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Optimization of Submerged Arc Welding Parameters for Joining SS304 and MS1018 Dissimilar Metal Welding: A Review

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Abstract

The main objective of this review paper is optimizing various Submerged arc welding parameters including welding voltage, welding current, nozzle to plate distance (NPD) and welding speed by developing a mathematical model for weld tensile strength, hardness, impact load of a mild steel and stainless steel (309) specimen. This mathematical model is developed with the help of the design of Matrix. This experimental study aims at half Factorial design approach has been applied for finding the relationship between the various process parameters and weld deposit area. And after that we can easily find out that which parameter will be more affect OR which parameter will be more influence variable to mechanical properties of the material.

Keywords

Submerged arc welding Process; half Factorial Design Approach; Weld Deposit Area.

Introduction

Welding is a process of joining different materials. It is more economical and is a much faster process compared to both casting and riveting. Submerged Arc Welding (SAW) Process is one of the oldest automatic welding processes introduced in 1930s to provide high quality of weld. The quality of weld in SAW is mainly influenced by independent variables such as welding current, arc voltage, welding speed and electrode stick out. The prediction of process parameters involved in submerged arc welding is very complex process. Researchers have several attempted to predict the process parameters of submerged arc welding to get smooth quality of weld.Metal electrode continuously feed and acts as a filler material. No any pressure is applied during this process. This process is completed without usual spark, smoke and spatter.

Figure 1:-setup of submerged arc welding

Factorial Design Approach and Terminology

Factorial experiments permits to evaluate the combined effect of two or more experiments variables when evaluated simultaneously. Information obtained from factorial experiments is more complete than those obtained from a series of single factor experiments, in the sense that factorial experiments permit the evaluation of interaction effects. An interaction effect is an effect attributable to the combination of variables above and beyond that which can be predicted from the variables considered separately. For the need of factorial experiments, the information gathered could be used to make decisions, which have a board range of applicability. In addition to information about how the experiments variables operate in relative isolation, it can be predicted, what will happen whentwo or more variables are used in combination. Apart from the information about interactions, the estimate of the effects of the individual variables is a more practical use. In the case of factorial experiments, the population to which inferences can be made is more inclusive than the corresponding population for a single factor experiments. Factorial experiments are concerned with answering the following questions:

- What factors should be included?
- How many levels of each factor should be included?
- How should the levels of the factors be spaced?
- How many experimental units should be selected for each treatment conditions?

A factor is a series of related treatments or related classifications. The related treatments making a factor constitute the levels of that factor. The number of levels within a factor is determined largely by the thoroughness with which an experimental desires to investigate the factor Components.

- **Notation**

  The levels for each factor were the highest value and the lowest value of the factors in between and at which the outcome was acceptable. These values were outcomes of trials runs. Highest value has been represented by "+" and the lowest value has been represented by "-"

- **When to Use**
  Factorial experiments can be used when there are more than two levels of each factor. However, the number of experimental runs required for three-level (or more) factorial designs will be considerably greater than for their two-level counterparts. Factorial designs are therefore less attractive if a researcher wishes to consider more than two levels.

- **Implementation**
  For more than two factors, a 2k factorial experiment can be usually recursively designed For more than two factors, a 2k factorial experiment can be usually recursively designed from a 2k-1 factorial experiment by replicating the 2k-1 experiment, assigning the first replicate to the first (or low) level of the new factor, and the second replicate to the second (or high) level. When the number of factors is large (typically more than about 5 factors, but this does vary by application), replication of the design can become operationally difficult. In these cases, it is common to only run a single replicate of the design. When there are many factors, many experimental runs will be necessary, even without replication. For example, experimenting with 16 factors at two levels each produces 216=65536 combinations. At some point this becomes infeasible due to high cost or insufficient resources.

