Experimental Investigation on Mechanical Property of MIG Welding Process

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Abstract— Metal Inert Gas welding is well known welding techniques, that are using in industries in current age.MIG welding is versatile and having less loss of alloying elements and can be operated as semiautomatic and fully automatic welding. An attempt will be made to investigate the effects of MIG welding on the mechanical properties of AA 6061 T6. Aluminium is the most commonly used material in aerospace industries. Aluminum is the second material in case of annual consumption after steel. Aluminium alloys are light in weight comparably less density with better mechanical properties with mild steel.So we considered Aluminum alloys for study. Different mechanical tests including tensile and hardness will be carried out to and identify the microstructure of the welded specimens.The input parameters of MIG welding such as welding current, arc voltage, welding speed is used as varying process parameters, which may plays a vital role in the determination of different properties.

Keywords: Metal Inert Gas welding, Aluminum alloys, welding current, arc voltage, welding speed.

I. INTRODUCTION

Metal inert gas arc welding (MIG) or more appropriately called as gas metal arc welding (GMAW) utilizes a consumable electrode and hence, the term metal appears in the title. There are other gas shielded arc welding processes utilizing the consumable electrodes, such as flux cored arc welding (FCAW) all of which can be termed under MIG. Though gas tungsten arc welding (GTAW) can be used to weld all types of metals, it is more suitable for thin sheets. When thicker sheets are to be welded, the filler metal requirement makes GTAW difficult to use. In this situation, the GMAW comes handy. The schematic diagram of GMAW or MIG welding process is shown in Figure 1. The consumable electrode is in the form of a wire reel which is fed at a constant rate, through the feed rollers.

The welding torch is connected to the gas supply cylinder which provides the necessary inert gas. The electrode and the work-piece are connected to the weldingpower supply. The power supplies are always of the constant voltage type only. Thecurrent from the welding machine is changed by the rate of feeding of the electrode wire.

Normally DC arc welding machines are used for GMAW with electrode positive (DCRP). The DCRP increases the metal deposition rate and also provides for a stable arc and smooth electrode metal transfer. With DCSP, the arc becomes highly unstable and also results in a large spatter. But special electrodes having calcium and titanium oxide mixtures as coatings are found to be good for welding steel with DCSP. In the GMAW process, the filler metal is transferred from the electrode to the joint. Depending on the current and voltage used for a given electrode, the metal transfer is done in different ways.

II. LITERATURE SURVEY

Over the years a lot of research has been done in the area of dissimilar welding and many interesting results have been brought up with regards to the problems encountered in dissimilar welding. With dissimilar welding finding its use in nuclear, petrochemical, electronics and several other industrial domains, this section brings into account the work of the predecessors in this field.

