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OPTIMIZATION OF SUBMERGED ARC WELDING (SAW) PARAMETERS

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ABSTRACT

The Welding processes that employ an electric arc is the most prevalent in industry are Shielded Metal Arc Welding, Gas tungsten Arc Welding, Flux cored arc welding, Gas metal arc welding, Gas submerged arc welding. 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) is one of the oldest automatic welding processes provided high quality weld. Submerged Arc Welding (SAW) uses the arc struck between a continuously fed electrode and the work-piece to melt the metal in the joint area and provide additional filler metal under a blanket of granular flux. The Submerged Arc Welding(SAW) is studied copper temperature field is gained in this process. In the Submerged Arc Welding is the lot of factors and effects affecting on the various metallic material. The thermal effect of Submerged Arc that specially depends on the electrical arc, flux type and temperature field of it in work-piece is the main key of analysis and optimization of this process.

Keywords:- RSM, ANOVA, MINITAB, S/N ratio.

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I. INTRODUCTION

Submersible arc welding can be employed for and extremely wide range of work-piece. SAW process is use in the arc struck between a continuously fed electrode and the work piece to melt the metal in the joint area and provide additional filler metal under a blanket of granular flux. This arc is completely submerged under the molten flux, which protects the molten metal from the atmosphere. There is no visible arc, spatter or fume during the welding operation. The electrode of SAW welding is cored wire. It is normally copper coated.

Factors affecting on SAW welding are-

Welding current, Welding voltage, Wire diameter, Wire stick out, Flux type, Welding speed, Electrode size, Angle of Electrode, Electrode Chemistry, Size, Preheat temperature, Electrode Protrusion and Worker Skills.

These parameters have to be selected and precisely controlled in a judicious manner to achieve weld of desired quality. Weld quality is depend upon the bead geometry. Increasing travel speed reduces weld penetration but can cause undercut. Reducing travel speed provides time for the gases to escape from the molten metal and thus porosity may be reduced optimal welding parameters maximum.

SAW process is suitable for Butt welding and Fillet welding excessively applications are structure of ships, cladding application. SAW is a generally indoor in fabrication shops. SAW process is used widely in the fabrication of pressure vessels, marine vessels, pipelines and offshore structures due to high deposition rate and wide range of work-pieces. Various optimization methods have emerged to define the desired output variables through developing mathematical models to establish the relationship between the input parameters and output variables. Observe that the optimization values of welding conditions in spiral pipes and process parameters in hard-facing through submerged arc welding process, Applied Taguchi method to the optimization of the submerged arc welding process, Applied Response Surface Methodology (RSM) for prediction and optimization of weld bead quality in submerged arc welding of pipes by establishing mathematical models, Analyze the effect of microstructure, hardness, and toughness of HSLA steel weld joints by varying heat input of submerged arc welding process. Curvilinear equations, linear regression equations, multiple regression analysis and Taguchi method have been used to model SAW process.

SAW hard facing process and Taguchi method is widely used for analysis, industry and needs a better prediction and

monitoring of its parameters. It is necessary to select most appropriate weld parameter settings to improve weld efficiency, process at low cost and produce high quality products, But traditional Taguchi method cannot solve multi-objective optimization problem effectively. Neural networks are considered for modeling the SAW process in hard facing.

II. LITERATURE REVIEW

KOZUKI Shohei [1] et al. studied the low heat input welding method is described and utilized. Use of new welding technologies such as high energy density beam welding by fibre laser welding systems and friction stir welding is also expected. Some parameters related to SAW process were studied that are Increase deposition rate by smaller diameter welding wire, Increases of penetration depth by smaller diameter wire welding, Effect of smaller diameter of wire on weld.

Sahal [2] et al. studied important welding process parameters for multiple performance characteristics weld bead width and bead hardness in the SAW process using Taguchi method. A mathematical model was developed and also studied the weld bead geometry and shape relationship in SAW of pipes.

S.M.Ravikumar[3]et al. studied the optimization of the Shielded Metal Arc Welding (SMAW) process parameters in wind velocity with multi-response criteria using Taguchi orthogonal array with grey relational analysis is studied. It was found that the optimal welding processes parameters.

