International Journal of Advanced Research Methodology in Engineering & Technology, ISSN 2456-6446
Volume 2, Issue 2, March 2018

A REVIEW ON OPTIMIZATION OF WELDING PARAMETERS USING GAS TUNGSTEN ARC WELDING

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Abstract - **Optimization means finding the optimum input values for a specific constraint in any manufacturing process. It is a way to improve a system or a process to work at optimum conditions, reduce waste and increase productivity. Optimization is currently applied in various manufacturing processes such as machining, welding, alloy preparation, etc. This is the collective information about optimization in welding using Gas Tungsten Arc Welding (GTAW) by various experiments. Its aim is to give complete outline of various techniques, methods, procedure to optimize the welding parameters.**

Keywords – Optimization; GTAW; Welding.

I. INTRODUCTION

Welding is a metal joining process. It aims to joining similar or dissimilar metals with or without filler rod. GTAW is a non consumable type welding process in which an inert shielding gas is used to prevent weld pool quality from atmospheric contamination .In GTAW, the following input parameters are welding current, voltage, speed, torch angle, nozzle to plate distance involves in welding. These parameters may change with respect to welding types. The major parameters are welding current, voltage, speed. Optimization of these parameters involves three major stages are process measurement, process control and optimization.

II. LITERATURE SURVEY

Optimization of welding parameters of Friction stir welding to obtain a good quality weld the process parameters for a welding process which affect the desired output for a welding process are welding speed ,arc voltage, welding current etc ., Process parameters were measured by Design of Experiment, Taguchi method, FEA simulation.Welding process controlled by Multiple Regression Analysis, Response Surface Modeling, Artificial neural network.[1]

A experiment is carried out to study optimization of welding parameters in GTAW of an Inconel 825 alloy. The following welding parameters involved in GTAW are welding voltage(V) ,welding current (I), Gas Flow Rate(GFR),Nozzle to Plate Distance (NPD),torch angle(Θ).Relationship between parameters found by developing mathematical model using factorial design approach. Experimental results suggested that increase in welding current, gas flow rate, torch angle increases weld deposit area, whereas voltage, nozzle to plate distance decreases the weld deposit area.[2]

The application of design of experiment is studied Plasma Arc welding process.DOE is statistical approach in which a mathematical model is developed through experimental runs. DOE predicts possible output based on the input parameters of the experimental setup. Response Surface Methodology uses model to make contour plots of predicted behavior**.**RSM has an edge over the Taguchi method in terms of significance of interactions and square terms of parameters.[3]

Demonstrated the experiment to predict and optimize the weld bead geometry of PGTAW Inconel 718 alloy using RSM and DOE .The experiments were performed based through three level five factor Box- Behhen design. Here, peak current, base current, pulse on time are the input parameters and bead geometry parameters (bead depth, bead width, depth to width ratio) are output parameters. The developed prediction models can be efficiently used to calculate the bead width, bead depth and depth to width ratio of GTAW welded Inconel 718 alloy at 95% accuracy level .[4]

Application of weld overlay using Gas metal arc welding process using solid Inconel 625 wires is studied to increase corrosion property of weld. The corrosion property of the weld overlay is based on Fe content. When Fe content is restricted to below 5%, the corrosion properties of weld are not affected. The study reveals that the good overlay is obtained below 5% Fe and with appropriate values of process variables that includes welding current ,voltage ,travel speed ,shield gas flow rate ,arc distance .[5]

The mechanical properties were analyzed for joining Dissimilar Metal Titanium (6Al-4V) and Aluminum 7075 by changing GTAW process parameters by Taguchi and ANOVA Techniques. This welding is carried out with three set of process parameter with five levels of values. The percentage of contribution by each process parameter for tensile strength is welding speed (mm/min) 52.88 %, welding current (Amps) 44.08 % and arc voltage (V) 2.17 %. The percentage of contribution for hardness value is welding speed (mm/min) 56.32 %, welding current (Amps) 41.31 % and arc voltage (V) 1.72 %.[6]

The application of experimental design and response surface methodology to model Gas Metal Arc Welding processes. The influence of different welding process variables on the geometrical parameters that define a weld bead explained. The study has focused on the influence of the shield gas flow rate, the electrode or wire feed rate, the welding voltage and the position of the torch on the penetration, width and over thickness of the bead.[7]

Study of weld quality characteristics of Inconel 625 sheets at different modes of current in micro plasma arc welding process. Welding was carried out on 0.25 mm thick Inconel 625 sheets using continuous current mode and pulsed current mode separately keeping all other welding parameters constant. Weld quality characteristics like bead profile, micro structure, hardness and tensile properties are investigated and it is found that the usage of pulsed current leads to better weld quality characteristics when compared to continuous current mode.[8]

Jinhui Xiong et al. (2015) investigated micro structure and mechanical properties of the Ti6321 alloy. The tensile fracture morphology of joint presents obviously the characteristic of ductile fracture, which is related to the bigger and deeper dimples distributed on the surface of joint. The HAZ impact toughness is lower than that of the BM and FZ. The micro hardness values of the HAZ and base metal are higher than that of FZ, and there are the peak values for HAZ near the base metal. The hardness values of HAZ evidently fluctuate, and decrease from the FZ to HAZ and base metal. [9]

Senthur Prabu et al.(2017) presented research work on dissimilar welding between Inconel 625 super alloy and AISI 904L super austenitic stainless steel using manual multi-pass continuous current gas tungsten arc (CCGTA) welding process employed with ERNiCrMo-4 and ERNiCrCoMo-1 fillers were performed to determine the mechanical properties and weldability. Based on the presented investigation on mechanical property, for joining these bimetallic combinations employing ERNiCrMo-4 filler could be better compared to ERNiCrCoMo-1 filler. [10]

