A Review on GMAW Process Parameter Taguchi based Optimization of Aluminium Alloy

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Abstract— Welding is the manufacturing method, which is carried out by joining two similar and dissimilar metals. GMAW welding is one of the most widely used processes in industry. The GMAW welding parameters are the most important factors affecting the quality, productivity and cost of welding. We studied input parameters of welding such as welding current, arc voltage, welding speed, root gap and output parameter are hardness and tensile strength. This review is based on optimization techniques and analysis tools used by researchers to optimize the parameters. In this research paper a review has been presented on GMAW welding. The previous literature has been discussed along with the future aspects included in the field of GMAW welding.

Key words: GMAW, Strength, Mechanical Properties, Review

I. Introduction

Welding is a process used to permanently join the different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and pressure. During welding process, the work-pieces which have to be joined are melted and after solidification of this melted metal a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material in between the two or more work pieces which after solidification gives a strong bond between the work pieces. Weld ability of a material depends on various factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position. Gas Metal Arc Welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a welding process in which an electric arc forms between a consumable wire electrode and the workpiece metal(s), which heats the workpiece metal(s), causing them to melt, and join. Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from contaminants in the air. Originally developed for welding aluminium and other non-ferrous materials in the 1940s, GMAW is the most common industrial welding process, preferred for its versatility, speed and the relative ease of adapting the process to robotic automation. Unlike welding processes that do not employ a shielding gas, such as shielded metal arc welding, it is rarely used outdoors or in other areas of air volatility. The GMAW setup is as shown in figure.

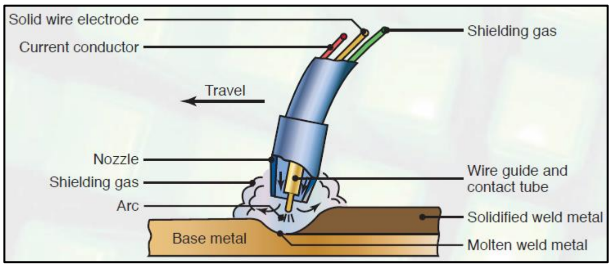

Fig. 1: Schematic Diagram of GMAW Welding System

Gas Metal Arc Welding is a process in which the source of heat is an arc format between consumable metal electrode and the work piece, and the arc and the molten puddle are protected from contamination by the atmosphere (i.e. oxygen and nitrogen) with an externally supplied gaseous shield of gas either inert such as argon, helium or an argon-helium mixture or active such as carbon dioxide, argon-carbon dioxide mixture, which is chemically active or not inert. Initially GMAW was called as MIG Welding because only inert gasses were used to protect the molten puddle. The application of this process was restricted to aluminum, deoxidized copper and silicon bronze. Later it was used to weld ferrite and austenitic steels, and mild steel successfully by using active gasses in place of inert gasses and hence was term MAG (Metal Active Gas) welding.

GMAW welding process overcome the restriction of using small lengths of electrodes and overcome the inability of the submerged-arc process to weld in various positions. By suitable adjusting the process parameters, it is possible to weld joints in the thickness range of 1-13 mm in all welding position. All the major commercial metals can be welded by GMAW (MIG/CO2) process, including carbon steels, low alloy and high alloy steels, stainless, aluminum, and copper titanium, zirconium and nickel alloys.

GMAW (MIG/CO_2) is also used in mechanized and automatic forms to eliminate the operator factor and to increase the productivity and consistency of quality.

II. Review of Past Studies

James, M.N. et al. (2008) investigation of the single-line residual stress profiles for 8 mm 5083-H321 aluminium plates joined by gas metal arc (MIG) welding. The data were obtained by synchrotron diffraction strain scanning. Weld metal stresses (up to 7 mm either side of the centreline) are quite scattered and unreliable because of the large epitaxial grain size in the fusion zone. The effect on residual stress and strain values of a sequence of applied fatigue loads was also considered and reported. Wang Rui, et al. (2008) carried out the dynamic progress and residual distortion of out-of-plane of aluminium alloy 5A12 was investigated under different welding conditions of TIG welding. The dynamic out-of-plane distortion was measured by self-developed distortion measuring system. Out of-plane distortion mechanism and

