Parametric Optimization of Gas Tungsten ARC Welding Using Activated Flux on Weld Penetration on SS 304

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Abstract— Gas tungsten arc welding has wide application in industries when high level of weld quality is required. To increase the productivity and decrease the cost advanced techniques are used in welding. Activating flux is a concept, which used in different welding process like GMAW, EBW, LBW, and PAW. The flux ingredient, which is inorganic compound (which can be used to produce deep penetration and arc constriction) are available in variety of range and compositions. In the present work, an attempt has been made to use of activating flux for improving depth-to-width ratio as well strength of welding joint. In present years heavier thicker job require so obviously need for higher depth of penetration and reduce angular distortion as well as number of passes hence decrease in cost is direct affect on productivity enhancement.decrease. It was found that the weld metal obtained using activated flux showed negligible changes in terms of physical appearance, arc stability, weld bead geometry mechanical destructive testing like tension testing of welding was passed. The experimental results showed that activating flux aided GTAW increased the weld area and penetration and tended to reduce the angular distortion of the weldment. The MgCO3 flux produced the most noticeable effect.

Key words: Gas Tungsten Arc Welding, Activated Flux (MgCo3,Tio2), Weld Penetration, Taguchi Method.

I. INTRODUCTION

Gas tungsten Arc Welding (GTAW) is an arc welding process that joins metals together by heating them with an electric arc that is established between a Non-Consumable electrode (tungsten) and the work piece. A filler wire is applied as and shielding gas (Ar, Hi, N) or gas mixture acts to shield the arc and molten weld pool. At first, it was considered to be fundamentally a high current density, small-diameter, non-consumable electrode process using an inert gas for arc shielding. As a result, it became known as Tungsten-inert gas (TIG) welding, which is still common nomenclature. Subsequent process developments included operation at low current densities and pulsed direct current, application to a broader range of materials, and the use of reactive gas(particularly Ar) and gas mixtures. The latter development, in which both inert and reactive gases are used, led to the formal acceptance of the term Gas tungsten arc welding. GTAW process can be operated in semi-automatic and manually modes.carbon steel,high speed steel,stainless steel,nickel alloys can be welded in all positions by this process if appropriate shielding gases, electrodes, and welding parameters are chosen.

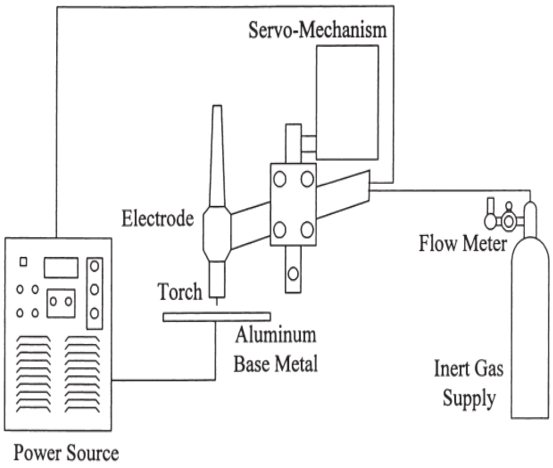


Fig. 1.1: Gas Tungsen Arc Welding

II. EXPERIMENTAL PROCEDURE

Design of experiment has become important me thodology that maximize the knowledge gained from experimental data by using a smart positioning of points in engineering.This methodology provides a strong tool to design and analyze the experiments.It eliminate redundant observation and reduce the time and resources to make experiments.

The design of Experiment based on

- Factorial design
- Taguchi Method
- Response surface Method

Chemical composition of SS 304

US N	AS TM	C%	Mn %	Si %	S %	P%	Cr %	Ni %	N %
S30 400	304	0.07 max	2.0 ma x	0. 75	0. 03 m ax	0.0 45	17. 5- 19. 5	8. 0- 10 .5	0. 1

Table 1.1: Chemical Composition of SS304

As per welding machine capability welding process parameters were selected on ASME SEC-IX

- Input parameters: Welding current, Arc Voltage, Gas Flow Rate, Activated Flux.
- Output parameters: Penetration.

