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A Review Paper On "Multi-objective Optimization Of Process Parameters In Shielded Metal Arc Welding For Joining Stainless Steel 304l And Mild Steel 1018.

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***Abstract:* -- The Quality of weld mainly depends on mechanical properties of the weld metal and heat affected zone (HAZ), In this research work the review of Multi-objective optimization of welding process parameters for obtaining greater weld strength with good mechanical properties of dissimilar metals like stainless steel 304l and Mild steel 1018 is done. The process used for welding is shielded Metal Arc welding and dissimilar metal used are stainless steel 304l and mild steel 1018. Welding speed, voltage, current, electrode angle, feed rate, Arc length are taken as controlling variables. The weld strength (N/mm2) and Bead geometry variables and Heat Affected Zone are obtained through set of experiment. Based on the previous research, the possible best outcomes and best method has been chosen.**

***Keywords:* HAZ, Multi objective optimization, Response surface Methodology, Shielded metal arc welding**

I. INTRODUCTION

Shielded Metal Arc Welding (SMAW) welding is an extensively used process and finds wide application throughout the power generating industry. As with other fusion welding processes, SMAW welding subjects both the weld and the surrounding material to complex thermal changes. The resulting microstructures near the weld are thus highly dependent on the welding conditions. Experience has shown that failures occur frequently at or near welds, and much work has been devoted to correlating the various failure modes with the presence of unfavorable microstructures. This approach to assessing the integrity of weld depends on the successful prediction of the microstructures to be found in the weld and heat-affected zone (HAZ) from the welding process variables. Unfortunately there are very few data in the literature which relate the size of the weld bead and HAZ to the welding process variables. The present work was undertaken to obtain such data for the MMA process, to model a multi-pass weld from these data, and to use this model as the basis for a practical welding procedure. Shielded metal arc welding (SMAW), also known as manual metal arc welding (MMA or MMAW), flux shielded arc welding or informally as stick welding, is a manual arc welding process that uses a consumable electrode covered with a flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined.

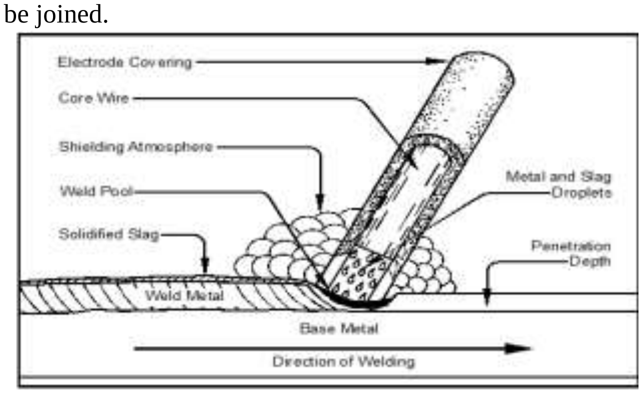

Fig no. 1 working of smaw

The work piece and the electrode melt forming a pool of molten metal (weld pool) that cools to form a joint. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination because of the versatility of the process and the simplicity of its equipment and operation. Shielded metal arc welding is one of the world's first and most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and though flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of heavy steel structures and in industrial fabrication.