Abdul wahabH.Khuder et al. [1] have studied the effect of welding process parameter in welding joint of dissimilar metal by using MIG spot welding. In this research the base material selected for welding are austenitic stainless steel-type AISI 316L and carbon steel. The filler metal use for welding this dissimilar metal is E80S-G and CO2 is used as shielding gas. The experiment was carried out by considering feed of wire, time of feed and weld current as input parameter. The effect of these parameters on diameter of the spot and shear force was predicted by doing the experiment. From the result they conclude that the size of spot weld and shear force is increase with increasing welding current while the shear force is decrease with increase of welding time. Also they found that the increasing welding current and time of welding will also increase diameter of weld zone and decreases the shear force. Amit Kumar et al. [2] have done work on optimization of MIG welding parameters using Artificial Neural Network (ANN) and Genetic Algorithm (GA). In this research work they make mathematical model by using ANN method for prediction effect of welding parameter such as welding voltage, welding speed and welding current on ultimate tensile stress during the welding of dissimilar material such as stainless steel grade 304 and grade 316. The argon gas was taken as shielding gas and experiment was done on full factorial. The Genetic Algorithm (GA) used to optimize the value of outputparameter. From the analysis it is concluded that the maximum ultimate tensile strength ismeet at 110 A welding current, 18 V welding voltage and 43.362 cm/min travel speed. Also they have shown that the Artificial Neural Network (ANN) successfully integrated as other regression model. AjitHooda et al. [3] have developed a response surface model to predict tensile strength of inert gas metal arc welding of AISI 1040 medium carbon steel joint. In this research the welding voltage, current, wire speed and gas flow rate are considered as input parameter. The experiment was designed by face centered composite design matrix.From the experiment they conclude that the optimum values of process parameter such as welding voltage 22.5 V, wire speed 2.4 m/min and gas flow rate 12 l/min for maximum yield strength both transverse and longitudinal are remain same but the current value is 190 A and 210 A respectively. Balasubramanian V. et al. [4] studied the high strength aluminium alloy joints produced by gas metal arc welding and gas tungsten arc welding under the effect of continuous current and pulsed current technique. Pure argon used as a shielding gas. The pulsed current gas metal arc weld joints produced high strength values and high joint efficiency than other welded joints. Due to that of fine grains the Base metal and heat affected zone regions produced high hardness values than weld metal. Pulsed current gas tungsten arc weld joints produced high highness values and continuous current gas metal arc weldjoints produced low hardness values. A very fine grain in the welded region was produced by the pulsated current gas metal arc welding. C. N. Patel et al. [5] evaluated the parameters; welding current, wire diameter and wire feed rate to investigate their influence on weld bead hardness for MIG welding and TIG welding by Taguchi's method and Grey Relational Analysis (GRA). From the study it was concluded that the welding current was most significant parameter for MIG and TIG welding. By use of GRA optimization technique the optimal parameter combination was found to bewelding current, 100 Amp; wire diameter 1.2 mm and wire feed rate, 3 m/min for MIG welding. Ghazvinloo H.R. et al. [6] analyzed robotic MIG welding AA6061 fatigue life, impact and bead penetration properties under the effect of welding speed, voltage and current. 2.35 mm and 10mm thickness 60 degree V groove plates were welded by using 1mm diameter ER5356 filler material. The welding parameters welding speed, voltage and current were varied during the process. The increased voltage and current reduced the fatigue life but the welding speed increased the fatigue life. Decreased welding speed and increased current voltage improved the impact energy. Bead penetration mainly influenced and depends on the welding current. Lakshminarayanan A.K. et al. [7] investigated the AA6061 Aluminium alloy joints mechanical properties welded by gas metal arc welding, gas tungsten arc welding and friction stir welding. Single V joint configuration, pure argon shielding gas and AA4043 filler wire were used for the gas metal arc welding and gas tungsten arc welding. Non consumable high carbon steel tool was used for the friction stir welding. Diamondcompound was used for a final polishing. The friction stir weld joints produced the high strength values than GMAW and GTAW. The strength value 34% higher than the GMAW and 15% higher than the GTAW. The base metal and heat affected zone produced the high hardness values than the weld metal. FSW produced the high hardness value and GMAW produced low hardness value. Equiaxed uniformly distributed fine grains increased the high tensile properties in the weld region for FSW joints. M. P. Lightfoot et al. [8] have used ANN to develop a model to study the FCAW process factors affecting the distortion of 6 – 8 mm thick D and DH grade steel plates. A sensitivity analysis was carried out, which highlighted a number of apparently key factors that influenced distortion. It was proven that the carbon content played a key role in the amount of distortion produced by the welding process. They found that an increase in the carbon content was beneficial in reducing thin plate distortion caused by welding. Also, they identified a number of distortion-related factors, such as carbon content, YS/TS ratio and rolling treatment. It was concluded that these factors can be controlled to reduce thedistortion in 6-8 mm thick plates. Monika K. et al. [9] analyzed the Mechanical Properties of MIG Welded Dissimilar Joints under the effect of heat input. Welding current, voltage and speed of wire determines the heat input. The IS 2062, IS 45 C8, IS 103Cr1 were used as a base material. 