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"A REVIEW ON PARAMETRIC OPTIMIZATION FOR TUNGSTEN INERT GAS WELDING"

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ABSTRACT

Tungsten inert gas welding (TIG) or gas tungsten arc welding (GTAW) is a popular technique for connecting ferrous and nonferrous metals. The gas tungsten arc welding procedure uses a non-consumable tungsten electrode to provide the arc for welding. During the welding cycle, an inert gas barrier removes air from the welding area, preventing oxidation of the electrode, weld puddle, and surrounding temperature impacted zone. A filler pole is inserted into the puddle for joints that require additional weld metal. The current review work makes an attempt to appreciate the influence of TIG welding parameters, which are affects on responsive yield characteristics, for example, welding rigidity, twisting due to welding by employing innovation approach. Welding parameters such as welding current, gas flow rate, root gap, and bevel angle are essential parameters that are commonly used.

Key Words: *TIG welding, Process Parameters optimization, Taguchi method, Grey Relational Analysis.*

I. INTRODUCTION

Gas tungsten arc welding process, comprise of non-consumable tungsten electrode which is utilized to give the arc to welding. A separate filler metal with an inert protecting gas is utilized. Gas tungsten arc welding process welding set used reasonable force source, a chamber of argon gas, welding light having association of link for current stock, tube for protecting gas supply and cylinder water for cooling light. In all welding, the best weld is one that has the properties storage room to those of base metal; hence, the liquid puddle must be shielded from the environment. The climate oxygen and nitrogen consolidate promptly with liquid metal which yields feeble welds dabs. The major inert gases that are utilized are argon and helium. Electrode is utilized distinctly to make the arc in Tungsten inert gas welding and it isn't expended in the weld. For joining comparative metal, where extra weld metal is required, a filler metal or pole is taken care of into the puddle. This sort of welding is regularly alluded to as "Heliarc" (Linde) or "Heliwelding" (Airco) which are producer's trade's name.

Power Supplies: There are three basics power supplies used in TIG welding process. They are a direct current straight polarity (DCSP) power supply, the direct current reverse polarity (DCRP) power supply, & the alternating current high frequency (ACHF) modified power supply.

Electrodes: The use of non-consumable electrodes – an electrode that does not supply filler metal-constitutes the major difference between GTAW and other metal arc welding process. Tungsten, which has highest melting temp of all metals 6170^{o} F, has proved to be the best materials for non-consumable electrodes. Three basic kinds of tungsten or tungsten alloys are used for electrode in TIG welding: pure tungsten, zirconiated tungsten & thoriated tungsten.

Filler Metal: The selection of proper filler metal is based primarily on the composition of the base metal which we are going to weld. Filler metals usually are matched as closely as possible on the base metal composition.

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Shielding Gas: The choice of shielding gas can significantly affect weld quality as well as welding speed. Argon, helium and argon- helium mixtures do not react with tungsten or tungsten alloy electrodes and have no adverse effect on the quality of the weld. Argon is more widely preferred, because in addition to it being less expensive, it provides a softer arc, which is smooth and stable. Argon is better for welding aluminium alloy, magnesium alloy, and beryllium copper.

II. METHODOLOGY

Taguchi Method: A Taguchi method has now a day's become a powerful optimization techniques for improving productivity during research and development, so that a high quality of the product can be produced at low cost and also quickly. Taguchi method is one of the best method which offers the effective selection process parameters minimum no.of experiments. Thus the combination of design of experiment with the optimal welding parameters to provide a best result is achieved in Taguchi Technique. With the help of Taguchi method it possible to find out which parameter is less influence and which is more influence. Taguchi technique use a special set or design called "Orthogonal array", to investigate the entire process parameter with a small number of experiments only. Dr. Taguchi S/N ratio, which are log function of desired output, serve as a objective functions for optimization, help in data analysis and prediction of optimum results. Taguchi method use the S/N ratio to identify the control factors to optimization process first one is to find out those control factor that reduce variability and second is to find out those control parameters which have a small or no effect on the signal-to-noise ratio and which move the mean to target. The S/N ratio under different noise condition measures how the response varies relative to the nominal or target value. Depending on the goal of your experiment, you can choose from different signal-to-noise ratios. Minitab offers S/N ratios, for static design.
There are three Signal-to-Noise ratio of common interest for optimization:
Smaller-The-Better:
n= -10 Log_{10} [mean of squares of measured data]
Larger-The-Better:
n= -10 Log_{10} [mean of square of the reciprocal of measured data]
Nominal-The-Best:
n= 10 Log_{10} (square of mean/variance)