Jalal Kangazian et al. (2017) studied influence of micro structural features on the mechanical behavior of Incoloy 825 Welds. Selected three types of filler wires and concluded that, in as-welded and aged conditions, the weldments employing ERNiCr-3 and ERNiCrCoMo1 fillers exhibited good micro structural features and mechanical properties. ERNiCrMo-3 weld metal showed higher hardness than the base metal and other weld metals.[11]

Rishi Pamnani et al. (2015) carried out a study to Optimize A-GTAW welding parameters for naval steel (DMR 249 A) by design of experiments approach. In order to enhance the depth of penetration (DOP) achievable in a single pass for gas tungsten arc welding (GTAW) process, activated fluxes were developed for the steel. Design of experiments (DOE) approach was employed using response surface methodology (RSM) and Taguchi technique to optimize the welding parameters for achieving maximum DOP in a single pass. RSM (D-optimal) was observed to predict optimized welding process parameters for achieving maximum DOP with better accuracy during A-GTAW process.[12]

Kohandehghan et al. (2010) presented a Study on Residual Stresses in Gas Tungsten Arc Welding of AA5251n this work, thermo-mechanical behavior of an aluminum alloy during gas tungsten arc welding (GTAW) is studied using a three-dimensional mathematical model. The model can be employed to determine residual stresses and their distribution after the welding operation. Model validation has been performed using experimental measurements of residual stress by means of hole-drilling technique. The results show that the maximum tensile residual stress, i.e., 140MPa, is produced at the region next to the welding line and it changes to compressive state as it moves along transverse direction, and at vicinity of free ages it tends to zero. [13]

Pavan Kumar Korrapati et al(2014) reported assessment of mechanical properties of PCGTA weldments of Inconel 625. In this work, an attempt has been made to investigate the weldability, metallurgical and mechanical properties of the PCGTA welded Inconel625 metals employing ERNiCrMo-3 filler wire. Structure-property relationships of Inconel 625 weldments are discussed. Tensile failures occurred at the weld region and the average tensile strength of the PCGTA weldments of Inconel 625 employing ERNiCrMo-3 was found to be 852.4 HV. [14]

Arun Kumar Srirangan et al.(2015) submitted a work on multi-response optimization of process parameters for TIG welding of Incoloy 800HT by Taguchi grey relational analysis. Incoloy 800HT welded with tungsten inert arcwelding process with N82 filler wire of diameter 1.2mm. Based on the ANOVA results of GRG, it was observed that the welding current (58%) exerted a significant influence on multiple responses followed by welding speed (30%) and voltage (12%).[15]

Ajit Khatter et.al (2017) carried out a study to optimize the welding process in TIG using Taguchi of Stainless Steel-304. The purpose of this study is to propose a method to decide near optimal settings of the welding process parameters in TIG welding. In an attempt to model the welding process for predicting the bead shape parameters (also known as bead geometry parameters) of welded joints by using Taguchi technique . The study found that the control factors had varying effects on the Tensile strength, welding voltage having the highest effects.[16]

Giridharan et al. (2009) conducted a study to optimize pulsed GTA welding process parameters for the welding of AISI 304L stainless steel sheets. It was carried out to obtain optimum weld bead geometry with full penetration in welding of stainless steel (304L) sheets of 3 mm thickness. A quasi-Newton numerical optimization technique was used to solve the optimization problem. Welding speed (S) is the most important and pulse current (Ip) the next most important influencing process variable on bead parameters, while pulse current duration is the least important among the three process parameters considered in this study. [17]

Kumar Rahul Anand et al. (2017) presented a work to optimize TIG welding process parameter on a joint of stainless steel (316) & mild steel using Taguchi technique. In this paper with the use of Taguchi method of optimization to optimize the various process parameters such as current, voltage and gas flow ratio (GFR) which has influence on tensile strength and hardness of the joint. Based on the ANOVA results, it was observed that contribution of arc current (44.06%) exerted a significant influence followed by arc voltage (16.6%) and GFR (5.81%). [18]

Srinivasan et al. (2017) explored Micro structure and mechanical properties of Gas tungsten arc welded High Strength Low Alloy (15CDV6) steel joints. Investigation was carried out by GTAW process using L9 orthogonal array. Technique for Order Preference by Similarity to Ideal Solution Method (TOPSIS) was used for the optimization of multi performance characteristics. In TIG welding of 15CDV6 high strength low alloy steels lower value of bead width and reinforcement, higher value of tensile strength are an indication of better performance. [19]

Mukundraj V. Patil et al. (2017) carried out a work in Multi response simulation and optimization of gas tungsten arc welding. In the fabrication of a pressure vessel, the successful bending operation (after welding) demands higher tensile strength of weld bead. Definitive screening design (DSD) is used for process improvement. The typical values of tensile strength and hardness are obtained at a low value of purging gas flow rate, filler rod dia.; intermediate values of root gap, plate thickness; and at high values of electrode dia., current, and gas flow rate. [20]

III. CONCLUSION

From this review it is able to understand optimization of welding parameter for a material using GTAW. The effect of process parameters in weld pool quality and comparison between two optimization technique for a same material are studied. This gives complete guide to do optimization in welding. Some major findings are

1. Welding current is the most influencing factor for the quality of welded joint.
2. RSM has an edge over the Taguchi method in terms of significance of interactions and square terms of parameters.
3. In GTAW ,Pulsed current leads to better weld quality characteristics when compared to continuous current mode.
4. Welding voltage has high effects on tensile strength of the welded joint.

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