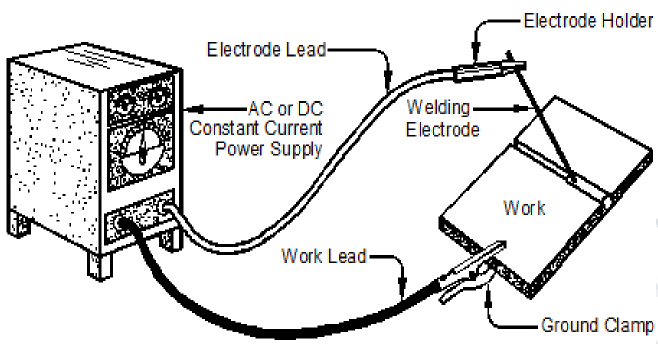

Fig no.2 Set up of SMAW

This research is to make the thin sheet welding easy and compatible by optimizing the process parameters. Specimen were welded using Shielded metal arc welding (SMAW) based on design of experiment on Minitab software. The Taguchi method is a good tool that uses a design to study the parameter with small number of experiments. In the factorial design, the number of factors and levels increases exponentially. This technique provides an efficient, simple and systematic approach to optimize design for quality, performance and cost. In present experiment, Signal-to-Noise ratio has been used to examine the effect of each factor on a particular response. The signal shows the effect of each factor on the response, whereas noise is the measure of the influence on the deviation from the average responses. S/N ratio is based upon the lower-the-better, larger- the- better and nominal-the better criteria. The S/N ratio is based on the previous knowledge and expertise, so it must be carefully chosen. In this study, output parameters are associated with the weld strength of the weld joint, Weld width, Depth of penetration and HAZ which should optimize as possible so the better criteria has been chosen. The strength of the weld joint which is generally expected to be high is examined by equation.

$$\frac{S}{N} = -10\log_{10}\left(\frac{1}{n}\sum_{i=0}^{n} 1/y_i^2\right)$$

Where n = number of measurements yi = response value for each noise factor. i = number of design parameters in this study.

1.1 Application of shielded metal arc welding

1. Shielded metal arc welding is one of the world's most popular welding processes, accounting for over half of all welding in some countries.
2. Because of its versatility and simplicity, it is particularly dominant in the maintenance and repair industry, and is heavily used in the construction of steel structures and in industrial fabrication.
3. In recent years its use has declined as flux-cored arc welding has expanded in the construction industry and gas metal arc welding has become more popular in industrial environments.
4. Because of the low equipment cost and wide applicability, the process will likely remain popular, especially among amateurs and small businesses where specialized welding processes are uneconomical and unnecessary.
5. SMAW can weld the metals: Aluminum ,Bronze, steel, Cast iron ,Hard facing alloys, High-strength steels, Low-alloy steels, Malleable iron, Nickel, Stainless steel.
6. Several combinations are possible with metals other than stainless steel. A number of them consist of carbon steel and alloy steels. To this list we can add high-strength steels and high temperature creep resistance steels. Advanced control welding techniques are a major asset for the fusion welding of these dissimilar welding metals. For high-strength low-alloy (HSLA) steels and low-carbon steels (LCS) the risk is of carbon migration from the LCS side to the HSLA side when welding is done without a filler material. It therefore becomes necessary to involve a suitable filler metal and acceptable temperature control to minimize the dilution zone and the heat affected zone (HAZ) by temperature.

1.2 INPUT PARAMETERS USED IN SMAW FOR OPTIMIZATION:

1. Welding current-

The value of welding current used in MIG has the greatest effect on the deposition rate, the weld bead size, shape and penetration.

1. Welding voltage-

The arc length (arc voltage) is one of the most important variables in MIG that must be held under control when all the variables such as the electrode composition and sizes, the type of shielding gas and the welding technique are held constant.

2. Arc Travel speed-

The travel speed is the rate at which the arc travels along the work- piece. It is controlled by the welder in semiautomatic

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welding and by the machine in automatic welding. The effects of the travel speed are just about similar to the effects of the arc voltage.

3. Electrode angle-

The position of the wire electrode with respect to the weld joint, affects the weld bead shape and the penetration to a greater extent than the arc voltage and the travel speed. The position of the wire electrodes is defined by means of two angles which are called “ork” and “travel” angles.

II. LITERATURE REVIEW

SHEKHAR SRIVASTAVA Et.al [2017] States about the Process parameter optimization of gas metal arc welding on IS: 2062mild steel using response surface methodology. It can be concluded that Response Surface Methodology is a powerful tool for optimization of welding process. He used the input parameters like welding speed, welding current, shielding gas flow rate, voltage, arc travel speed, contact tip – work distance, type of shielding gas. And the effect of these all input parameters on the output parameters like Bead geometry variables, heat affected zone, bead width, bead height, penetration and area of penetration. The result obtained from the experimental methods and the uses of response surface methodology technique is described to optimization of these input parameters for good weld quality and better surface penetration.

