Experimental Investigation For Parametric Optimization Of Gas Metal Arc Welding Process For Welding Of AISI 1018 - A Review Paper

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ABSTRACT

Gas metal arc welding is a fusion welding process having wide applications in industries. Gas metal arc welding is one of the conventional and traditional methods to join materials. The present study is to investigate the influence of welding parameter on the penetration. The effect of welding current, welding voltage and gas flow rate on the depth of the penetration in gas metal arc welding of AISI 1018 mild steel having a different plate thickness 6mm and 8mm has been going to study through experiments and analysis, and investigate the optimization process parameter. The optimization for gas metal arc welding process parameters of Mild Steel work piece using Taguchi method will done. Nine experimental runs (L9) based on an orthogonal array Taguchi method will performed and investigate the effect of welding parameters like welding current, welding voltage and gas flow rate on depth of penetration. The depths of penetration were measured for each specimen after the welding operations and the effects of these parameters on penetration were researched.

Keyword: - *Gas Metal Arc Welding, AISI 1018 Mild Steel, Process Parameter, Depth of Penetration, S/N ratio*

1. INTRODUCTION

A Gas Metal arc welding (GMAW) is the process that included of heating, melting and solidification of parents metals and a filler (wire electrode) material in restricted fusion zone by transient heat source to form a joint between the parents metals. The continuous wire electrode from an automatic wire feeder and fed through the contact tip inside the welding torch is melted by the internal resistive power and heat transferred from the welding arc. Pressure regulator and flow meters are used to regulate the gas flow and pressure from the gas cylinder. Shielding of the arc and the molten weld pool is done by using inert gases such as argon, carbon dioxide and helium. The GMAW welding parameters influence the quality, productivity and cost of welding joint. The perfect arc will be achieved if all the welding parameters in conformation. These parameters consists of arc welding current, arc voltage, welding speed, torch angle, free wire length, nozzle distance, welding position and gas flow rate. The enough penetration, high heating rate and right welding profile occur the quality of welding joint. These are affected from welding current, arc voltage, welding speed and protective gas parameters All commercially important metals such as carbon steel, stainless steel, aluminum and copper can be welded with this process in all positions by choosing the appropriate shielding gas, electrode and welding condition The equipment involve in the welding are power source, wire fed unit, welding gun, shielding gas. This method is different from TIG welding because in TIG welding a non-consumable wire is used but in MIG welding consumable wire is used.[2][3][5]

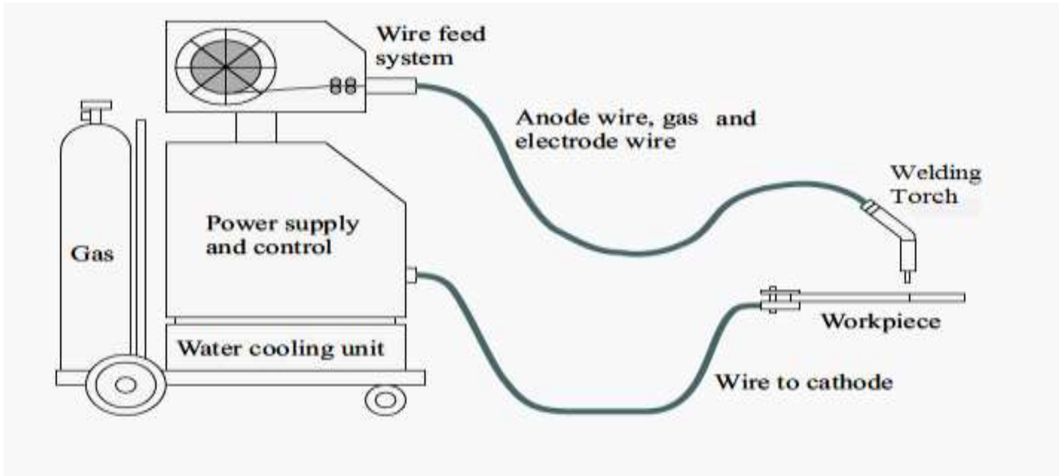

Fig.1 Schematic Diagram of GMAW process [13]

2. LITERATURE REVIEW

Erdal Karadeniz et al.[1] presented the effects of various welding parameters on welding penetration in Erdemir 6842 steel having 2.5 mm thickness welded by robotic gas metal arc welding were investigated. Erdemir 6842 steel plate was used as base metal in MIG welding process. The welding current, arc voltage and welding speed were chosen as variable parameters. The depths of penetration were measured for each specimen after the welding operations and the effects of these parameters on penetration were researched. The welding currents were chosen as 95, 105, 115 A, arc voltages were chosen as 22, 24, and 26 V and the welding speeds were chosen as 40, 60 and 80 cm/min for all experiments. As a result of this study, it was obvious that increasing welding current increased the depth of penetration. In addition, arc voltage is another parameter in incrimination of penetration. However, its effect is not as much as currents. The highest penetration was observed in 60 cm/min welding current.

