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STUDY OF OPTIMIZATION OF PROCESS PARAMETERS AND ITS RESPONSES IN ARC WELDING PROCESS

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Abstract

Welding is a fabrication or sculptural process that connects materials, typically metals or thermoplastics, through high heat to melt the objects together and allow them to produce fusion. Welding is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. The arc welding is the highly promising joining process because of its wide industrial application involving joining of similar or dissimilar materials at high speed. Arc welding is a common joining method, which is usually characterized by bead dimensions and mechanical properties. Manufacturer face the problem of control the process input parameters to obtain a good welded joint with the required weld quality. Traditionally, it has been necessary to study the weld input parameters for welded product to obtain a welded joint with the required quality. It requires a time-consuming trial and error development method. The purpose of this study is to propose a method to decide optimal settings of the welding process parameters in welding.

Keywords: *Arc Welding; Process Parameter, Response; Optimization.*

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1. Introduction

Welding is the most economical and efficient way to bond metals permanently. It plays an important role in the manufacture and repair of steel. It is also used in the construction of spacecraft, fighter jets, submarines and nuclear power plants. Welding occupies a prominent place among industrial processes and contains more scientific principles and variables than those involved in any other industrial process. There are many different types of welds. Some processes emit sparks and others do not require additional heat. Welding can be done anywhere, outdoors or indoors, underwater and outdoors. Many welding methods or techniques are commonly used for a wide range of applications. The quality of welding plays an important role as it improves the strength, hardness and hardness of the product. The quality of a welded product is evaluated by various parameters, such as the geometry of the weld bead, deposition rate, and hardness. These characteristics are controlled by a range of welding parameters, such as welding current, welding speed, arc voltage, and electrode output and, therefore, in order to obtain good quality, it is important to determine the parameters in the proper welding process. Welding is a permanent bond between two or more similar or different materials by applying filler to them at a certain temperature with or without pressure or with / without filling only.

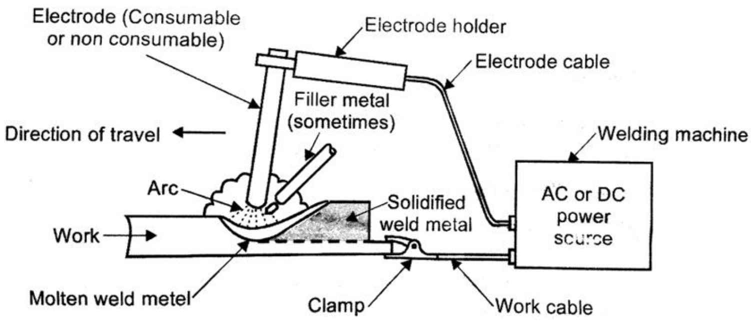

Figure 1. Basic circuit diagram of arc welding process

2. Literature Review

Osayi et al (2015), studies based on the design of experiments (DOE) using the Taguchi method with four welding parameters; Welding current, (ii) welding speed, (iii) inertial separation and (iv) electrode angle are considered for the experiment. An orthogonal matrix of experimental design L9 was adopted and the ultimate tensile strength was examined for each experimental run. Tensile testing was performed on welded specimens and not welded using a universal testing machine (UTM). The microstructure of the welded specimens was analyzed and analyzed. Statistical analysis (ANOVA) and signal-to-noise ratio were used to study the significant effect of input parameters on the ultimate tensile strength and conditions optimized for process performance, respectively.

Moradpour et al (2015), studied in the welding of such structures, the parameters of the selection process have a great influence on the geometry of the weld bead and, as a result, affect the quality of the weld. Based on fuzzy logic and the NSGA-II algorithm (a genetic algorithm of non-dominated classification-II), a new approach was proposed for predicting the geometry of weld bead and optimization of process parameters. First, various welding parameters, including voltage, current, and welding speed, were established to perform SAW in varying conditions on API X65 steel plates. Subsequently, the designed fuzzy model was used to predict the weld bead geometry and process modeling. Average percentage of error obtained from penetration depth, width, and height of weld bead of the proposed fuzzy model.