Parameters	Welding Current (Amp)	Arc Voltage (Volt)	Gas Flow Rate (L/Min)
Value	160-180-200	10-12-14	5-10-15

Table 1.2: Specific Range Of Process Parameters

- In this research Experiment is run as 3 Phases and each Phase have 9 level so Total 27 Reading has been taken

- Welding is done on SS304 Plate at 3 different Phase and we get bead on plate.
- Phase 1: Without using activated flux
- Phase 2: with using Tio2 as activated flux
- Phase 3: with using Mgco3 as activated flux

Taguchi is the one of the Design of Experiment gives orthogonal array without using Activated flux given below.

Experiment. No	Welding current(Amp)	Arc Voltage(Volt)	Gas Flow Rate (L/Min)
1	160	10	5
2	160	12	10
3	160	14	15
4	180	10	10
5	180	12	15
6	180	14	5
7	200	10	15
8	200	12	5
9	200	14	10

Table 1.3: Taguchi L9 Orthogonal Array For Experimental Runs With And Without Activated Flux

A. *Material Selection*

I had selected material for Experiment runs **Stainless steel** (SS304) as a base metal having size is **200×77×8 mm.**

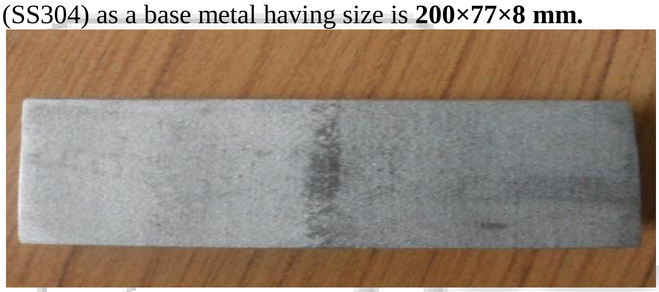


Fig. 1.2: Test Specimen

III. RESULT AND ANALYSIS

After performing analysis of different part of welding joint with various parameters such as welding current, arc voltage and Gas flow rate with and without activated flux in orthogonal array (L9) and finding out best way to improve penetration of welding joint.

Sr. No.	Welding Current(amp)	Arc Voltage(volts)	Gas Flow Rate(l/min)	Penetration(mm)
1	160	10	5	3.245
2	160	12	10	3.355
3	160	14	15	3.405
4	180	10	10	3.255
5	180	12	15	3.530
6	180	14	5	3.270
7	200	10	15	3.250
8	200	12	5	3.280
9	200	14	10	3.370

Table 1.4: L9 Orthogonal Array Experimental Runs Without Using Activated Flux

Sr. No.	Welding Current(amp)	Arc Voltage(volts)	Gas Flow Rate(l/min)	Penetration(mm)
1	160	10	5	3.535
2	160	12	10	3.745
3	160	14	15	3.865
4	180	10	10	3.645
5	180	12	15	4.120
6	180	14	5	3.570
7	200	10	15	3.680
8	200	12	5	3.490
9	200	14	10	3.785

Table 1.5: L9 Orthogonal Array Experimental Runs With Using Tio2 As Activated Flux

Sr. No.	Welding Current(amp)	Arc Voltage(volts)	Gas Flow Rate(l/min)	Penetration(mm)
1	160	10	5	3.535
2	160	12	10	3.745
3	160	14	15	3.865
4	180	10	10	3.645
5	180	12	15	4.120
6	180	14	5	3.570
7	200	10	15	3.680
8	200	12	5	3.490
9	200	14	10	3.785

Table 1.6: L9 Orthogonal Array Experimental Runs With Using Mgco3 As Activated Flux

