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Effect of Welding Parameters on Weld Properties of Gma Welded Steel Plate – An Overview

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Abstract- The weld quality at the joint is directly influenced by the input welding parameters. A common problem faced by manufacturer is to control process input parameter to obtain the good welded joint with required bead geometry, good mechanical properties, weld quality with minimal detrimental residual stresses and distortion. Structural steel is frequently used for industrial purpose as it is more economical as compared to other steels. In the present research article, an attempt has been made to find, how the weld profile and microstructure properties of the GMA welded structural steel are affected by the different welding parameters such as shielding gas flow rate, voltage, wire feed speed and welding current, etc... The parameters are analysed for getting a good quality weld profile and micro structural properties of welded joint.

Process Keywords: Gas Metal Arc Welding (GMAW), Shielding Gas, Optimization, Structural Steel, Welding Parameters.

INTRODUCTION

Welding is a process of joining materials and is more economical and is a much faster process compared to both casting and riveting. Gas Metal Arc Welding (GMAW) is an arc welding process that joins metals together by heating them with an electric arc that is established between a consumable electrode (wire) and the work piece. An externally supplied gas or gas mixture acts to shield the arc and molten weld pool. Although the basic GMAW concept was introduced in the 1920s, it was not commercially available until 1948. At first, it was considered to be fundamentally a high-current density, small-diameter, bare-metal electrode process using an inert gas for arc shielding. Its primary application was aluminium welding. As a result, it became known as Metal Inert Gas (MIG) welding, which is still a common nomenclature. Subsequent process developments included operation at low current densities and pulsed direct current, application to a broader range of materials, and the use of reactive gases (particularly carbon dioxide) and gas mixtures. The latter development, in which both inert and reactive gases are used, led to the formal acceptance of the term gas-metal arc welding.

GMAW can be done in three different ways:

1. Semiautomatic welding – equipment controls only the electrode wire feeding. Movement of welding gun is controlled by hand. This may be called hand-held welding.
2. Machine welding – uses a gun that is connected to a manipulator of some kind (not hand-held). An operator has to constantly set and adjust controls that move the manipulator.
3. Automatic welding – uses equipment which welds without the constant adjusting of controls by a welder. On some equipment, automatic sensing devices control the correct gun alignment in a weld joint.

WORKING PRINCIPLE OF GMAW

This process uses an electric arc as a source of heat to melt and join the metals. An arc is an electrical discharge over a gaseous path between two electrodes which takes place through an electrically conducting hot ionized gas known as plasma

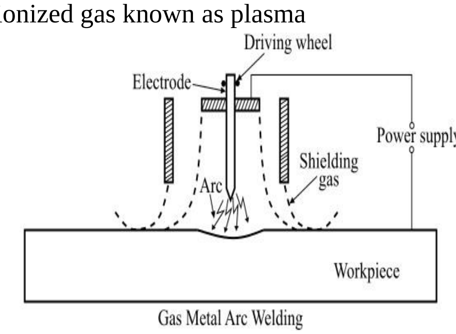

Figure.1 Schematic diagram of GMAW

Electric arc is established between the workpiece and the consumable bare wire electrode which is fed through a welding gun. The heat of the arc melts the surface of the base metal and the end of the electrode. The electrode serves to carry the current and sustain the electric arc between its tip and workpiece and continuously melts the wire as it is fed to the weld puddle. This also supplies filler metal to the joint. 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. These gases are delivered through the welding gun and cable assembly from external supply. They also transfer heat to the base metal and involve in heat input process.

WELDING PARAMETERS

1. Voltage
2. Current
3. Wire Feed Speed
4. Travel Speed
5. Electrode Diameter
6. Gas Composition
7. Welding Technique
8. Joint Design
9. Welding Position
10. Base Material

LITERATURE SURVEY

[1]. Ajit Hooda et al., investigated the maximum yield strength both transverse and longitudinal, at the optimum values of process variables-welding voltage, welding current, wire speed and gas flow rate was experimented. The longitudinal yield strength is greater than the transverse yield strength.

[2]. Diganta Kalita, Parimal Bakul Barua investigated the effect of the three process parameters of Metal Inert Gas Welding (MIG), welding current, voltage and shielding gas flow rate on tensile strength of welded joints having Grade C20 Carbon Steel as parent metal and ER70S-4 electrode. An experiment has been designed using Taguchi‟s Orthogonal Array L9.

[3]. P. Srinivasa Rao et al., have investigated the weld bead plays an important role in determining the mechanical properties of the weld. Its geometric parameters, viz., width, reinforcement height, and penetration, are decided according to the welding process parameters, such as wire feed rate, welding speed, pulse current magnitude, frequency (cycle time), etc. Therefore, to produce good weld bead geometry, it is important to set the proper welding process parameters.

[4]. Ravi Bharadwaj et al., suggested the effect of MIG welding parameters specifically Welding current, Voltage, Gas flow rate and Plate thickness during welding of AISI-304 stainless steel Material on MIG welding machine at different level presents in this work. All the welding parameters are modeled using Taguchi-based Principle Component Analysis (PCA).

