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Optimization of Welding Parameters Using Taguchi and Fuzzy Methods

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ABSTRACT

Welding is technique to weld dissimilar metals or alloys. A variety of problem arises during welding of dissimilar metal or alloys like stress corrosion cracking, comprehensive and tensile stresses etc. To overcome all these problems the study is required of welding parameters on mechanical properties. To optimize welding parameters for single property is obtained by using Taguchi Method, but to optimize welding parameters for multiple properties Fuzzy method is applied.

KEYWORDS | Fuzzy Method, Taguchi Method, Optimization, Welding

I. Introduction

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined or welded together, with or without the application of pressure and a filler material. The materials to be joined may be similar or dissimilar to each other. The heat required for the fusion of the material may be obtained by burning of gas or by an electric arc. The weld property depends on the various welding parameters like current, voltage, speed, position etc.

Taguchi Method was developed by Genichi Taguchi. The overall objective of Taguchi method is to produce high quality product at low cost for the manufacturers. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied. Instead of having to test all possible combinations the Taguchi method tests pairs of combinations. This allows for the collection of the necessary data to determine which factors most affect the product quality with a minimum amount of experimentation, thus saving time and resources. Taguchi method is basically used to optimize welding parameters for single weld property, it don't work well in case of multiple weld property. For optimizing welding parameters for multiple weld property Fuzzy method is used

II. Related Work

Aditya Kumar et al. [1] worked on the submerged arc welding and fuzzy logic. In submerged arc welding flux composition plays an important role in deciding the quality of weld. In a SiO2 based flux NiO, MnO and MgO are added in three different proportions. The Vickers hardness and impact strength of the weld was measured and the effect of each flux alloying element was investigated. For multi-objective optimization, a Fuzzy Logic model was proposed and optimal levels of NiO, MnO and MgO was obtained using a single multi-response performance index (MRPI).

Prasenjit Mondal et al. [2] worked on the dissimilar metal weld joints. The dissimilar metal weld joints have been used as structural material for industrial applications and provides good combination of mechanical properties like corrosion, strength, resistance with lower cost. In this study stainless steel plate of AISI-304 has been welded with mild steel plate of IS: 1079 by Metal Inert Gas (MIG) welding processes. The tensile strength and hardness of dissimilar metal joints have investigated. The results are compared for different joints made by MIG welding processes and finally optimize the best combination of input parameters.

Manoj Raut et al. [3] experimental study was based on an investigation of the effect and optimization of welding parameters on the tensile shear strength in the Resistance Spot Welding process. The experimental studies were conducted under varying electrode forces, welding currents, and welding times. The settings of welding parameters were determined by using the Taguchi experimental design of Orthogonal array L18 method. The combination of the optimum welding parameters have determined by using the analysis of Signal-to-Noise (S/N) ratio. The confirmation test performed clearly shows that it is possible to increase the tensile shear strength of the joint by the combination of the suitable welding parameters.

Ajit Khatter et al. [4] worked on the welding process parameters in TIG welding. This paper proposes a method to decide optimal settings of the welding process parameters in TIG welding. Welding properties affecting parameters are like Tensile Strength, Impact Force, Hardness etc. Experiments are performed, based on the data collected from experimental value, the optimized parameters are calculated. By using Taguchi method and ANOVA analysis technique, optimized solution is obtained.

Nabi Mehri Khansari et al. [5] used Friction Stir Welding (FSW) for joining aluminium alloys system. In order to decrease the count of experimental tests, Mamdani-Type Fuzzy implication has been applied. In this paper an intelligent relationship has been created between the input and output data i.e. between the forward and rotational speed as inputs and mechanical properties as output using fuzzy logic. The result indicated that by adopting and using an appropriate fuzzy method, both the number of experiments conducted and mechanical properties of welded FSW can be optimized. Fuzzy logic created a relationship between input and output data so that mechanical properties for an untested rotational speed can be estimated.

S. V. Sapkal et al. [6] papers presents the influence of welding parameters like welding voltage, welding current and welding speed. Metal Inert Gas (MIG) welding process is an important component for many industrial operations. The welding parameters are the most important factors that affect the quality, cost and productivity of welding. A plan of experiments based on Taguchi technique is used to acquire the data. An orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) are used to investigate the welding characteristics of MC C20 material and optimize the welding parameters (i.e. welding voltage, welding current and welding

speed). At the last confirmation test is carried out to compare the predicted value with the experimental value that confirms its effectiveness in the analysis of penetration.

Joseph I. Achebo [7] the strength value most desired in any welding process is an excellent Ultimate Tensile Strength (UTS) of the weld, compared with the parent metal. The optimization was achieved by employing the Taguchi Method. A step by step approach for applying the Taguchi Method is applied. The study shows that by using Taguchi Method successfully improved value is obtained on the existing process parameters, giving the industrial firm a more efficient welding protocol.

Claudio Morga et al. [8] worked on the fuzzy if-the rules optimization. Evolutionary optimization of fuzzy if-then rules for the approximation in the area of research achieved much attention. A new possibility has been added by proposing a method for data driven reshaping or designing the uncertainty transitions for piecewise linear fuzzy sets representing the linguistic terms of the fuzzy rules. Method disclosed to optimize the shape of the sides of a piecewise linear linguistic terms. This method is based on fine tuning of the parameter which controls the sides of the linguistic terms. The shapes of the linguistic variable are controlled by both dilation and compression of shapes. The constrained optimization can be improved by changes in position and size of the core and support of the linguistic terms.