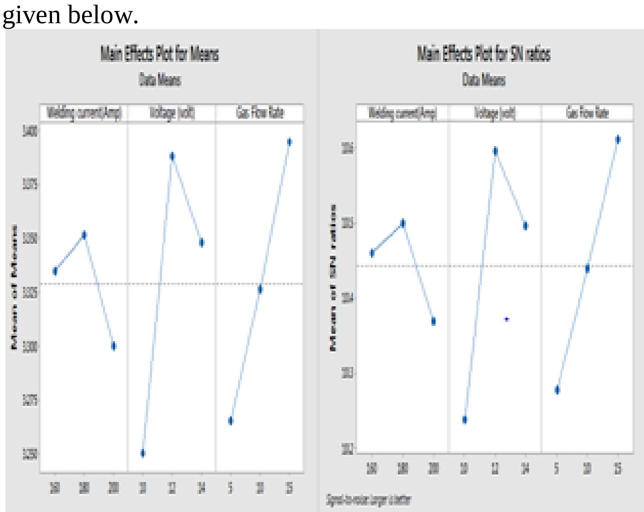
A. *Minitab Result*

After performing experiment and collactiing data of experiment at all 27 weld specimen in 3 Phases I analyze the data using minitab 17 software.

Minitab offers four types of designed experiments: factorial, response surface, mixture, and Taguchi (robust). The step follow in Minitab to create, analyze, and graph an experimental

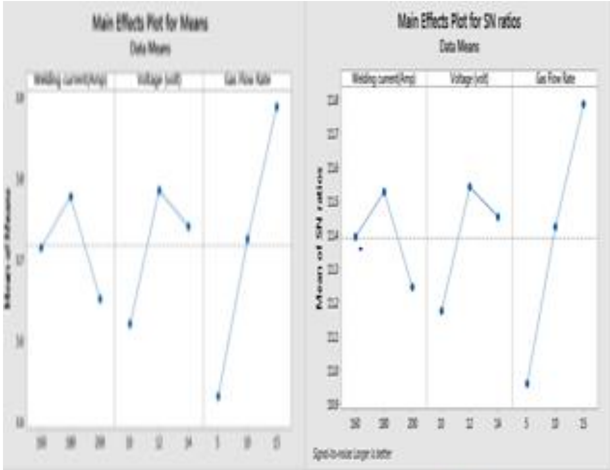
design are similar for all design types. After conducting the analysis and entering the results, Minitab provides several analytical and graphing tools to help understand the results.

Below graphs indicated SN ratio and Mean value of without using activated flux and with Tio2, Mgco3 are given below.



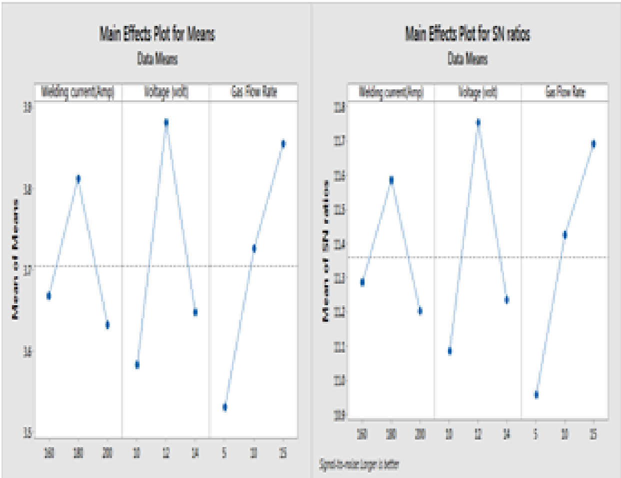
Means Graph **S/N Ratio Graph**

Graph 1.1: Mean And SN Ratio Graph For Without Using Activated Flux(Phase-1)



Means Graph **S/N Ratio Graph**

Graph 1.2 Mean And SN Ratio Graph For Activated Flux Tio2(Phase-2)



Means Graph **S/N Ratio Graph**

Graph 1.3 Mean And SN Ratio Graph For Activated Flux Mgco3(Phase-3)

