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A Review on Optimization and Prediction of MIG Welding Process Parameters Using ANN

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Abstract **- Welding is widely used by manufacturing engineers and production personnel to quickly and effectively set up manufacturing processes for new products. 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 rate, etc. on weld strength, ultimate tensile strength, hardness of weld joint, weld pool geometry of various metal material during welding. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality. The analysis from DOE method can give the significance of the parameters as it give effect to change of the quality and strength of product.**

Keywords **- Welding, MIG welding, Parametric Optimization, ANN,**

I. INTRODUCTION

Metal Inert Gas welding as the name suggests, is a process in which the source of heat is an arc formed between a 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 inert gas such as argon, helium or an argon-helium mixture. No external filler metal is necessary, because the metallic electrode provides the arc as well as the filler metal. It is often referred to in abbreviated form as MIG welding. MIG is an arc welding process where in coalescence is obtained by heating the job with an electric arc produced between work piece and metal electrode feed continuously. A metal inert gas (MIG) welding process consists of heating, melting and solidification of parent metals and a filler material in localized fusion zone by a transient heat source to form a joint between the parent metals. Gas metal arc welding is a gas shielded process that can be effectively used in all positions.

II. WORKING PRINCIPLE OF MIG WELDING

The electrode in this process is in the form of coil and continuously fed towards the work during the process. At the same time inert gas (e.g. argon, helium, Co2) is passed around electrode from the same torch. Inert gas usually argon, helium, or a suitable mixture of these is used to prevent the atmosphere from contacting the molten metal and HAZ. When gas is supplied, it gets ionized and an arc is initiated in between electrode and work piece. Heat is therefore produced. Electrode melts due to the heat and molten filler metal falls on the heated joint.

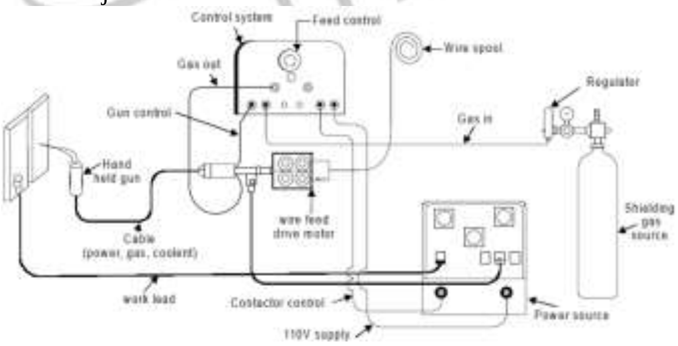

Figure 1: MIG welding Process Setup

The arc may be produced between a continuously fed wire and the work. Continuous welding with coiled wire helps high metal depositions rate and high welding speed. The filler wire is generally connected to the positive polarity of DC source forming one of the electrodes. The workpiece is connected to the negative polarity. The power source could be constant voltage DC power source, with electrode positive and it yields a stable arc and smooth metal transfer with least spatter for the entire current range.

III. MIG WELDING EFFECTING PARAMETERS:

Weld quality and weld deposition rate both are influenced very much by the various welding parameters and joint geometry. Essentially a welded joint can be produced by various combinations of welding parameters as well as joint geometries. These parameters are the process variables which control the weld deposition rate and weld quality. The weld bead geometry, depth of penetration and overall weld quality depends on the following operating variables.

- Electrode size, Welding current, Arc voltage.
- Arc travel speed, Welding position.
- Gas Flow rate, Shielding Gas composition.
- Electrode extension.

IV. LITERATURE REVIEW:

Haken ates et al. **[1]** has performed an experiment in which low carbon steel plates (15 x 150 x 450 mm) were welded under 180 A and 28 V. A MIG/MAG welding machine was used, and CO_2, Ar and O_2 mixtures of three gases were used as the shielding media. The flow rate of the shielding gas was 15l/min, and the experiment was performed by setting the contact tip to the workpiece distance of 15 mm. The electrode wire has a diameter of 1.2 mm. A test conducted to analyze the mechanical properties in these experiments. Artificial neural networks (ANNs) using for prediction of gas metal arc welding parameters. Input parameters of the model consist of gas mixtures, whereas, the outputs of the ANN model include mechanical properties such as tensile strength, impact strength, elongation and weld metal hardness, respectively. The study has shown the possibility of the use of neural networks for the calculation of the mechanical properties of welded low alloy steel using the GMA method.

Joseph I. Achebo et al. **[2]** showed by his work that on selecting input parameters such as welding current, voltage, speed and time against response of ultimate tensile strength of steel, optimization was achieved with the help of Taguchi Method. From the analysis conducted by applying the Taguchi Method, an optimum process parameter of welding current of 240A, welding time of 2.0mins, welding speed of 0.0062 m/s, and welding voltage of 33V, was suggested. These optimum parameters were found to have an improvement of 2.32dB of the S/N ratio, and 1.11 times over the UTS of the existing process parameters. This study elucidates a step by step approach for applying the Taguchi Method.

D.S. Nagesh et al. **[3]** predicted weld bead geometry and penetration by selecting input parameters such as electrode feed rate, arc-power, arc-voltage, arc-current, arc-length and by using ANN method for optimization of output parameters such as bead height, bead width, depth of penetration, Area of penetration and Arc travel rate. The experimental results concluded that use of either preheated plates or low arc-travel rate or high arc-power yielded better fusion. Both the bead height and width decrease with the increase in arc-travel rate but the decrease in height is comparatively more to make a flatter bead with a higher arc-travel rate. The penetration and HAZ increase with the increase in electrode feed rate keeping arc-length constant.

D. S. Correia et al. **[4]** presented the optimization of MIG welding parameter using Genetic algorithm (GAs). The search for the near-optimal was carried out step by step, with the GA predicting the next experiment based on the earlier and without information of the modelling equations between the inputs and outputs of the MIG welding process. The GA was able to establish near optimum conditions with a relatively small number of experiments. But, the optimization by GA technique requires a good setting of its own parameters, such as number of generations, population size, etc. Otherwise, there is a risk of an inadequate extensive of the search space.

Wahab H. Khuder et al. **[5]** 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. **[6]** 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 output parameter. From the analysis it is concluded that the maximum ultimate tensile strength is meet 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.
Ajit Hooda et al. **[7]** 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 centred 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. **[8]** 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 weld joints 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. **[9]** 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 be welding current, 100 Amp; wire diameter 1.2 mm and wire feed rate, 3 m/min for MIG welding.

Ghazvinloo H.R. et al. **[10]** 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.

V. CONCLUSION:

Many researchers have worked on different type of materials with various types of laser by using various types of design of experiment (DOE) technique such as taguchi, Response Surface method, full factorial design, Box-Behnken design. Also effect of various process parameters like Electrode size, Welding current, Arc voltage, Arc travel speed, Welding position, Gas Flow rate, Shielding Gas composition was studied on various materials and its effect on output parameters like tensile strength, hardness was studied. From this literature review, it is found that with proper optimization of process parameters of MIG welding precise output with high production can be obtained. The conclusive remarks are very beneficial to the industry people.

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