MINGXUAN YANG ET.AL [2017] focuses on Effect of arc behavior on Ti-6Al-4V welds during high frequency pulsed arc welding. It finally states that core region of arc plasma rate increased from43.7% to 51.5%. Meanwhile, the arc force increased, and the large arc pressure is beneficial for the heat efficiency during the arc welding process. 2. The welding joints were strengthened with pulsed arc welding. 3. Compared with CAW, the grain size reduced by 24%–30% with UHFP-AW. He selected the input parameters for the study is Arc behavior and the effect of this arc behavior is to optimize the microstructure. .Mechanical Properties of the weld metal and method used to optimize is experimental techniques.

HOUMAN ALIPOORAMIRABADA ET.AL [2017] clarify in his paper of ‘Investigating the effects of welding process on residual stresses, microstructure and mechanical properties in HSLA steel welds’ that the 1.With the SMAW process, the scale of fusion zone and HAZ are increased. 2. The microstructure of weld changes with welding process. 3. Significantly higher level of longitudinal residual stresses was found in the specimen with MSAW and FCAW processes. Residual stresses in excess of yield strength. The factors affecting due to types of welding process on the residual stresses and microstructure of the weld metal and by using the Neutron diffraction technique he solve the problems related to the effect of these controlling factor to the process.

ALEKSANDRA SWIERCZY NSKA ET.AL[2017] states about Diffusible hydrogen management in underwater wet self-shielded flux cored arc welding. .He used the different types of process parameters related to stick out length, welding current, arc voltage, and travel speed and water salinity on the diffusible hydrogen content in the welding. Finally he concluded that welding speed and water salinity is statistically significant. The strongest effect on the diffusible hydrogen content in deposited metal in wet welding with a self-shielded flux cored wire has the stick out length followed by welding speed, salinity, arc voltage and welding current by experimental technique.

JIYOUNG YU ET.AL[2017] states about Metal-cored welding wire for minimizing weld porosity of zinc-coated steel in journals of processing technology the key factor of this study are Effect of C,Si,Mn Chemical composition on the Weld porosity formation the final result states about The interaction between Si and Mn has the most significant effect on reducing the weld porosity. The weld pool viscosity decreases with decreasing Mn and Si contents. This effect promotes Zn vapor emission from the weld pool. The C content rarely affects the emission of Zn vapor although it affects the hardness of welded joints.

ZENGXI PAN ET.AL [2016] presents the data of Effects of heat accumulation on the arc characteristics and metal transfer behavior in Wire Arc Additive Manufacturing of Ti6Al4V. This study include the input parameter Heat accumulation on the resulting parameters like bead formation, arc stability, and metal transfer behavior in arc welding Experimental techniques are used to modify the result In summary, the influence of heat accumulation on the deposition stability is proven to be very significant during the TiAl64V GT-WAAM process using localized shielding. Therefore, to achieve better geometry and more stable metal transfer, inter pass temperature must be strictly controlled during the WAAM of Ti6Al4V.

T. JAYAKUMARB ET.AL [2016] states about Investigations on the impact toughness of HSLA steel arc welded joints in the journal of manufacturing process he used the input parameters like weld metal grain size, chemical composition of weld metal, acicular ferrite and inclusion content and the effect of these parameters on the impact toughness and result obtained about the The high impact toughness observed at room temperature in FCAW and A-GTAW. Based on the present investigations, FCAW and SMAW processes are suggested to be better than SAW and A-GTAW processes considering impact toughness as the criterion for selection of the welding process.

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RAN ZONG, JI CHEN ET.AL [2016] states that Influence of shielding gas on undercutting formation in gas metal arc welding and in this gas metal arc welding he uses the input parameters like 1. CO2 content in shielding gas. 2. Welding current. 3. Welding speed and represented the effect of these parameters on the Size of undercutting defects and by the visual inspection method he represented that The undercutting width, length and volume decreased with increasing CO2 content. Welding spatters deteriorated the weld bead appearance when the CO2 content was higher than 20%.

A.V. SAVINOV O.A.ET.AL[2016] represents that Electro physical Characteristics of arc and formation of welded joints for welding joints for welding with non-consumable electrode. The input parameters used are shielding-gas composition, and magnetic-field configuration near the cathode spot and its effects on the arc thermal-force effect on the weld pool. A physical model of a welding arc in inert gases was proposed here, which considers the working-area shape of the non-consumable electrode, dependence of the materials' thermal-physical properties on temperature, interaction of the magnetic field produced by the electrode with the discharge self-magnetic field, and correlation of these parameters with the force effect of the arc on the weld pool.