1.2mm diameter copper coated mild steel was used as a filler wire. The both joints (IS 2062 & IS 45 C8) and (IS2062 & IS 103 Cr1) increased the tensile strength when increased with the heat input and also increased the hardness value when decreased with the heat input. M. Aghakhani et al. [10] have done work on optimization of gas metal arc welding process parameter for increase quality and productivity of weldment. In this research work for increasing quality and productivity of weldment they have considered weld dilution as output parameter and effect of input parameter wire feed rate (W), welding voltage (V), nozzle-to-plate distance (N), welding speed (S) and gas flow rate (G) was found on it. The base material use for experiment is ST-37 steel plate and the mixture of 80% argon and 20% CO_2 is use as shielding gas. The experiment was designed by Taguchi's L25 orthogonal array and analysis was carried out by ANOVA method also they develop mathematical model for weld dilution. From the experimental result they found that the wire feed rate has the most significant effect on the weld dilution while gas flow rate has no effect on weld dilution. Okuyucu H. et al. [11] developed a model using ANN for the analysis and simulation of the correlation between friction stir welding (FSW) parameters of aluminium plates and mechanical properties of the welded joint. The process parameters consist of weld speed and tool rotation speed verses the output mechanical properties of weld joint, namely: tensile strength, yield strength, elongation, hardness of WZ and hardness of HAZ. Good performance of the ANN model was achieved and the model can be used to calculate mechanical properties of the welded plates as a function of process parameters. Also, it was found that the correlation between the measured and predicted values of tensile strength, hardness of HAZ and hardness of weld metal were better than those ofelongation and yield strength. Pawan Kumar et al. [12] have investigate the use of Taguchi's parameter design methodology for parametric study of gas metal arc welding of dissimilar material. In this research work they have considered the AISI 304 and low carbon steel as base material and CO_2 as shielding gas. The parameters considered for experiment were welding current, welding voltage and gas flow rate as input parameter and tensile strength and Hardness (PM, WZ and HAZ) as out put parameter. The experiment was designed by L9 orthogonal array and analysis was done by signal to noise (S/N) ratio and ANOVA. Form the analysis they found that the optimum parameter value for tensile strength are 25 V welding voltage, 100 A welding current and 25 CFH gas flow rate and the welding current is most significant parameter for tensile strength and it is effected by 52.45 %. Also they conclude the Taguchi method is very good approach for improve the hardness. Pradip D. Chaudhari et al. [13] have investigated the effects of welding process parameters of Gas Metal Arc Welding (GMAW) on tensile strengths of SS 3Cr12 steel material specimen. In this research work the welding voltage, wire feed rate, welding seed and gas flow rate were considered as inflating input parameter. The experiment was designed by central composite design matrix and the analysis was done by using Minitab software. From the analysis they found that the tensile strength was increasing with increasing with increase the value of welding speed and gas flow rate whereas the increasing with decrease the value of wire feed rate and welding voltage. Rajkumar Duhan et al. [14] have developed a response surface model to predict tensile strength of inert gas metal arc welding of AISI 50110 (EN 31) high carbon steel joint. In this research the welding voltage, current are considered as input parameter. The analysis was carried out by ANOVA method and the mathematical model was developed topredict the effect of welding parameter. From the analysis they found that the welding voltage is most effected parameter for tensile strength of EN 31 weld joint. Sheikh Irfan et al. [15] have done experimental study to find the effect of MIG welding process parameter for decrease the depth of penetration in weldability of galvenizesteel.In this research work the welding current, arc voltage, welding speed, are chosen as welding parameters. The mixture of Argon-78%, Carbon Dioxide-20% and 2% Oxygen is considered as shielding gas. From the experiment they found that the penetration will increase with increase of speed of travel at constant arc voltage and current. Sterjovski Z. et al. [16] have applied the ANN models to predict the mechanical properties of steels in various applications, namely: impact strength of quenched and tempered pressure vessel steel exposed to multiple postweld heat treatment cycles, the hardness of the simulated HAZ in pipeline and lap fitting steel after in-service welding and the hot ductility and hot strength of various microalloyed steel over the temperature range for stand or slab straightening in continuous casting process. It was found that the three ANN models successfully predicted the mechanical properties. It was also shown that ANNs could successfully predict multiple mechanical properties and the result of the sensitivity analysis were in agreement with both findings of the experimental investigation and reported results in the literature. Furthermore, it was mentioned that the use of ANNs resulted in large economic benefits for organizations through minimizing the need for expensive experimental investigation and/or inspection of steels used in various applications. Suresh Kumar L. et al. [17] discussed the austenitic stainless steel 304 mechanical properties with dye penetrate testing welded by TIG and MIG. In this study the TIG welding produced the less hardness value than the MIG welding. The TIG welds of stainless steel withstand the high load and produced high ultimate strength than MIG welds. Austenitic grains were presented in the microstructure and no remarkable indication from the Dye Penetrate Testing. The HAZ was increased by increased the welding current.