Literature Survey

Behcetgulenceet. at. [2003] discovered that the submerged arc welding process is mostly used due to the high current and ability to deposit a large amount of weld metal using more than one wire at the same time and especially in the restoration of the worn parts. The results shows that the hardest weld metal has higher wear resistance, and the low hard weld metal showed low wear resisctance.[1]

A. joseph et. at. [2005] discovered that the maximum tensile residual stress in the dissimilar welded joints with or without the buttering layer are almost the same. however the residual stress present in the HAZ of the ferrite steel of the dissimilar joints with a buttering layer are less significantly than those of a dissimilar welded joints without buttering layer.[2]

Ana. Ma. Paniagua Mercado et. al.[2005] discovered that the effect of flux composition for tensile properties and microstructure of a submerged-arc weld AISI 1025 steel. There were three flux composition used with a low-carbon electrodes. The welding condition was allmost same as before. Tension tests did at the room temperature. Macrostructure and microstructure of welds were observed with the light and scanning electron microscopes (SEM). The presence of ferrite was detected for welds of fluxes with the highest value of titanium oxide. The ultimate and yield tensile strengths were affected by the presence of ferrite. The elongation and area reduction percentages were influanced by the volume percentage. Microstructure and tensile properties were compared with the values predicted by the computer programs.[3]

D. Geryet. at [2005] discovered that heat source model is based on Goldak's double-ellipsoid heat flux distribution. C++ programme was developed to investigate heat inputs into finite element thermal simulation of the plate butt joint welding. The temperature variations and transient temperature distributions of welded plates during welding were predicted and the heat affected zone and fusion zone were obtained. Effects of energy input, welding speed and heat source distribution on temperature changes for the further calculations.[4]

Keshav Prasad et. at [2006] discovered that the affect of the submerged arc welding on the hardness, microstructure and the microstructure of the plain carbon steel weld joint. He analyze the result on the basis of heat input. SAW process was used for welding a 16 mm thickness plates of plain carbon steel. Results shows that hardness changes from weld center line to the base metal and the peak hardness was found at the heat affected zone .the increase in the heat input coarsen of the grain structure both in the weld metal and hardness. The increase in the welding current at given speed increased toughness and increase in the welding current lower the toughness.[5]

Paul Colegroveet. al. [2009] discovered that how the diferent welding process influences on the distortion and residual stresses. In this study he compare the welds made by SAW the gas metal arc welding(DC), gas metal arc welding (pulsed), autogenous laser and laser hybrid welding on butt welds havind thickness of 4mm . laser hybrid and Laser welding were studied to produce the lesser distortion. He studied that the higher the heat input and distortion of the SAW is abundantly clear: both are nearly twice as the other arc welding processes. Therefore there is an advantage in using an alternate welding processfor the lesser distortion. Overall, distortion reduction of 20-70% is realizable with the GMAW processes over the submerged arc welding(SAW) process and 80-95% reduction is possible by using the laser processes[6]

James amanieet. at. [2011] discovered that the effects of submerged arc welding (SAW) and speed current on the microstructures of SA516 grade 70 and A709 grade 50 steel welds were studied in this study. Steel plates 17 mm-thick were submerged arc welded using different welding currents (from 700 to 850 A) and welding speeds (from 5.3 to 15.3 mm/s). The results showed that it is difficult to discribe changes in microstructure that generate in the heat affected zone (HAZ) and the weld metal regions to single welding process parameter. Inclusion analysis shows that two types of inclusions formed in the weld metals for both steels. They are faceted and spherical inclusions. It was also observed that ferrite nucleated only on the spherical inclusions. energy dispersive X-ray spectroscopy (EDS) analysis showed that these two inclusions both have different chemical composition.[9]

E.m. anawa et. at. [2008] found that the welding speed has the strongest effect on the residual stress among the studied parameter. So increasing in the welding speed decreasing in the residual stress and lesser in the welding speed can be applied successfully for the joining dissimilar metals.[7]

SerdarKaraoglu et. al. [2008] discovered that the process parameter that have high influence on the quality of the welded connection. Mathematically modeling can be used in the optimization of the process parameters. The study mainly focus on the sensitivity analysis of the parameters and very less adjustment requirement such as welding voltage, welding current and welding speed are used as design variables. Effect of all three variables play an important role in the good quality of welding process. The result also showed that the penetration is almost non-sensitive to the variation in the welding speed and welding voltage.[8]

Conclusion

In this work, i will determine an important welding process parameters for multiple performance characteristics weld bead width, tensile strength, hardness,impact load and bead hardness in the SAW process using half factorial design method. Careful attention is necessary to select the welding parameters to obtain a desirable weld quality, the major key process parameters affecting the bead geometry are arc voltage, welding current, welding speed and nozzle distances.

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