

STUDY OF THE EFFECT OF PROCESS PARAMETERS ON WELD BEAD GEOMETRY OF SAW PROCESS: A REVIEW

GYANENDRA SINGH¹ & ANKIT KUMAR²

¹Assistant Professor, Department of Mechanical Engineering, Invertis University, Bareilly, Uttar Pradesh, India

²Research Scholar, Department of Mechanical Engineering, Invertis University, Bareilly, Uttar Pradesh, India

ABSTRACT

One of the main welding processes used in the industries for the purpose of fabrication of huge sized structures is Submerged Arc Welding (SAW) process. The SAW process consists of a copper coated wire (spooled form, diameter 2 to 10 mm) and granular flux that enables without interruption welding. The flux covers the joint ahead of an electrode wire that remained submerged in flux, thus, there is no requirement of shielding gases. The flux cover eliminates the weld spatter and the arc radiation. The key features of this process are high deposition rates and long weld runs. SAW is mainly used for welding low carbon and low alloy steels; however, heat resistant steel, medium carbon steel and corrosion resistant steel are also welded using SAW. In addition, SAW is used for welding of nickel and monel. The process is used mainly in the downward welding position for plate thickness between 5 to 50 mm, particularly where the welds are straight and long. The SAW is popular for butt and fillet welds in pressure vessel fabrication, ship building, structural engineering, pipe welding and rail-road tank cars. The important process variables in submerged arc welding are: welding current, arc voltage, welding speed, nozzle to plate distance etc. This paper presents the review of the effect of process parameters on weld bead geometry of SAW process

KEYWORDS: Submerged arc Welding, Weld Bead Geometry, Welding Process Parameters

INTRODUCTION

Submerged arc welding (SAW), high quality, very high deposition rate welding process commonly used for joining plate. The SAW includes formation of an arc between work piece and wire electrode which is fully submerged under fusible flux [1]. The flux avoids the contamination and ensure concentrating heat into the weld joint [10]. The molten pool is solidified and the parts are permanently bonded together. This process is widely employed as one of the major fabrication processes in industry due to its inherent advantages of deep penetration, smooth bead and superior quality [8]. The productivity, quality, and cost of welding are affected by SAW parameters. The weld bead geometry affects the weld schedule and thus the welding cost. A number of parameters (current, voltage, wire feed speed, torch speed, electrode stick out and torch angle) directly affects the weld quality [9]. The present work includes a review over the literature in the field of SAW.

LITERATURE REVIEW

A. Ghosh, S.Chattopadhyaya, P.K. Sarkar [1], In this paper, an attempt has been taken to develop a model to predict the yield characteristics (weld bead parameters) of Submerged Arc Welding (SAW) process with the help of neural network technique and analysis of various process control variables and important weld bead parameters in SAW. The SAW process has been chosen for this application because of the complex set of variables and high set up cost

involved in the process as well as its significant application in the manufacturing of critical equipments which have a lot of economic and social implications. Also an attempt has been taken for prediction of output variable of SAW process in this paper.

Deepak Kumar Choudhary, Sandeep Jindal and N.P.Mehta[2]. To investigate the effect of welding parameters on bead geometry. Mathematical models were developed by using 2- level half factorial technique to predict the bead geometry within the range of control parameters or operating variables for single wire submerged arc welding. The models developed can be employed easily in automatic or robotic welding, in the form of program, for obtaining the desired high quality welds. Current, open circuit voltage, welding speed and nozzle-to-plate distance were taken as welding variables constant. The models were developed from the observed values, with the help of design matrix the adequacies of the models were tested by use of analysis of variance technique and signification of coefficients was tested by student' s-test'. The combined and main effect of different parameters involved has been presented in graphical form.

Hinal B. Thakker[3]. To investigate the Selection of process parameters on bead geometry of SAW process. Welding input parameters play a significant role in determining the quality of a weld joint. Here, this joint quality can be defined in terms of properties such as weld bead geometry and flux consumption. All the welding processes are used with the aim of obtaining a welded joint with the desired weld bead geometry and excellent mechanical properties with maximum metal deposition rate and minimum distortion rate.

Mr. Pradeep Deshmukh, Prof. S. N. Teli[4]. The research on controlling metal transfer modes in SAW process is essential to high quality welding procedures. Quality has now become an important issue in today's manufacturing world. Experiments are conducted using submerged arc process parameters viz. welding current, arc voltage and welding speed (Trolley speed) on mild steel of 12 mm thickness, to study the effect of these parameters on penetration depth. The experiments are designed using Taguchi method (with Taguchi L9 orthogonal array) considering three factors and three levels.