Grey Relational Analysis: In Grey relational analysis, the experimental data i.e. the measured features of quality characteristics are first normalized ranging from 0 to 1.Then, the Grey relational coefficient is calculated, based on normalized experimental data, to represent the correlation between the desired and actual experimental data. Then, the Grey relational grade is determined by averaging the Grey relational coefficient corresponding to selected responses. The overall evaluation of the multiple response process is based on grey relational grade. Hence, with this approach, optimization of the complicated multiple process responses can be converted into optimization of a single grey relational grade. Optimal parametric combination is then evaluated which would result highest Grey relational grade.

III. LITERATURE REVIEW

Ugur Esme, Melih Bayramoglu, Yugut Kazancoglu, Sueda Ozgun [1] were carried out investigated the multi-response optimization of tungsten inert gas welding (TIG) welding process for an optimal parametric combination to yield favorable bead geometry of welded joints using the Grey relational analysis and Taguchi method. Sixteen experimental runs based on an orthogonal array of Taguchi method were performed to derive objective functions to be optimized within experiment. The objective functions have been selected in relation to parameters of TIG welding area of penetration, bead geometry; bead width, bead height, penetration, as well as tensile load and width of heat affected zone. The Taguchi approach followed by Grey relational analysis to solve the multi-response optimization problem. And also, the significance of the factors on overall quality characteristics of the weldment has also been evaluated quantitatively by the analysis of variance method (ANOVA). Optimal results have been verified through additional experiments. It shows application feasibility of the Grey relation analysis in combination with Taguchi technique for continuous improvement in product quality in manufacturing industry.

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Experiments were performed on 1.2mm AISI 304 thin stainless steel plate with size (25 x 240mm). 4 factor and 4 level is used i.e L16 Orthogonal array is used. Welding parameters were taken is travel speed, current, gas flow rate, Gap distance. Result of ANOVA indicates that the welding speed 52.14% contribution is most effective parameter on the responses under the multi criteria optimization (higher tensile load, penetration area, area of penetration & lower heat affected zone, bead width, bead height). The % contribution of other parameters are gap distance 20.12%, current 15.40%, shielding gas flow rate is 9.09%.

Dheeraj Singh, Vedansh Chaturvedi, Jyoti Vimal [2] this research paper discuss the optimum welding parameters for Gas tungsten arc welding. Taguchi method with an L16 orthogonal array (4-level and 4-factor) based on 16 experiment run were performed. Parameters namely used is current, gas flow rate, welding speed & gun angle is taken as a process parameters. The objective function have been chosen in relation to parameter of TIG welding bead geometry i.e. area of penetration, tensile load, , bead width, bead height, and penetration for quality target. Experiment were perform on a specimen of1.2mm 304 stainless steel plate (30 x 250 mm). The paper presented the optimization of the TIG welding process of stainless steel work piece by the grey relational theory. The optimal process parameters that have been identified the best combination of process variables for S.S are current at 40 A, gas flow rate at 5 l/min, welding speed 12m/min and gun angle at a 80 ^{o}. After the predicted optimal parameter setting with the help of (ANOVA) the most significant factor also found in this case gun angle is having max % contribution.

Mukesh, Sanjeev Sharma [3] these paper discuss the influence of different input parameters such as welding current, gas flow rate and welding speed on the mechanical properties in TIG. The output response such as microstructure, hardness, and tensile strength of weld specimens are investigated in this study. In this L9 orthogonal array is used, which consist of 3 input parameters. Analysis was done by the application of Taguchi design using Minitab 16. Austenitic stainless steel 202 grade size 100 x 50 x 6 mm with square edge butt joints were prepared in this experiments. ANOVA analysis was performed for the analysis purpose which show that the current is the most significant parameters that influenced the tensile strength and micro-hardness of the weld. The delta ferrite in matrix of austenite SS 202 Microstructure of weld metal structure shows. The highest tensile strength is 0.595 KN/mm2 is obtained at a welding current of 210 amp, gas flow rate 14 l/min and welding speed of 190 mm/s. At a welding current of 210 amp, gas flow rate 12 l/min and welding speed of 180 mm/s obtained maximum micro hardness.