[5]. Nabendu Ghosh et al., suggested welding input process parameters play a very significant role in determining the quality of the welded joint. Only by properly controlling every element of the process can product quality be controlled. The quality of the weld has been evaluated in terms of yield strength, ultimate tensile strength and percentage of elongation of the welded specimens. They also investigate

[6]. Nabendu Ghosh et al., To study and analyze the effects of welding parameters: welding current, gas flow rate and nozzle to plate distance, on ultimate tensile strength (UTS) and Yield Strength (YS) in MIG welding of AISI409 ferritic stainless steel to AISI 316L Austenitic Stainless Steel materials. Experiments have been conducted as per L9 orthogonal array of Taguchi method.

[7]. P.Pavani et al., studied Manual Metal Arc Welding of carbon steel plates were studied. The finite element analysis of residual stresses in butt welding of two similar plates is performed with the ANSYS software. This analysis includes a finite element model for the thermal and mechanical welding simulation.

[8]. Dragi Stamenković and Ivana Vasovic studied Manual Metal Arc Welding of carbon steel plates were studied. The finite element analysis of residual stresses in butt welding of two similar plates is performed with the ANSYS software. This analysis includes a finite element model for the thermal and mechanical welding simulation.

[9]. M. D. Faseeulla Khan, D. K. Dwivedi, Satpa Sharma investigated the development of a response surface model to study the influence of process parameters of weld-bonding on tensile shear strength of the weld-bond of 2 mm thick aluminum alloy 6061 T651 sheets. Welding current, welding time and

welding pressure were identified as significant and controllable parameters.

[10]. Amit Kohli and Hari Singh studied an effective procedure of response surface methodology (RSM) has been utilized for finding the optimal values of process parameters while induction hardening of AISI 1040 under two different conditions of the material i.e., rolled and normalized. Various process parameters, such as feed rate (speed at which the induction coil moves, which is measured in mm/sec), current, dwell time (time after which heat intensity starts to heat work piece in seconds) and gap between the work piece and induction coil have been explored by experiments.

[11]. G Haragopal et al., presents taguchi method to design process parameters that optimize mechanical properties of weld specimen for aluminum alloy (Al-65032), used for construction of aerospace wings. Process parameters of MIG welding setup considered are gas pressure, current, groove angle and pre-heat. Assigning process parameters to L-9 orthogonal array, experiments were conducted and optimization condition was obtained along with the identification of most influencing parameters using S/N analysis, mean response analysis and ANOVA.

[12]. Satyaduttsinh P et al., studied the MIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. This paper presents the influence of welding parameters like welding current, welding voltage, Gas flow rate, wire feed speed, etc. on weld strength, weld pool geometry of Medium Carbon Steel material during welding. By using DOE method, the parameters can be optimized and having the best parameters combination for target quality.

[13]. H.R. Ghazvinloo et al., investigated aluminium alloys forming to AA6061 have a wide range of desirable properties which are used in different industries such as aircraft industry and other aerospace structures. The effect of processing variables on fatigue life, impact energy and bead penetration of AA6061 joints produced by MIG robotic welding process was analysed in the present study.

EFFECTS OF WELDING PARAMETERS

1. Voltage: Voltage controls the electrical potential difference between the welding gun's electrode wire and the workpiece. Higher voltage results in a hotter arc and more profound penetration, while lower voltage produces a cooler arc and shallower penetration. Voltage is typically adjusted based on the material thickness and desired weld profile.
2. Current: Current determines the rate at which the electrode wire melts and the amount of heat generated during welding. Higher current leads to more heat input and faster deposition of filler material. Lower current produces less heat and slower deposition. Current is chosen based on the material type and thickness.
3. Wire Feed Speed: Wire feed speed controls the rate at which the consumable electrode wire is fed into the welding arc. Increasing the wire feed speed results in a higher deposition rate and wider weld bead. Slower wire feed speed produces a narrower bead. The appropriate wire feed speed is determined by the desired weld size and the selected current.
4. Travel Speed: Travel speed refers to how fast the welding gun is moved along the joint. A consistent travel speed helps ensure even deposition of filler material and proper fusion with the base metal. Travel speed is adjusted to achieve the desired bead shape and fusion.
5. Electrode Diameter: The diameter of the consumable electrode wire used in GMAW affects the weld's heat input and deposition rate. Thicker electrodes require higher amperage and voltage settings, while thinner electrodes need lower settings. The choice of electrode diameter depends on the material thickness and welding application.
6. Gas Type and Flow Rate: GMAW typically uses shielding gases to protect the welding arc and molten metal from atmospheric contamination. Common shielding gases include argon (Ar), carbon dioxide (CO_2), and mixtures of both. The specific gas and its flow rate are selected based on the material being welded and the desired weld characteristics.
7. Electrode Stick-Out: Electrode stick-out refers to the distance between the end of the electrode wire and the contact tip of the welding gun. Maintaining the correct stick-out is crucial for stable arc performance and preventing wire stubbing or erratic arc behavior.
8. Joint Preparation: The type of joint (e.g., butt joint, lap joint, fillet joint) and its preparation, such as beveling or chamfering, impact welding parameters. Proper joint preparation ensures good penetration and fusion.

9. Welding Position: The welding position (e.g., flat, horizontal, vertical, overhead) can affect the weld's quality and the choice of parameters. Some positions may require adjustments to voltage, wire feed speed, and travel speed to maintain the desired bead shape and penetration.

10. Base Material Type: Different base materials (e.g., carbon steel, stainless steel, aluminum) have varying thermal properties and electrical conductivity. Welding parameters must be tailored to the specific material being welded.

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