Edwin Raja Dhas [4] et al. studied the effects of welding parameters and the optimum welding parameters for a SAW process on the multiple performance characteristics are systematically investigated by grey relational analysis and fuzzy logic with orthogonal array. The optimum procedure of grey-fuzzy logic with orthogonal array, the level constitution of optimal welding parameters is acquired.

A.BalaramNaik [5] et al. studied the characteristics of duplex stainless steel and their properties in welding metal examined. To determine the behavior of properties and transformation, difference in het treatment process and systematically investigate the effects of different fluxes were studied.

Shashank Soni [6] et al. studied the research explores practical solutions for welding operations performance improvement by applying the six sigma principle.The principle provides the metrics required to establish performance improvement goals and a methodology for measuring and evaluating improvement. To study a real time monitoring system by which the shear strength of the weld can be estimated without destructive testing without error and reducing the scrapped cost.

Ankush Batta [7] et al. studied important parameters in submerged arc welding, submerged arc welding methods, wire types and current for welding, wire angle and position: advantages and drawbacks.

M. Satheesh[8]et al. studied the high pressure difference across the wall of pressure vessels is potentially dangerous This paper addresses the application of desirability function approach combined with fuzzy logic analysis to optimize the multiple quality characteristics. For the experiment using Taguchi L27 orthogonal array method. Solutions from this method can be useful for pressure vessel manufacturers and operators to search an optimal solution of welding condition.

Mr. Pradeep Deshmukh [9] et al. studied the various parameters and experiment conducted was using Taguchi's orthogonal array L9 method. An experiment was carried out to establish the relationship between process variables and optimization tools are used to find an optimal solution. A confirmation experiment was also conducted and verified the effectiveness of Taguchi optimization method.

S Kumanan[10]et al. studied Multiple regress analysis (MRA) is conducted using statistical package for social science (SPSS) software and the mathematical model is built to predict the bead geometry. The experiment was conducted by using the Taguchi's technique and regression analysis to determine the optimal process parameters for SAW process. The proposed mathematical model is used to predict the SAW process parameters for any given welding conditions.

Dr. P. Ravinder Reddy [11] et al. studied Application of factorial design approach for optimizing four submerged arc welding parameters viz. Arc voltage, welding speed, weld feed speed and nozzle to plate distance. All weld bead parameters increases with an increase in wire feed rate and decrease with increase in weld speed. The equations developed to predict output parameters when all input parameters lie within limits.

Gyanendra Singh [12] et al. studied the important parameters in submerged arc welding, Submerged Arc Welding method. Literature concluded that metal transfer in SAW very less work has been reported, which influences the metallurgy and chemical composition of weld metal. Weld bead geometry, arc stability as well as strength of the weld. The amount of heat generated at work piece and welding electrode is effected by polarity change. Thus influences the metal, weld bead, deposition rate, x, HAZ and mechanical properties of the weld metal.

Arvind Kumar Kachhoriya[13]et al. studied welding is extensively used in fabrications of automobiles, aircrafts, ships, electronic equipment, machinery, and home applications etc. as an alternative of casting or as a replacement of riveted or bolted joints and the study of types of wildings

S Datta[14]et al. studied The study proposes an integrated optimization approach using Weighted Principal Component Analysis (WPCA) in combination with Taguchi's robust design methodology. Experiments have been conducted based on Taguchi's L25 Orthogonal Array design with combinations of process control parameters: voltage, wire feed, welding speed and electrode stick-out.

Aniruddha Ghosh [15] et al. studied detailed information on effects of input parameters on weld bead quality parameters and finding out the relationship between them are very essential for decreasing trial run of SAW process. Literature concluded that Condition for optimization of submerged arc welding process is maximum penetration, minimum reinforcement height, bead width and HAZ width.