Sukhbaj Singh, Jasvinder Singh, Viranshu Kumar, Shailesh Kumar[5]. 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.

Uma Gautam, Mohd. Abbas[6]. The study of weld bead geometry is important, as it determines the stress carrying capacity of a weld. For the same reason, this paper highlights the analysis and study of process parameters: arc Voltage, welding current, travel speed and electrode extension, on the bead geometry response such as, bead height, bead width and bead penetration. Design Expert 8.0 with 4 factors, 5 levels, rotatable Central Composite Design was used to develop relationship for predicting weld bead geometry, which enables to quantify the direct and interaction effects. Mathematical models prepared for the submerged arc welding of 16 mm thick mild steel by using response surface methodology which correlate the process variables with the bead geometry characteristics. Then the adequacy of developed models were checked by using ANOVA technique. Using p-test, the significant terms were selected from the adequate models. The finally proposed models contain only the significant terms. Using the model, Graph drawn which shows the

main and interaction effects of the process variables on weld bead geometry.

The developed models can be used for prediction of important weld bead dimensions and control of the weld bead quality by selecting an appropriate processor parameter value.

Shahnwaz Alam, Mohd. Ibrahim Khan [7], while discussing the effect of the submerged arc process variables on weld bead geometry said that the control parameters are required to be fed to the system according to some mathematical formulation achieve the desired end results. The response, namely, weld bead width as affected by voltage, current, wire feed rate, welding speed, nozzle to plate distance have been investigated. The main and interactive effect of the control factor is shown in graphical form, which is more useful in selecting the process parameters to achieve the desired quality of the overlay.

Hamid Reza Ghazvinloo[8], In this investigation, the relationship between SAW variables and bead width in a type of medium carbon steel having 10 mm thickness was experimentally studied. The welding current, arc voltage and welding speed were chosen as welding variables and welding joints were prepared for different values of selected variables. After finishing the welding process, the bead width (W) was measured for any given welding condition.

Pranesh B. Bammankar and Dr.S.M.Sawant [9], Focuses on the effect of process parameters on depth of penetration and bead width in the submerged arc welding process. The experiments are designed using Taguchi method (with taguchi L9 orthogonal array) considering three factors and three levels. The results show penetration will be maximum value when welding current and arc voltage are at their maximum possible value and welding speed is at its minimum value.

Mr. Pratik Umrigar, Prof. Sandip J. Chaudhry[10], In which inputs parameters for submerged arc welding are welding current, arc voltage and welding speed and the output parameter are hardness, tensile strength and microstructure of material. We use stainless steel-304 material for welding. Small scale trial welding experiments, in the light of field joint of plate have been planned to perform on 5 mm plate thicknesses and V-groove joint is used. For Experimental design full factorial method ($L=m^n$) to find out numbers of reading is used. To find out the percentage contribution of each input parameter for obtaining optimal conditions, manual method will be used. Mathematical model regarding different input parameter values by using any one optimization techniques will be used.

Dr.P.Ravinder Reddy, N.L.S Himaja, M.Vijaya Bharathi, P.Naveen Kumar [11], while dealing with parameter optimization and prediction of the bead geometry of submerged arc welding using response surface methodology. Development of mathematical models also helps to improve the understanding of the effect of process parameters on bead quality and heat input and to optimize the same, to obtain a high quality welded joint at a relatively low cost with high productivity. Optimization designs focus on only one or two factors, but in much more depth to gain a precise understanding of relationships between factors. A full factorial design combines the levels for each factor with all the levels of every factor. It covers all combinations and provides best data. The results also revealed that all weld bead parameters increases with an increase in wire feed rate and decreases with increase in weld speed. They developed equations for penetration, bead width and heat input can be used to predict theses output parameters, when all input parameters lie within limits. The parameters with required desirability can be used for the purpose of welding.