	Without activated Flux		With Tio2		With Mgco3	
	s/n Ratio	Mean	s/n Ratio	Mean	S/n Ratio	Mean
1	10.2243	3.245	1f 10.9678.9678	3.535	1 10.99230109923	3.545
2	10.5139	3.355	11.4690	3.745	11.4922	3.755
3	10.6423	3.405	11.7430	3.865	11.3758	3.705
4	10.2510	3.255	11.2340	3.645	11.2577	3.655
5	10.9555	3.530	12.2976	4.120	12.3190	4.310
6	10.2910	3.270	11.0534	3.570	10.8066	3.470
7	10.2377	3.250	11.3170	3.680	11.0046	3.550
8	10.3175	3.280	10.8565	3.490	11.0777	3.580
9	10.5526	3.370	11.5613	3.785	11.5268	3.770

Table No 1.7: Results of S/N Ratio For Penetration

B. *Anova(Analysis of Variance)*

ANOVA gives parentage contribution of each process parameters on output value.

Sources of variation	DOF	Sum of squares S	Variance (mean Square)	Variance ratio F	Percentage contribution P
Factor A	2	0.004183	0.002091	0.31617	18.0696%
Factor B	2	0.03041	0.01705	2.5780	41.534%
Factor C	2	0.025383	0.01269	1.9188	34.676%
Error E	2	0.013227	0.066235	1	5.7144%
Total	8	0.0732			100%

Table 1.8: Percentage Contribution of Process Parameter For Penetration (With Out Using Activated Flux)

Sources of variation	DOF	Sum of squares S	Variance (mean Square)	Variance ratio F	Percentage contribution P
Factor A	2	0.02400	0.012	0.5509	14.39%
Factor B	2	0.04367	0.02183	1.0022	14.13%
Factor C	2	0.19129	0.09564	4.3911	63.23%
Error E	2	0.04356	0.02178	1	7.93%
Total	8	0.302525			100%

Table 1.9: Percentage Contribution of Process Parameter For Penetration (With Using Tio2 As Activated Flux)

Sources of variation	DOF	Sum of squares S	Variance (mean Square)	Variance ratio F	Percentage contribution P
Factor A	2	0.05363	0.026815	0.396144	27.30%
Factor B	2	0.147708	0.073854	1.091062	29.79%
Factor C	2	0.159075	0.0795375	1.17502	32.08%
Error	2	0.135387	0.06769	1	10.81%

E					
Total	8	0.4958			100%

Table 1.10: Percentage Contribution Of Process Parameter For Penetration(With Using Mgco3 As Activated Flux)

Above analysis shows the percentage contribution of individual parameters on Penetration. The percentage contribution of Welding Current is 18.0696%(without activated flux),14.39%(with Tio2), 27.30% (with Mgco3).The Percentage contribution of Arc volta is41.534%(with out flux),14.13%(With Tio2),29.79%(With Mgco3) .The Percentage contribution of Gas Flow Rate 34.676%(with out flux),63.23%(With Tio2),32.08%(With Mgco3).

IV. Conclution

– Main Focus on this Research is to Find out optimum welding parameter for penetration using activated flux.
– Aim of this Research is to find out effect of Activated flux on weld Penetration and weld strength.
– This Research done at Three Phases,without activated flux,with Tio2 flux and with Mgco3 flux,with Process Parameters like welding current,arc voltage,gas flow rate.From experiment result we found that all three Parameters have their own percentage contribution on penetration in gtaw.
– From Experiment Result and analysis It shows clearly that Mgco3 gives a positive Result Towards penetration improvement and It prove by Penetration test and Tensile Test.
– By ANOVA analysis conclude that our optimum set parameters Welding Current, Arc Voltage, Gas Flow Rate and Activated Flux is 180Amp, 12 Volt, 15 L/min with Mgco3 Activated Flux gives lesser errors.

V. Scope of Future Work

[1] Find out effect of mixture of activated flux on weld bead.
[2] By applying activated flux on double sided for getting higher section thickness.
[3] Study the effect of activated flux on dissimilar metal joint.
[4] Applying different activated flux ,evaluate best activated flux which gives better result on different kind of mechanical distructive testing.
[5] In depth characterization of mechanism responsible for increase in DOP in A-GTAW process.
[6] By applying different combination and set of Process Parameters and applying different optimization method we can evaluate Best flux and optimal Process Parameters which gives Higher Penetration.

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