Electric Current, MMA, Sorong

I. INTRODUCTION

The process of joining two or more materials, typically metals, by heating the material to be joined until it melts is known as welding. Welding is the process of joining two or more materials, typically metal, through the application of heat energy until the material to be joined melts and subsequently fuses or combines, with or without the addition of pressure and materials [1]. Welding is performed primarily to create a sturdy and long-lasting connection between metal components. Welding processes find widespread application across diverse sectors such as construction, manufacturing, automotive, and aviation [2]. Additionally, welding is frequently used in the shipping industry.

Welding is utilized to create joints that are resistant to mechanical loads, pressure, and high temperatures; such joints are crucial for the construction and manufacture of a variety of products. Welding serves as a prerequisite for improved manufacturing rather than the ultimate objective of construction. A frequently employed welding technique is the Manual Metal Arc (MMA) method, in which a joint is formed by melting metal from a coated electrode. Manual Metal Arc Welding (MMAW), also referred to as "stick electrode" welding, operates on the principle of an electric circuit. The two purposes of the electric arc generated between the electrode and workpiece are to melt the joint's edges, which result in the formation of a melt pool on the workpiece, and to melt the coated electrode's tip. By combining with the molten base material, the electrode is consumed and functions as a filler material to fill the joint [3].

The MMA method is the preferred approach for welding aluminum plates due to its adaptability in processing thin materials and its capability of surmounting the unique attributes of aluminum, including its elevated thermal and electrical conductivities. MMA-based aluminum plate gluing necessitates careful consideration of a number of factors, with electric current being one of the most significant. One of the seven parameters that determines successful MMA (Manual Metal Arc Welding) outcomes is responsible for controlling the welding current [4]. Welding current is one of the parameters that influences the quality of the resulting welds [5].

In welding, the quality of the resulting joint, welding penetration, and welding rate are all significantly influenced by the electric current. Consequently, the purpose of this research is to determine how electric current influences the MMA-welding procedure for aluminum plates. By attaining a more comprehensive comprehension of this correlation, it is anticipated that this study will contribute positively to the advancement of welding methodologies, enhance efficacy, and ultimately elevate the quality of aluminum plate welding outcomes when employing the MMA technique.

Welding metal is an essential manufacturing process for producing sturdy and long-lasting structures,

particularly aluminum, which has numerous applications in the shipping industry. In this process, shielded metal arc welding (SMAW) and manual metal arc (MMA) are frequently utilized. While these techniques have been extensively implemented, there is still a lack of comprehensive knowledge regarding the impact of welding position and electric current on aluminum metal.

II. METHOD

This study employs a qualitative descriptive research design. Descriptive qualitative research is an approach to investigating phenomena that transpire within a specific context through the application of a variety of natural processes. Discussion in the form of exposure to words and language, within a unique natural context, and through the use of a variety of natural methods comprise this research [6]. As a result, the author attempts to explicate the outcomes of all studies and research conducted on a given object in the subsequent discussion.

The methodologies employed for data collection encompass observation, documentation, and literature review. The effect of an electric current on aluminum metal plates was observed utilizing the MMA method. The investigation commenced on February 13, 2023, and concluded on May 11, 2023, within the workshop laboratory of Sorong Shipping Polytechnic. The research materials utilized consist of AWS E 6013 welding electrodes and ASTM A36 plates, as well as welding cables, mass clamps, welding pliers, and MMA machines, among other apparatus. Data analysis, which includes data reduction, data presentation, and conclusion formulation, follows data collection [7].

III. RESULT AND DISCUSSION

Variation in electric current voltage has a significant impact on the welding characteristics of aluminum plates using the MMA method, according to the findings. Welding penetration observations indicate that, on average, an increase in amperage results in a corresponding depth of penetration. The study was conducted using a current range of 90-110 Amperes and a plate thickness of 3.2 mm in diameter, in accordance with the guidelines outlined in the Kobelco welding handbook, 2008 [8]. Nevertheless, overabundances may lead to undesired melting and the formation of joints that lack stability.

TABLE I. WELDING PARAMETERS

Diameter (mm)	Length (mm	Current (Ampere)	
		1F,1G,2F,2G	3G ,4G
2,6	360	60-90	50-80
3,2	400	90-130	80-110
4,0	400	130-180	90-140

An increase in the electric current voltage generally results in a corresponding acceleration of the welding procedure. It is important to acknowledge, nevertheless, that an excessively high welding rate may undermine the integrity of the joint, resulting in imperfections like porosity and cracking.

Inappropriate amperage voltage can result in defects and unstable joints, whereas proper amperage voltage can produce strong and uniform joints. Hence, when determining amperage, it is crucial to strike a balance between weld rate, joint quality, and penetration depth.

A greater depth of penetration and accelerated melting of the parent metal are outcomes of welding with a greater electric current; however, an increased current can also result in an enlargement of the HAZ (Heat Affected Zone) region [9]. In weld areas characterized by a high heat absorption capacity, welding necessitates the application of a substantial electric current and potentially additional heat [10].

For proper execution of the welding procedure, the welder must be aware of the required parameters. Those with prior experience in welding typically comprehend the extent to which parameters are utilized. The following welding parameters are detailed in the WPS, or welding procedure specification. However, ensure that both the WPS and the product you intend to weld remain within their respective qualification ranges [11].

A low current intensity can impede the ignition of the electric arc, resulting in insufficient power to melt both the electrode and the base material. Consequently, this limitation leads to uneven melting patterns and shallow material penetration. On the contrary, excessive current strength will result in rapid electrode melting, a broad weld surface, and excessive material penetration, all of which contribute to the material becoming brittle. As a result, numerous factors affect the quality of the weld, including the determination of the current strength during welding.

IV. CONCLUSION

An intricate correlation between critical parameters is uncovered by the investigation into the effect of electric current voltage variation on the welding characteristics of aluminum plates utilizing the MMA method. The results underscore the relationship between amperage increase and drilling depth, which impacts the welding process as a whole. Consistent with the 2008 Kobelco welding handbook recommendations, the research was carried out using a current range of 90-110 Amperes and a plate thickness of 3.2 mm. Aside from that, however, extreme amperage may result in the formation of unstable joints and unintended melting, which are both undesirable outcomes. Maintaining a careful equilibrium among amperage, weld rate, joint quality, penetration depth, and weld rate is emphasized in the study. An increase in welding current results in deeper penetration and quicker melting, but this is accompanied by the potential for the Heat Affected Zone (HAZ) to expand. It is imperative for welders to possess knowledge of the welding parameters outlined in the Welding Procedure Specification (WPS), as this knowledge is essential for attaining accurate results while adhering to qualification limits. As inadequate or excessive current may hinder the ignition of the electric arc, contribute to uneven melting patterns, or facilitate excessive material penetration, thereby affecting the overall quality of the weld, the complexities of current intensity further emphasize the need for precise control.

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