Kumar et al (2016) relate the use of relational analysis of grey based on Taguchi to optimize gas arc welding parameters. The multiple reaction optimization procedure employs an orthogonal matrix to be used with the GRA and Taguchi methods. The optimal configuration of welding parameters simultaneously minimizes the width of the bead, maximizing the height of the bead HAZ and penetration of the weld. It has been shown that many reactions in gas metal arc welding are enhanced with the grey-based Taguchi method.

Jadoun et al. (2016) adopted the Taguchi method to analyze the effect of each parameter of the welding process on the welding resistance and optimum parameters of the process are obtained to obtain maximum welding resistance. The study includes selection of parameters using an orthogonal matrix, performance of experimental runs, data analysis, determination of optimal combinations, finally experimental validation. Experimental results are provided to illustrate the proposed approach.

Yan et al. (2017) conclude that an optimization approach of arc welding process parameters is presented to reduce energy consumption and improve thermal efficiency. In the multi-objective optimization model of the arc welding process, total energy consumption and thermal efficiency are chosen as optimization objectives, and welding current and welding speed are chosen as independent variables. FSGA is applied to solve the optimization problem and a case study is used to validate the proposed model.

Patil (2017) focuses on multiple reaction simulations and optimization of gas tungsten arc welding. The purpose of their work is to achieve specific tensile strength and stiffness after the welding process. 304 stainless steel is a widely used material in almost all industrial applications, therefore, it is chosen as a candidate material for the study of tungsten inert gas welding process. To produce a reliable and high-quality weld, the welding process needs to be robust in performance.

Shukla et al. (2018) focuses on the analysis of armoured metal arc welding parameters to maximize this document focuses on the penetration of analysis using the reaction surface method. Welding current, electrode polarity and flashlight angle were taken as input parameters. The experiment was designed using a complete factual method. The RSM-based model has been developed to determine the penetration depth achieved by various welding parameters. The quadratic model developed using RSM shows high accuracy and can be used to predict within the range of the probe factor.

Ghosh et al. (2018) presents work on AISI 316L stainless steel samples welded by MIG Welding. He has been made a butt joint. Welding quality has been evaluated in terms of ultimate strength, elastic limit and elongation percentage of welded specimens. Interpretation, discussion, and analysis of observed data has been done through the use of principal component analysis (PCA). The optimal parametric configuration has also been estimated and validated. The experimental results and subsequent analyzes have been fruitfully interpreted to draw some important conclusions.

Sheikh and Kamble (2018) conducted experiments to eliminate welding defects and increase welding quality. During the study it was discovered that the welding defect affects the welding appearance of the product. If there are welding defects on the sheet, the product cost of sale is reduced. Additional cost of repair was required to eliminate product defects. Taguchi are used with the help of DOE analysis. This was done to obtain a better result, that is, minimization of defects when welding the sheet.

Kumar et al. (2018) hybrid technique was applied, and ANOVA is applied to determine the importance of input parameters to optimize the degree of Gray's relationship.

Choudhary et al. (2019), the Jaya algorithm is applied for multibiotic optimization of the SAW process, and the optimization results based on the Jaya algorithm are compared with the traditional desirability approach, the genetic algorithm.

3. Noteworthy Contributions in the Field of Proposed Work

Manufacturer face the problem of control the process input parameters to obtain a good welded joint with the required weld quality. Traditionally, it has been necessary to work out the weld input parameters for welded product to obtain a welded joint with the required quality. It requires a time-consuming trial and error development method. In the field of arc welding, the main problem facing for the manufacturer is how to choose the process input parameters that would produce an excellent weld joint, welding quality, and its strength. Conventionally, defining the weld input parameters (for newly welded products) to produce a welded joint with the required specifications is a time-consuming process involving error development effort and the skill of the welding engineer or welding machine operator in choosing the right weld input parameter and get optimum response.

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