Izzatul Aini Ibrahim et al.[2] present Gas Metal Arc Welding (GMAW) process is leading in the development in arc welding process which is higher productivity and good in quality. The variables that choose in this study are arc voltage, welding current and welding speed. The arc voltage and welding current were chosen as 22, 26 and 30 V and 90, 150 and 210 A respectively. The welding speed was chosen as 20, 40 and 60 cm/min. The penetration, microstructure and hardness were measured for each specimen after the welding process and the effect of it was studied. As a result, increasing the parameters value of welding current increased the value of depth of penetration. Other than that, arc voltage and welding speed is another factor that influenced the value of depth of penetration. The microstructure shown the different grain boundaries of each parameters that affected of the welding parameters.

Behcet Gulenca et al.[3] presented 304L stainless steel was bonded by MIG welding and mechanical and microstructural properties of the welded samples were investigated. Welding was carried out under different shielding media, which are argon and different additions of hydrogen in Ar. As current values, 140, 180 and 240A were chosen for the welding current parameters. The sample that was welded under 1.5% H2–Ar shielding media and with a welding current of 240A was found to be the best in terms of means of tensile strength. Impact tests revealed that toughness of the welding increases with increasing hydrogen amount in Ar and welding current. For all the welding parameters, hardness test results showed that base metal gave a higher hardness value than HAZ and weld metal. As results the highest tensile strength was obtained from the welding that was carried out under 1.5% H2–Ar shielding with a welding current of 240A and The best toughness value was obtained from the samples that were welded under 5% H2–Ar shielding with a welding current of 240A.

Nabendu Ghosh et al. [4] presented, visual inspection and X-ray radiographic test has been conducted in order to detect surface and sub-surface defects of weld specimens made of AISI 316L austenitic stainless steels. Effect of current, gas flow rate and nozzle to plate distance on quality of weld in metal inter gas arc welding of AISI 316L austenitic stainless steel has been studied. The welding currents were chosen as 100, 112, 124 A, Gas flow rate 10, 15, 20 l/min and the nozzle to plate distance 9, 12, 15 mm for all experiments. Butt welded joints have been made by using several levels of current, gas flow rate and nozzle to plate distance. The quality of the weld has been evaluated in terms of yield strength, ultimate tensile strength and percentage of elongation of the welded specimens. Results of visual inspection indicate that undercut, blow holes and spatter have been found in few samples, uneven deposition, and excessive penetration have also been found in some samples and in X-ray radiography test indicate lack of penetration, low – level porosity and lack of fusion in some of the samples.

S. D. Ambekar et al.[5] presented, the optimization for Gas metal arc welding process parameters (GMAW) of Martensitic Stainless steel work piece AISI 410. Sixteen experimental runs (L16) based on an orthogonal array Taguchi method were performed. The welding currents were chosen as 80, 90, 100, 110 A, welding speed were chosen as 30, 40, 50 and 60 V and the wire diameter were chosen as 0.8, 0.9, 1.0 and 1.2 mm for all experiments. As a result of this study, it was obvious that increasing welding current increased the depth of penetration. It is observed that by using Taguchi method analysis the optimum combination of the machine is found that Welding speed = 60 cm/min , welding current = 110 amp and wire diameter = 1.2 mm percentage contribution of various parameters for MIG welding found to be welding speed 46.61 %, welding current 21.24 % and wire diameter is 27.25 % and the error is found to be 4.90 %. This error is due to human ineffectiveness and machine vibration.

Tarun Patel et al.[6] presented the effect of Current (A), Voltage (V), Gas Flow rate (Ltr/min) and on weld depth of ST-37 low carbon alloy steel material. Experiment by using L9 orthogonal Array to find out weld depth and also perform confirmatory Experiment to find out optimal run set of current, voltage speed and gas flow rate. The welding currents were chosen as 270, 300, 330 A, arc voltages were chosen as 35, 42, and 49 V and the welding speeds were chosen as 11, 14 and 18 Lir/min for all experiments. The results of the Taguchi experiment identify that 42 voltage, 330 current, flow rate 14 Ltr/min are optimum parameter setting for weld depth.

Rajkumar Duhan et al.[7] studied of MIG (GMAW) welding process for study of micro structure and effect of heat on hardness of base metal, weld bead and HAZ by welding of EN 31. In this present research paper an electrode of 308 having diameter 1.2 mm was used with direct current electrode positive polarity. CO2 was employed for shielding purposes. Double – V butt joint was applied with 90°, two variables are decided current and voltage. In heat affected zone (HAZ) the value of hardness was found highest but the harness at weld-ment was found minimum. In order to understand the micro structural changes occurring in the weld zone is investigated through the optical microscopy. The hardness measurements were taken across the weld zone and HAZ.

Rakesh Sharma et al[8] presented to investigate the optimization process parameters for MIG welding. In the present work, bead-on -plate welds were carried out on MS 5986 Fe 410 carbon steel sheets using Gas Metal Arc Welding (GMAW) process. The welding voltages were chosen as 32, 42, 45 A, travel speed were chosen as 1, 2, and 3mm/s and the gas flow rate 8, 10, 11 Lir/min and current 280, 300, 320 A were chosen for all experiments. A mixture of argon-carbon dioxide was employed for shielding purposes. The minimum depth of penetration obtained from the experimental studies was 0.2mm when the process parameters such as voltage, travel speed, gas flow rate and welding current were maintained at 32V, 1mm/sec, 8 lit/min and 280 amp respectively. And maximum depth of penetration obtained from the experimental studies was 2.4mm when the process parameters such as voltage, travel speed, gas flow rate and welding current were maintained at 42V, 1mm/sec, 10 lit/min and 320 amp respectively.