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the effecting parameters on distortion process were analyzed, and the effect of plate thickness and welding heat input on distortion was discussed. Simone Matteı, et al. (2009) studied in the order to deepen the understanding of the differences between laser and laser-arc hybrid welding, comparisons were undertaken using thermograph. The experiments were carried out for a T assembly of aluminium alloy plates. Modelling, based on the finite element method approach, was realized using IR temperature measurements and seam geometry. Manoj Singla, et al. (2010) discussed Gas Metal Arc Welding is a process in which the source of heat is an arc format between consumable metal electrode and the work piece with an externally supplied gaseous shield of gas either inert such as argon, helium. This experimental study aims at optimizing various Gas Metal Arc welding parameters including welding voltage, welding current, welding speed and nozzle to plate distance (NPD) by developing a mathematical model for sound weld deposit area of a mild steel specimen. Suresh Kumar, L. at al. (2011) discussed about the mechanical properties of austenitic stainless steel for the process of TIG and MIG welding. As with other welding processes such as gas metal arc welding, shielding gases are necessary in GTAW or MIG welding is used to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity, and weld metal embitterment if they come in contact with the electrode, the arc, or the welding metal. Lihui, Lu. et al. (2012) discussed the double-variable decoupling control scheme was proposed for GMAW-P process of aluminium helping to efficiently develop welding procedure. Weld pool width and arc length were both measured through vision sensing in welding process. Weld bead shape was improved by changing the current waveforms to adjust the heat input while the arc length was controlled to stabilize the welding process. Pawan Kumar, et al. (2013) investigated about the welding is widely used by manufacturing engineers and production personnel to quickly and effectively set up manufacturing processes for new products. This study discusses an investigation into the use of Taguchi's Parameter Design methodology for Parametric Study of Gas Metal Arc Welding of Stainless Steel & Low Carbon Steel. In this research work, bead on plate welds were carried out on AISI 304 & Low Carbon Steel plates using gas metal arc welding (GMAW) process. Taguchi method is used to formulate the experimental design. Design of experiments using orthogonal array is employed to develop the weldments. Priti Sonasale, et al. (2014) carried out the Metal arc Welding (MIG) process finds wide application because all commercially important applicable metals such as carbon steel, high-strength, low-alloy steel, and stainless steel, aluminium, copper, titanium, and nickel alloys can be welded in all positions with this process by choosing the appropriate shielding gas, electrode, and welding variables. Vivek Saxena, et al. (2015) discussed days Alloy of aluminium is widely used due to its versatility especially in automotive industry. Most of the component is made by casting but some may require welding too. These components are loaded statically and dynamically as per application. Due to these reason corresponding strength is needed to be insured for the product having welded joint. This paper unveiled the influence of welding parameters on tensile strength of AM40 (EN AW 5083) aluminium alloy material during welding. A Set of experiments on MIG Welding Set up based on Taguchi technique has been used. Fuheng Nie et al., (2016) studied about the microstructure and mechanical properties of pulse metal inert-gas (MIG) welded dissimilar joints between 4 mm thick wrought 6061-T6 and cast A356-T6 aluminum alloy plates. In testing the tensile strength of the joints reaches 235 MPa, which is 83% of that of 6061 aluminum alloy, and then decreased with the increase of travel speed while keeping other welding parameters constant. The microstructure, composition and fractography of joints were examined by the optical microscopy (OM), scanning electron microscopy (SEM) and electron probe microanalysis (EPMA). Grain boundary liquation and segregation occurred in the partially melted zone (PMZ) on 6061 aluminum alloy side, and brittle Fe-rich phases were observed in partially melted zone on A356 aluminum alloy side. The minimum microhardness appeared in heat-affected zone (HAZ) near A356 aluminum alloy substrate. Anil Kumar (2017) studied input parameters of welding such as welding current, arc voltage, welding speed, root gap and output parameter are hardness, tensile strength, impact energy, and microstructure. This review is based on optimization techniques and analysis tools used by researchers to optimize the parameters. In this research paper a review has been presented on MIG welding. The previous literature has been discussed along with the future aspects included in the field of MIG welding. Mayur D. Jagtap and Niyati Raut (2018) Joining of metals has discovered its utilization broadly in control age, electronic, atomic reactors, petrochemical and substance businesses because of ecological concern. However effective welding of unique metals has represented a noteworthy test because of distinction in mechanical and concoction properties of the materials to be joined under a typical welding condition. This causes a lofty slope of the mechanical properties along the weld. An assortment of issues come up in different welding like breaking, extensive weld leftover burdens, relocation of particles, amid welding causing pressure fixation on one side of the weld, compressive and tractable anxieties, push consumption splitting, and so on. To beat this cause there is a requirement of perfect welding process parameter on mechanical property. MIG welding is a standout amongst the most generally utilized procedures in industry. Welding process parameters are influencing quality and efficiency of welding. Streamlining methods are utilized to improve the procedure parameters. This audit depends on enhancement procedures and investigation instruments utilized by specialists to advance the parameters. Additionally numerous scientist conveyed think about on different reaction parameters like penetration depth, globule width ,bead height, strength of joint and so forth.

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