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EFFECT OF TITANIUM POWDER ADDITION ON TENSILE STRENGTH IN SUBMERGED ARC WELDING

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ABSTRACT

Submerged arc welding is a type of arc welding process having wide applications in industry. In this process proper selection of input welding parameters is necessary in order to obtain a good quality weld and subsequently increase the productivity of the process. In order to obtain a good quality weld, it is therefore, necessary to control the input welding parameters. In this research work, bead on plate welds were carried out on IS 2062 mild steel plates using submerged arc welding (SAW) process. Taguchi method is used to formulate the experimental design. A total no of 9 experimental runs were conducted using an L9 orthogonal array, and the ideal combination of controllable factor levels was determined for the tensile strength. The optimal value of tensile strength is maximum on the parameter when current is 350 ampere, electrode stick out 25 mm and flux 3 is used. After all study it was found titanium powder is helpful to increase tensile strength of weld in submerged arc welding.

KEYWORDS: SAW welding, orthogonal array, optimization, ANOVA.

INTRODUCTION

Metal Submerged arc welding produces coalescence of metals by heating them with an arc between a bare metal electrode and the work. The arc and molten metal are "submerged" in a blanket of granular fusible flux on the work. Pressure is not used, and filler metal is obtained from the electrode and sometimes from a supplemental source such as welding rod or metal granules. In submerged arc welding, the arc is covered by a flux. This flux plays a main role in that the stability of the arc is dependent on the flux, mechanical and chemical properties of the final weld deposit can be controlled by flux, and the quality of the weld may be affected by the care and handling of the flux. Submerged arc welding is a versatile production welding process capable of making welds with currents up to 2000 amperes, ac or dc, using single or multiple wires or strips of filler metal. Both ac and dc power sources may be used on the same weld at the same time. [1]

survey-

B. Beidokhti, A.H. Koukabi and A. Dolati [2] said that the effect of titanium addition on the microstructure and inclusion formation in submerged arc welded HSLA pipeline steel. K.S. Bang, C. Park, H.C. Jung and J.B. Lee [3] has explained the Effects of Flux Composition on the Element Transfer and Mechanical Properties of Weld Metal in Submerged Arc Welding. B. Beidokhti, A.H. Koukabi and A. Dolati [4] introduce the Influences of titanium and manganese on high strength low alloy SAW weld metal properties. K. Singh and S. Pandey [5] was work on Recycling of slag to act as a flux in submerged arc welding, Resources, Conservation and Recycling. Uwe Reisgen, Simon Olschok, Stefan Mansur [6] was investigated on Laser Submerged Arc Welding (LUPuS) with Solid State Lasers. K. Sharma [7] was researched on Enrichment of Flux by Nickel to Improve Impact Strength in Submerged Arc Welding. Lukáš Holub, Jiří Dunovský, Karel Kovanda, Ladislav Kolařík [8] was explained SAW - Narrow Gap Welding CrMoV Heat-Resistant Steels Focusing to the Mechanical Properties Testing. The experimental studies were conducted under varying current, electrode stick out and flux.

MATERIALS AND METHODS

Taguchi's Design Methode

Taguchi Technique is applied to plan the experiments. The Taguchi method has become a powerful tool for improving productivity during research and development, so that high quality products can be produced quickly and at low cost. Dr. Taguchi of Nippon Telephones and Telegraph Company, Japan has developed a method based on "ORTHOGONAL ARRAY" experiments which gives much reduced "variance" for the experiment with "optimum settings" of control parameters. Thus the marriage of Design of Experiments with optimization of control parameters to obtain best results is achieved in the Taguchi Method. "Orthogonal Arrays" (OA) provide a set of well balanced (minimum) experiments and Dr. Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as objective functions for optimization, help in data analysis and prediction of optimum results.

Signal to Noise Ratio

There are 3 Signal-to-Noise ratios of common interest for optimization

(I) Smaller-The-Better:

n = -10 Log10 [mean of sum of squares of measured data]

(Ii) Larger-The-Better:

n = -10 Log10 [mean of sum squares of reciprocal of measured data]

(Iii) Nominal-The-Best:

n = 10 Log10 Square of mean / Variance

Work Material

The work material used for present work is Mild Steel IS 2062, the dimensions of the work piece length 250mm, width of 125mm, thickness 10mm.

Table 1: % age composition of base metal

C (%)	Mn (%)	Si (%)	P (%)	S (%)
0.1567	0.9718	0.1175	0.01521	0.00780

Electrode

EH-14 type of electrode wire is used in this experiment. The diameter of the electrode wire is 3.2mm is constant.

Table 2: % age composition of electrode

C (%)	Mn (%)	Si (%)	P (%)	S (%)
0.14	1.5	0.3	0.03	0.03

Flux

Firstly, AUTOMELT B31 type of flux is used in this experiment. Basicity index of AUTOMELT B31 is 1.5 with grain size of 0.25-2.0 mm and is being considered neutral flux, according to the basicity index.

Table 3: % age composition of flux

SiO_2+TiO_2 (%)	CaO+MgO (%)	Al_2O_3+MnO (%)	CaF_2 (%)
15	20	30	35

Parameters and their levels

For selection of parameters and their level is based on pilot study.