Mandeep et al [4] investigate that the angular distortion is a major problem in butt weld plates. Restriction of this distortion by restraint may lead to higher residual stress. In initially angular distortion in (–ve) direction is provided to reduce the angular distortion if the magnitude of distortion is predictable. For optimizing the weld parameter control ANOVA is applied. In these paper the transverse direction of TIG, welding process was evaluated using following as main input parameter welding current, filler rod diameter, length of plate and time gap between passes. Experiment was carried out with SS 302 & MS samples of varying length, 50mm width and 6mm thick. The stainless steel and mild steel plates were prepared with V grove design and butt weld type. With single pass filler metal, the distortion is measured with dial gauge fitted to a height gauge. 70 to 100 Amps was used as a current variation. A carbon steel filler rod of 1.5 to 2.5 used as a filler metal in these cases .In this L9 orthogonal array was selected for design of experiments towards the distortion optimization caused by welding. MATLAB 16 software is used to developed a source code to do optimization. Direct and interaction effect of the process parameters were analyzed & presented in graphical form. At the end conclusion was explain that the highest effect on angular distortion is found of diameter of electrode. The least effect on angular distortion is found of time between successive passes.

J.Pasupathy, V.Ravisankar [5] this paper presents the influence of welding parameters like welding speed, current on strength of low carbon steel on AA1050 materials during welding. A Taguchi method has been used to obtain the data. An analysis of variance (ANOVA), orthogonal array and S/N ratio are used to investigate the welding characteristics of dissimilar welding joint and to optimize the process parameters. Experimentally work us carried with 1mm thick low carbon steel & 2mm AA1050 aluminium alloy were used, size is (150mm width & 300mm length). In this study L9 orthogonal array is used. The experiment value that is observed from optimal welding parameters, strength is 61.37 MPa & S/N ratio is 16.45.

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Mallikarjun Kallimath, G.Rajendra, S,Sathish [6] this paper discuss the TIG welding is used extensively in industry to join similar metals and dissimilar metal as requirement. It can also be used for hard facing and surfacing of metal. The main thing should be considered in the TIG welding process is the selection of the optimum combination of input variables (welding parameters) for achieving the required qualities of welding. This problem can be solved by the development of mathematical models through effective and strategic planning and the execution of experiments by Taguchi techniques and ANOVA. This paper use the Taguchi method by designing a 3-factor and 2-level orthogonal array with full replication. Experiment is carried out with specimens of AA6160 base metal with filler metal of 4043. Input parameters used is current, voltage and gas flow rate. The Gas flow rate is found to be a major contributing factor. The interactions of current and voltage greatly influences the tensile strength of the material.

S.Akella, B.Ramesh Kumar [7] this research paper discuss about the distortion is one of the major constraints in TIG welding which cannot be completely avoided irrespective of types of material & thickness of material is used. This paper discuss about the optimization welding parameter of TIG welding along with Taguchi method and ANOVA for the transverse distortion control applied to mild steel plate. In this research paper the main welding parameters is used for the transverse distortion control is welding current, root gap, gas flow rate, and welding speed & weld voltage. In this study the paper is based on 2 level and 5 factor i.e. L8 orthogonal design is selected for optimizing process parameter of TIG welding. Experiment was perform with specimen of M.S. plate of 200mm x 50mm x 3mm in size & the final sample is of size 200mm x 100mm x 3mm. The sample is V butt weld with groove angle of 60^o. In this research paper the output response distortion is calculated with the help of dial gauge fitted to a height gauge. The effect of each parameter of welding contribution for distortion control for MS structure have been resulted as: root gap contribution 43%, weld current contributes 37%, weld speed 14% and the error is about 6%.

III. CONCLUSION

From above literature review it is found that TIG welding is an essential joining techniques for various alloys and Materials. Tungsten welding processes are widely used in joining pipes for off shores application automotive, ship, construction, aerospace and many other industries. Much research paper has gone with Taguchi optimization method was applied to find mechanical properties such as tensile strength, hardness and distortion control etc.The Factorial design, Grey relational analysis, Taguchi method, Response surface method can applied as the design of experiment. Software were seen using by scholars are Minitab for above purpose Root gap, welding current, bevel angle, gas flow rate, welding speed etc are important input parameters of TIG welding. In many research paper we seen that many researcher has gone with ferrous metal like SS202,SS304 etc. and method commonly used is Taguchi method, S/N ratio, ANOVA etc. to obtain the result.

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