Meenu Sharma1, Prof. (Dr.) M. I. Khan[12], The investigation of optimal submerged arc welding (SAW) process parameters that affect weld bead geometry and quality of welds using TAGUCHI method. A planned experimental

investigation has been carried out on a semiautomatic SAW machine. The effects of process parameters and signal to noise ratios have been computed and the contribution of each factor has been validated by ANOVA. The results indicate the welding voltage to be the most significant contributor to weld penetration. The contribution of voltage, current, welding speed and nozzle to plate distance have been found to be respectively 60.8 %, 9.9%, 3.5% and 13.8%. Optimum parameters have been found to be 26V, 475A, at welding speed of a 15 m/s and NTP distance of 16 mm . The main interaction effects of control factors on bead geometry have also been presented in graphical form.

Shivam Bhardwaj, Simranjeet Singh, Sahil Barry, Manish Saini, ER.Ajay Sharma, ER.Harpreet Singh[13], The research on controlling metal transfer modes in SAW process is essential to high quality welding procedures. The experimentation work details the application of Taguchi techniques for optimization of weld bead geometry on EN24 (low steel alloy) using submerged arc welding (SAW). The planned experiment work conducted in the semi automatic submerged arc welding machine and signal to noise ratio has been computed. The contribution of each factor has been calculated by Analysis of Variance (ANOVA) method. The result of the present experiment shows that the welding voltage is the highly dominating factor and most significant parameter that controls the bead penetration as compared to the other parameters.

L.J. Yang[14], The results of bead-on-plate weld measurements are presented to determine the effects of the process variables on the bead width for the submerged-arc welding process, at a heat input of 3 kJ/mm. It is found that bead width is affected by the electrode polarity, electrode diameter, and electrode extension, welding current, welding voltage and welding speed. However, the present work suggests that heat input alone is not sufficient for predicting bead width in submerged-arc welding. The bead width is not affected significantly by the power source, constant voltage or constant current, when an acidic fused flux is used. However, when a basic fused flux is used, constant-current operation gives somewhat larger bead widths. It is found also that basic fused flux welds have a somewhat larger bead width than acidic fused flux welds. Regression equations are presented for computing bead width from the welding parameters, the analysis including both linear and curvilinear multiple-regression analysis techniques. Surprisingly, the correlation coefficients of the linear multiple-regression equations were found to be somewhat better than those of the curvilinear analysis

RESULTS & CONCLUSIONS

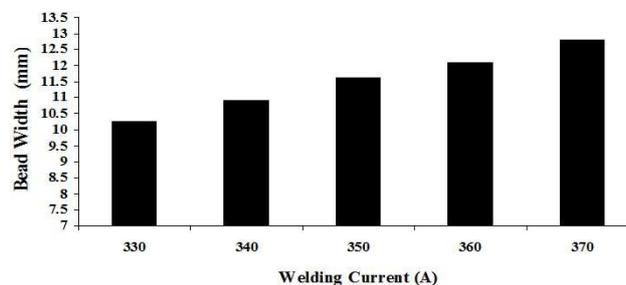


Figure 1: Effect of Welding Current on Weld Bead Width

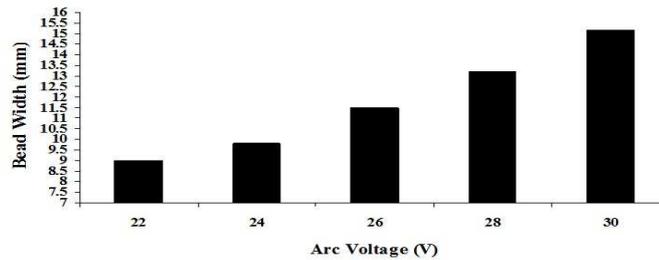


Figure 2: Effect of Arc Voltage on Weld Bead Width

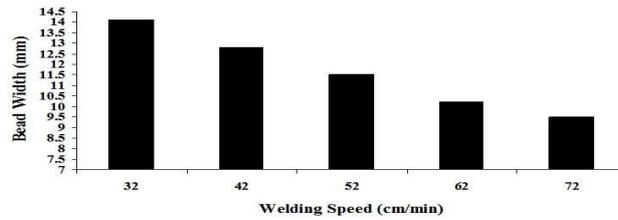


Figure 3: Effect of Welding Speed on Weld Bead Width

- The open circuit voltage, current, travel speed and nozzle to plate distance are found to effect the bead height and bead width of the weld metal significantly.
- An increase in voltage increases bead width but bead height decreases.
- As current increases, bead width remains unaltered but bead height increases.
- The values of weld bead width and weld bead height decrease with the increase in welding speed.
- As the nozzle-to-plate distance increases, bead width decreases, but bead height increases. The value of hardness increases with increase in current.
- There is no significant change in the value of hardness with an increase in voltage and travel speed.