III. PROBLEM IDENTIFICATION AND OBJECTIVE

The metal inert gas arc welding (MIG) is most commonly uses to joining of metals in power generation, electronic, nuclear reactors, petrochemical and chemicalindustries. The joining of the dissimilar material by using welding process is new area for reduction in weight in above industries. The welding of the dissimilar material face variety of problem such as cracking, reduction of strength, porosity, surface quality and stress due to thermal, mechanical and chemical properties of the materials. An attempt will be made to investigate the effects of MIG welding on the mechanical properties of AA 6061 T6. Aluminium is the most commonly used material in aerospace industries. Aluminum is the second material in case of annual consumption after steel. Aluminium alloys are light in weight comparably less density with better mechanical properties with mild steel. So we considered Aluminum alloys for study. Different mechanical tests including tensile and hardness will be carried out to and identify the microstructure of the welded specimens. The input parameters of MIG welding such as welding current, arc voltage, welding speed is used as varying process parameters, which may plays a vital role in the determination of different properties.

IV. EXPERIMENTAL WORK AND ANALYSIS

An experiment work is carried out for MIG welding process on AA 6061 Aluminium Alloy. Good strength is possible at high welding rate by proper control of the welding parameter. The experimental work presented in this chapter shows the study conducted on tensile strength and Hardness as output parameters.Tensile testing was done using ASME Section IX-2004 standards. The equipment used was a UTM Machine with a maximum capacity of 1000 kN. The welded specimen was prepared according to the procedures given in ASME Section ix-2004 and typical dimensions of the specimen are shown below in Figure1.

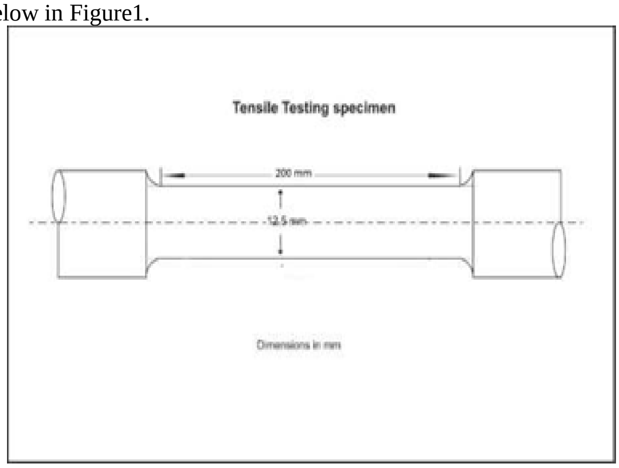

Figure 1 Tensile Testing specimen

V. CONCLUSION

In this present work a deep literature survey has been conducted and finalized the objective of the present research. An attempt will be made to investigate the effects of MIG welding on the mechanical properties of AA 6061 T6. Aluminium is the most commonly used material in aerospace industries. Aluminum is the second material in case of annual consumption after steel. Aluminium alloys are light in weight comparably less density with better mechanical properties with mild steel. So we considered Aluminum alloys for study. Different mechanical tests including tensile and hardness will be carried out to and identify the microstructure of the welded specimens. The input parameters of MIG welding such as welding current, arc voltage, welding speed is used as varying process parameters, which may plays a vital role in the determination of different properties.

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