III. PROCESS PARAMETERS LEVELS

The process parameters of SAW are welding current, voltage, travel speed, wire diameter, electrode stick out, flux,

heat input, polarity and current type (AC orDC). Welding current directly influence the depth of penetration and extend of base metal fusion. The welding arc voltage has direct influence on the shape on bead and external appearance of bead. The travel speed has pronounced effect on weld size and penetration for given combination of current and welding voltage. Careful attention is necessary to select the welding process parameters to obtain adesirable weld quality. Though many direct and indirect parameters affect the quality of weld in SAW the major key process parameters affecting the be adgeometry are arc voltage, welding current and welding speed. In the present study, three-levels of
the three process parameters, i.e., current, voltage and travel speed was considered. The values of the welding process parameter at different levels are listed in table1

Table1. Process parameters levels

Level	Current (Amp)	Voltage (V)	Speed (mm/min)
1	300	28	300
2	340	32	400
3	380	36	500

Procedure

The experiment was conducted on semiautomatic AUTO WELD MAJOR (LW) with CPRA 800 (S)Power source manufactured by Sab India. Mild steel plates of dimensions 50 mm (length) x 50 mm(width) x 12 mm (height) were used as base metal. Auto melts EH 14 copper coated electrode of 2.4 mm diameter was used as filler wire. Agglomerated flux, OK Flux 10.71 (L) Manufactured by ESAB INDIA Coding - AWS / SFA 5.17 was used. A square butt joint with a 1.6 mm root opening was selected to join the plates in flat position, keeping electrodeperpendicular to plates. Specimens of 10 mm width were cut transverse to the welding direction from cleaned, ground, polished and etched with 10% nital (90%alcohol + 10% of nitric acid).Weld bead profiles were traced by using an optical microscope at 20Xmagnification. Measurements were made for depth of penetration and bead width. The observed values of the responses are given in Table.2

Table 2. L9 Orthogonal array design and output responses

Run	Current	Voltage	Speed	Micro-hardness
1	300	28	300	323.11
2	300	32	400	314.66
3	300	36	500	306.54
4	340	28	400	283.98
5	340	32	500	303.39
6	340	36	300	314.66
7	380	28	500	251.56
8	380	32	300	245.74
9	380	36	400	234.70

Signal-to-noise ratio (S/N ratio)In order to evaluate optimal parameter settings, the Taguchi method uses a statistical measure of performance called signal-to-noise ratio. The S/Nratio developed by Dr. Taguchi is a performance measure to select control levels that best cope with noise. The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio ofthe mean (signal) to the standard deviation (noise).The standard S/N ratios generally used are as follows: nominal-is-best (NB), lower-the-better (LB),and higher-the-better (HB). In this paper, the characteristic values are selected by the bead width and depth of penetration.

S/N ratio and mean values for output responses

ANOVA (Analysis Of Variance)

In statistics, analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance is partitioned into components due to different explanatory variables. The initial techniques of the analysis of variance were developed by the statistician and geneticist R. A. Fisher in the 1920s and 1930s, and are sometimes known as Fisher's ANOVA or Fisher's analysis of variance, due to the use of Fisher's F-distribution as part of the test of statistical significance By using MINITAB statistical software we are going to optimize the result and results are plotted graphically by using above software.

ANOVA for micro- hardness:-The results for micro-hardness are shown in the Table 3. The table consists of the values of micro-hardness for the nine trials. ANOVA table for means is given in following Table. ANOVA table indicates that *p* value for current is having minimum value when micro-hardness is taken as response. *P* value for current is *0.038,* which is lesser than *0.05. F* value for the current is maximum, which indicates that it is a significant factor contributing to the response, which includes the ranks of the contributing factors. In the present study current is the most significant factor.

IV. CONCLUSION

Wide research has done on optimization parameters on submersible arc welding parameters mostly SAW process is a submersible welding and various factors affecting that are Welding current, Welding voltage, Wire diameter, Wire stick out, Flux type, Welding speed, Electrode size, Angle of Electrode, Electrode Chemistry, Size, Preheat temperature, Electrode Protrusion and Worker Skills. Types of Submerged Arc Welding are as follows Shielded Metal ArcWelding, Gas tungsten Arc Welding, Flux cored arc welding, Gas metal arc welding, Gas submerged arc welding.

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