REFERENCES

1. A.Ghosh, S.Chattopadhyaya, P.K.Sarkar, Effects of input parameters on weld bead geometry of saw process, International Conference on Mechanical Engineering 2007 (ICME2007) 29- 31 December 2007, Dhaka, Bangladesh.
2. Deepak Kumar Choudhary, Sandeep Jindal and N.P.Mehta, To study the effect of welding parameters on weld bead geometry in SAW welding process, Elixir International Journal Volume 40, 18 November 2011 pp 5519-5524.
3. Vasava, V.M., Prajapati, A.B, Design and analysis of wireless welding arm, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), Volume 6, Issue 4, July-August 2016, pp. 9-24
4. Hinal B.Thakker, A review study of the effect of process parameters on weld bead geometry and flux consumption in saw (submerged arc welding) process, International Journal of Modern Trends in Engineering and Research (IJMTER) Volume 01, Issue 06, December 2014.

5. Mr. Pradeep Deshmukh, Prof. S. N. Teli, Parametric Optimization of SAW Welding Parameters using Taguchi L9 Array, International Journal of Engineering, Business and Enterprise Applications (IJEBA), 8(1), March-May, 2014, pp. 43-47.
6. Sukhbaj Singh, Jasvinder Singh, Viranshu Kumar, Shailesh Kumar, Optimization of Submerged Arc Welding Parameters for Joining SS304 and MS1018 Dissimilar Metal Welding: A Review, International Journal of Technology Innovations and Research (IJTIR), Volume 14, April 2015.
7. Uma Gautam, Mohd. Abbas, Analysis of weld bead geometry in SAW and modeling using CCD, International journal of mechanical engineering and robotics research (IJMERR), Volume 2, No.3, July 2013.
8. Shahnwaz Alam, Mohd. Ibrahim Khan, Prediction of the Effect of Submerged Arc Welding Process Parameters on Weld Bead Width for MS 1018 Steel, International Journal of Engineering and Innovative Technology (IJEIT), volume 1, Issue 5, May 2012.
9. Hamid Reza Ghazvinloo, Experimental Study on Bead Width Changes of St 52-2 Carbon Steel Welds Produced by Submerged Arc Welding Process, Australian Journal of Basic and Applied Sciences, 4(12): 6492-6495, 2010.
10. Pranesh B.Bammankar and Dr.S.M.Sawant, Study of the effect of process parameters on depth of penetration and bead width in saw (submerged arc welding) process International Journal of Advanced Engineering Research and Studies, E-ISSN2249-8974.
11. P. Sreeraj , T. Kannan & Subhasis Maji, Prediction and Control of Weld Bead Geometry in Gas Metal Arc Welding Process Using Genetic Algorithm, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), Volume 3, Issue 1, March-April 2013, pp. 143-154
12. Mr. Pratik Umrigar, Prof. Sandip J. Chaudhry, Parametric optimization of submerged arc welding on stainless steel-304, International journal for technological research in engineering volume 1, issue 11, july-2014.
13. Dr.P.Ravinder Reddy, N.L.S. Himaja, M. Vijaya Bharathi, P.Naveen Kumar, "Parameter Optimization and Prediction of Bead Geometry of SAW using Response Surface Methodology", International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS), ISSN (Print): 2279-0047, ISSN (Online): 2279-0055, 5(1), June-August 2013, pp. 61-69.
14. Meenu Sharma, Prof. (Dr.) M. I. Khan, optimization of weld bead geometrical parameters for bead on plate submerged arc welds deposited on is-2062 steel using Taguchi method, International Journal of Technical Research and Applications(IJTRA),Volume2, issue 1, January – February 2014,PP 8-11.
15. Shivam Bhardwaj, Simranjeet Singh, Sahil Barry, Manish Saini, ER.Ajay Sharma, ER.Harpreet Singh, Optimization of Weld Bead Geometry in Submerged Arc Welds Deposited On En24 Steel Alloy Using Taguchi Method, IOSR Journal of Mechanical and Civil Engg. (IOSR-JMCE), Volume 12, Issue 6 Ver. IV, Nov. - Dec. 2015.
16. L.J. Yang, the effects of process variables on the bead width of submerged-arc welding deposits, Journal of Materials Processing Technology Volume 29, Issues 1–3, January 1992