K. DEVENDRANATH RAMKUMAR ET.AL[2016] states that Development of pulsed current gas tungsten arc welding technique for dissimilar joints of marine grade alloys. The effect of type of weldment on joint strength are presented on the paper the final result obtained that Charpy v-notch studies showed the average impact toughness of both the weldments are almost equal or slightly greater than one of the base metals, AISI 904L by using charpy v test studies.

K.S. BANG, ET.AL [2016] presents in his paper named Effects of welding parameter on tensile strength of weld metal that Welding Current, Welding voltage, Travel speed will definitely affects Tensile strength, pcm value, Microstructure of weldments and he proved that when Heat below 2.1 kj/mm, Then tensile strength increases when heat goes above 2.1 kj/mm then tensile strength decreases.

III. PROBLEM STATEMENT

The aim of this research project has been to study dissimilar metal joint using a SMAW process. It is obvious that SMAW process is very difficult to weld the two dissimilar metal like Stainless steel 304L and mild steel 1018. Dissimilar welding is used to fabricate the pressure vessels and piping in nuclear reactors, thermal power plants, vessels and heat exchangers but failures occurs frequently due to low tensile strength and Poor microstructure of the weldment. Optimization of the process parameter is done. This tensile strength of weld specimen is most commonly affected due to welding process parameters so in this project work Increase of tensile strength, Reduce heat affected zone, optimum weld dimensions are carried out.

IV. METHODOLOGY

Shielded metal arc welding (SMAW) operation has been used for butt joint of stainless steel 304L and Mild steel 1018 plates of size 100×50×3 mm. The composition of the base metals is reported in table 1

The selected input parameters and there levels are presented in table 2. A set of 8 experiments has been designed by Taguchi method. The design of experiment of the Orthogonal array..

To study the effect of each input parameters ANOVA was applied.

Response surface methodology (RSM) is a combination of statistical and mathematical techniques to analyze the model and optimize the operation. It is useful for any field of engineering to determine the relationship between the input parameters with the desired output parameters. In this study, RSM shows the effect of input parameters on response values using following steps; these are,

(i) It defines the independent input parameters and the desired output parameters, (ii) It creates an experimental design plan, (iii) Perform the regression analysis with models of RSM, (iv) It perform a statistical analysis of variance (ANOVA) of the independent input variables in order to find the parameters which affect most significantly on output parameters, (v) It Determines the condition of the RSM model and decide whether this model needs screening variables or not and finally, (vi) It optimizes the parameters by conduct confirmation experiment with verifying the predicted responses. To generate the regression equation between input parameters and outcomes the response surface methodology was applied.

$$Y = \beta_0 + \sum_{i=1}^{k} \beta_i X_i + \sum_{i=1}^{k} \beta_{ii} X_i^2 + \sum_{i\cdot} \sum_j \beta_{ij} X_i X_j$$

Where

y = estimated output parameters

β_o= constant, βi, βii and βij represents the coefficients of linear (here, I, S, ɵ and L) input factors.

The chemical composition of stainless steel 304L and mild steel 1018 are shown below

Table 1 chemical composition of S.S. 304L

Element	Composition %
Carbon	0.08
Manganese	2.00
phosphorus	0.045

Sulphur	0.030
Silicon	0.75
Chromium	18-20
Nickel	8-12
Nitrogen	0.10
Iron	Balance

Table 2 Chemical composition of mild steel 1018

Element	Composition %
Carbon	0.14 to 0.20
Manganese	0.60 to 0.90
Phosphorus	0.040
Sulphur	0.050
Iron	Balance

V. POSSIBLE OUTCOMES

From the review paper study, it is found that when the welding current ,depth of penetration ,HAZ increases ,The tensile strength decreases ,but when welding speed increases ,the tensile strength also increases. When we will increase Optimization was done to find optimum welding conditions to maximize tensile strength and percentage of elongation of welded joints. Strength of weld bead may be increased. And the tensile properties of the material also remain at higher values. As possible the depth of penetration should be high for Weld quality improvement. Microstructure refinement of the Weldment reduce the Heat Affected Zones to minimizes Temperature stresses.

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