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Table 4: Welding Parameters and Their Levels

Parameters	Level 1	Level 2	Level 3
Current (Amp.)	250	300	350
Electrode stick out (mm)	22	25	28
flux	1	2	3

L9 3 Level Taguchi Orthogonal Array

Taguchi's orthogonal design uses a special set of predefined arrays called orthogonal arrays (OAs) to design the plan of experiment. These standard arrays stipulate the way of full information of all the factors that affects the process performance (process responses). The corresponding OA is selected from the set of predefined OAs according to the number of factors and their levels that will be used in the experiment. Table No.5 shows L_9 Orthogonal array

Table 5: L9 orthogonal array

Experiment no.	Process Parameter		
	Current (Ampere)	Electrode stick out (mm)	flux
1	L1	L1	L 1
2	L1	L2	L 2
3	L1	L3	L3
4	L2	L1	L 2
5	L2	L2	L3
6	L2	L3	L 1
7	L3	L1	L3
8	L3	L2	L 1
9	L3	L3	L 2

1st flux is (AUTOMELT B31), 2nd flux is (10 % titanium powder addition in AUTOMELT B31) and 3rd flux is

(20 % titanium powder addition in AUTOMELT B31).

RESULTS AND DISCUSSION

Analysis Of Tensile Test Results

In this study, an (L9; 3*3) orthogonal array with three columns and 9 rows was used. This array can handle three-level process parameters. Nine experiments were required to study the welding parameters using L9 orthogonal array. In order to evaluate the influence of each selected factor on the responses: The mean for each control factor had to be calculated.

Table 6: Experimental result for Tensile Strength and mean:

RUN	Current (Ampere)	Electrode stick out (mm)	Flux	Tensile Strength (MPa)	mean
1	250	22	1	457	457
2	250	25	2	589	589
3	250	28	3	644	644
4	300	22	2	558	558
5	300	25	3	628	628
6	300	28	1	335	335
7	350	22	3	676	676
8	350	25	1	489	489
9	350	28	2	579	579

ANALYSIS OF VARIANCE (ANOVA)

The purpose of the analysis of variance (ANOVA) is to investigate which design parameters significantly affect the quality characteristic. ANOVA has been performed in the statistical software package Minitab 15. The analysis of variance is carried out at 95% confidence level. The main purpose of analysis of variance is to investigate the influence of the design parameters on tensile strength by indicating that which parameters is significantly affected the quality characteristics. It uses the P-value, termed as probability of significance. If the P-value appears less than 0.05, then it can be concluded that the corresponding factor has significantly influence on the selected response, at 95% confidence level. The result of ANOVA is shown in given table 7.

Table 7: Result of analysis of variance for Tensile Strength

Source	**D.O.F**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**	**% age contribution**
Current	**2**	9450	9450	4724.8	4.85	0.171	10.29
Electrode stick out	2	3504	3504	1752.1	1.80	0.357	3.81
Flux	**2**	**76911**	**76911**	**38455.4**	**39.45**	**0.025**	**83.77**

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Residual error	2	1950	1950	974.8			2.12
Total	8	91814					

At minimum value of P the F (Fisher value) value should be maximum From Table 7 we have concluded that flux has significant effect on the tensile strength with contribution of 83.77 %, whereas current and electrode stick out have insignificant affected the tensile strength with contribution of 10.29 % and 3.81 %. %. The response table for mean is shown in Table No.4 as below

Table 8: response table for Tensile Strength

Level	**Current**	**Electrode stick out**	**Flux**
1	560.0	563.7	427.0
2	507.0	**565.3**	575.3
3	**584.7**	522.7	**649.3**
Delta	77.7	42.7	222.3
Rank	2	3	1

The optimum parameters for the Tensile strength is find out is shown in table given below:

Table 9: shows the optimum parameter level

Current	Level 3	350 Ampere
Electrode stick out	Level 2	25 mm
Flux	Level 3	3

So these are optimum welding parameters on which we have attain the higher tensile strength of IS 2062 mild steel welds. Main effect plot for mean of tensile strength is shown in Fig. 1

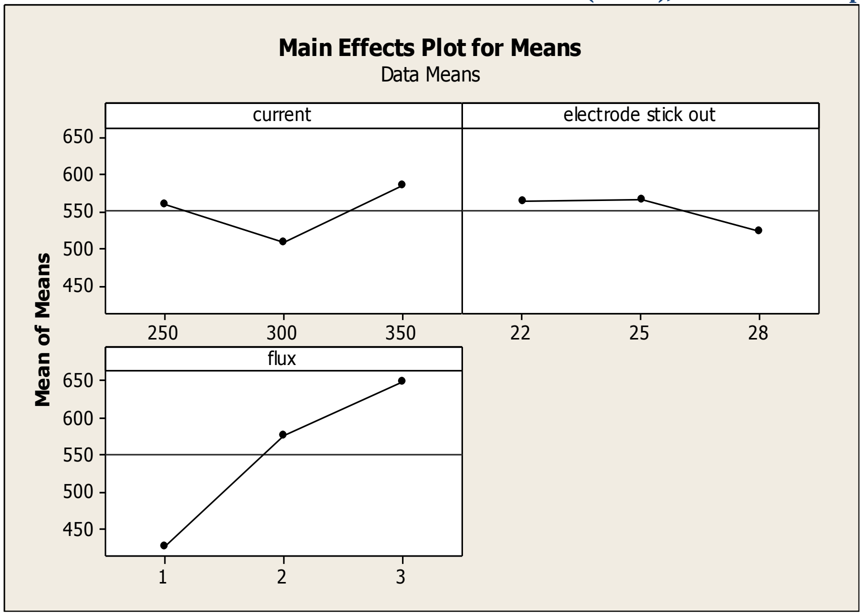

Fig. 1 Main effect plot for mean of tensile strength

CONCLUSION

Taguchi optimization method was applied to find the optimal process parameters for Tensile Strength. A Taguchi orthogonal array, the signal-to-noise (S/N) ratio and analysis of variance were used for the optimization of welding parameters. Flux has significant effect on the tensile strength with contribution of 83.77 %, whereas current and electrode stick out have insignificant affected the tensile strength with contribution of 10.29 % and 3.81 %.

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