P.Sathiya et al[9] presented bead-on -plate welds were carried out on AISI 904 L super austenitic stainless steel sheets using Gas Metal Arc Welding (GMAW) process. In this present investigation AISI 904 L solid wire having 1.2 mm diameter was used as an electrode with direct current electrode positive polarity. Argon was employed for shielding purposes. The shape of the fusion zone depends upon a number of parameters such as gas flow rate, voltage, travel speed and wire feed rate. The bead profile parameters such as bead width, bead height and depth of penetration are measured. From the experimental results, the gray relational analysis is applied to optimize the input parameters simultaneously considering multiple output variables. In order to understand the microstructural changes occurring in the weld zone is investigated through the optical microscopy. The hardness measurements were taken across the fusion zone.

H.R. Ghazvinloo[10] presented impact energy and bead penetration of AA6061 joints produced by robotic MIG welding. Different samples were obtained by employing arc voltages of 20, 23 and 26 V, welding currents of 110, 130 and 150 A, welding speeds of 50, 60 and 70 cm/min. After finishing of the welding process, the mechanical properties of the samples were evaluated by means of fatigue and impact test at room temperature and the depth of weld penetration was measured in all of geometrical specimens. Results were clearly illustrated that when heat input increases, fatigue life of weld metal decreases whereas impact energy of weld metal increases in first and then drops significantly. A linear increase in depth of penetration with increasing welding current and arc voltage was also observed. The biggest penetration in this investigation was observed for 60 cm/min welding speed.

C.W. Dong[11] presented additional shielding gas for compensation to overcome welding defects, which often occur when high temperature solid and liquid phase welds are exposed to air. This method properly modifies the current pulsed MIG welding device by adding an airflow control branch of shielding gas for compensation. This modified welding device with additional airflow is then used to conduct bead-on-plate pulsed MIG welding experiments using 18-8 type austenitic stainless steel as the base material. The study of microstructure and physical properties of the weld indicates that after introducing a certain amount of shielding gas for compensation, not only is weld formation significantly improved, but there is also timely track and protection of the weld surface. This largely inhibits the occurrence of welding defects during high-speed pulsed MIG single-wire welding and helps improve welding efficiency.

M. Aghakhani[12] mathematical model was developed using parameters such as, wire feed rate (W), welding voltage (V), nozzle-to-plate distance (N), welding speed (S) and gas flow rate (G) on weld dilution. After collecting data, signal-to-noise ratios (S/N) were calculated and used in order to obtain the optimum levels for every input parameter. Subsequently, using analysis of variance the significant coefficients for each input factor on the weld dilution were determined and validated. Finally a mathematical model based on regression analysis for predicting the weld dilution was obtained. Results from this research work show that wire feed rate (W),arc voltage (V) have increasing effect while nozzle-to-plate distance (N) and welding speed (S) have decreasing effect on the dilution whereas gas Flow rate alone has almost no effect on dilution but its interaction with other parameters makes it quite significant in increasing the weld dilution.

[13] **S. D. Ambekar[13]** presented to investigate the influence of process parameters on depth of penetration in Gas metal arc welding (GMAW) process. The optimization for Gas metal arc welding process parameters of Martensitic Stainless steel work piece AISI 410 using Taguchi method is carried out. Sixteen experimental runs (L16) based on an orthogonal array Taguchi method were performed. It is observed that by using Taguchi method analysis the optimum combination of the machine is found that Welding speed = 60 cm/min , welding current = 110 amp and wire diameter = 1.2 mm percentage contribution of various parameters for GMAW welding found to be welding speed 46.61 %, welding current 21.24 % and wire diameter is 27.25 % and the error is found to be 4.90 %. This error is due to human ineffectiveness and machine vibration.

3 SUMMARY

Following is summary of literature review:

- The value of depth of penetration increased by increasing the value of welding current. Welding current is factor that will determine the penetration. Penetration also influence by the factors from welding speed and arc voltage.
- Impact tests revealed that toughness of the welding increases with increasing hydrogen amount in Ar and welding current.
- Current is found to be more significant than gas flow rate and nozzle to plate distance in influencing the strength of the joint.
- The heat affected zone hardness values are higher than the weld metal and base metal. Due to high amount of interdendritic austenitic phase and fast cooling rate the grains are getting finer in HAZ.
- The grains of the weld metal became larger with increasing heat input because of increasing hydrogen addition into the shielding media.
- The grain boundaries of microstructure changes from bigger size to smallest size when the variables welding parameters changed.
- Increasing hydrogen content in argon as a shielding medium increased the penetration profile depth and width.

4. CONCLUSIONS

In this study to investigate the effect of GMAW processes on different welding parameters. it concluded that the penetration increased by increasing the welding current and voltage, and mechanical properties improved.

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