J. L. Lin et al. [9] worked on optimizing electric discharge machining process based on Taguchi method with Fuzzy Logic. A Multi Response Performance Index (MRPI) is used to solve the electric discharge machining process with multiple performance characteristics index. The machining process parameters like workpiece polarity, duty factor, pulse-on time, open discharge voltage, discharge current and dielectric filed, are optimized with considerations of the multiple performance characteristics such as electrode wear ratio and material removal rate. Experimental results presented, demonstrate this approach. Taguchi method has been concerned in optimizing single process parameter, handling multiple process parameters is done using fuzzy logic.

Y. S. Tarng et al. [10] used the application of the Taguchi method to optimize submerged arc welding process. The Taguchi method helps to formulate the experimental layout, to analyze the effect of each welding parameters on welding performance. The Taguchi method is also used to predict the optimal setting for each welding parameter. As shown in this study the Taguchi method provides a very systematic and efficient methodology for determining optimal welding parameters with far less work than that would have been required for most optimization techniques. It has been shown that deposition rate and dilution can be significantly improved in the submerged arc welding process using the optimized welding parameters. The experiments were performed and based on the experimental results confirm the effectiveness of the approach. As a result, the performance characteristics such as dilution and deposition rate can be simultaneously considered and improved through this approach.

Yasuhiko Dote [11] worked on fuzzy logic and its control. Fuzzy logic has been mostly used for control and measurement. Fuzzy membership functions are designed according to the requirements of the input and output terms. Further operations like and, or applied on the designed membership function to achieve the desired output. The crisp inputs are fed to the fuzzifier on which rules are fired, the resultant produces fuzzy sets, the output is further fed to the defuzzifier where the fuzzy input are converted back to the crisp form. Work also has been done on the membership function and various operations are also performed on it.

N. Rajesh Jesudoss Hynes et al. [12] their purpose of the work is to study the influence of process parameters of friction stud welding on joining of steel AA 6063 and AISI 1030. With the application of fuzzy logic, empirical models are developed for output response characteristics. Rotational speed, friction time and friction pressure are considered as the influential input process parameters. The values of Impact strength and axial shortening are predicted by fuzzy models and they are compared with the experimental data.

III. Conclusion

By using welding dissimilar metal or alloys can be welded together. To obtain better welding properties, various welding parameters like current, speed, voltage etc can be optimized. For single welding property Taguchi method is used but for multiple welding properties Fuzzy Method is in use.

References

[1]. Aditya Kumara, Sachin Maheshwarib and Satish Kumar Sharma, "Fuzzy Logic Optimization Of Weld Properties For Saw Using Silica Based Agglomerated Flux", ICRTC-2015, Elsevier.

[2]. Prasenjit Mondal and Dipankar Bose, "Optimization Of The Process Parameters For Mig Welding Of Aisi 304 And Is 1079 Using Fuzzy Logic Method", International Research Journal of Engineering and Technology (IRJET), Vol. 02, Issue: 08, pp 483-488, November, 2015.

[3]. Manoj Raut and Vishal Achwal, "Optimization Of Spot Welding Process Parameters For Maximum Tensile Strength", IJMERR, Vol. 3, No. 4, October 2014.

[4]. Ajit Khatter, Pawan Kumar and Manish Kumar, "Optimization Of Process Parameter In Tig Welding Using Taguchi Of Stainless Steel-304", IJRMET Vol. 4, Issue 1, pp 31-36, Nov ember 2013 - April 2014.

[5]. Nabi Mehri Khansari, Namdar Karimi and Dr. Mohammad Hosein Sabour, "Optimization Of Friction Stir Welding By Fuzzy Logic", IFSC2013, Tehran, Iran, 27-29 August 2013.

[6]. S. V. Sapakal and M. T. Telsang, "Parametric Optimization Of MIG Welding Using Taguchi Design Method", International Journal of Advanced Engineering Research and Studies, IJAERS, Vol. I, Issue IV, pp 28-30, July-September, 2012.

[7]. Joseph I. Achebo, "Optimization of GMAW Protocols and Parameters for Improving Weld Strength Quality Applying the Taguchi Method", Proceedings of the World Congress on Engineering 2011, Vol I, WCE 2011, London, U.K., July 6 - 8, 2011.

[8]. Claudio Moraga and Rodrigo Salas, "A New Aspect For The Optimization Of Fuzzy If-Then Rules", Proceedings of the 35th (ISMVL'05), IEEE.

[9]. J. L. Lin, K. S. Wang, B. H. Yang And Y. S. Tarng, "Optimization Of Electric Discharge Machining Process Based On The Taguchi Methods With Fuzzy Logic", Journals of Material Processing Technology, pp 48-55, 2000.

[10]. Y. S. Tarng & W. H. Yang, "Application Of The Taguchi Method To The Opti mization Of The Submerged Arc Welding Process", Materials and Manufac turing Processes, Vol. 13, No.3, 455-467, 1998.

[11]. Yasuhiko Dote, "Introduction To Fuzzy Logic", IEEE, pp 50-56, 1995.

[12]. N. Rajesh Jesudoss Hynes, R.Kumar and J. Angela Jennifa Sujana, " Modeling Of Process Parameters Of Friction Stud Welding Using Fuzzy Logic System", Hynes et al., IJAET