OPTIMIZING TIG WELDING PROCESS PARAMETER OF SS316 MATERIAL USING TAGUCHI METHOD

Hiren padhiyar[1], M.S.Kagthara[2], Dr. G.D.Acharya[3]

[1]*Student M.E. CAD/CAM, A.I.T.S, Rajkot, Gujarat, India*
[2]*Assistant Professor, A.I.T.S, Rajkot, Gujarat, India*
[3]*Principal, A.I.T.S., Rajkot, Gujarat, India*

ABSTRACT

TIG welding is most popular method for welding of stainless material. SS316 is commonly used for producing milk silo in dairy industry. The objective behind this research is to optimize process parameter and to determine the influence of process parameter on the quality of weld. Welding current and included angle is process parameter selected for experimental work. In this research taguchi method is used to optimize welding current and included angle. Tensile test is performing as an output parameter to determine the strength of the weld joint. From the result it is observe that strength of weld is influence by current and included angle is identify for weld metal deposition.

Keywords: - *Included angle, tensile strength, taguchi, hardness.*

---

1. INTRODUCTION

TIG welding is a most preferable technique for SS, Al, and Ti. Filler metal is used for the joint. Inert gas is used (argon or helium) to prevent molten weld pool from atmosphere contamination and prevent reaction of base metal. Tungsten electrode, joint and arc is shielded with inert gas. In TIG welding better penetration is achieved. To achieve quality weld, right choice of process parameter is the basic key [1]. Most effective parameters like current, speed, and gas flow rate; and preferred filler metal is also an affective parameter for quality weld. Weld quality is checked by non-destructive techniques as per ASME.

TIG welding is arc welding process in which arc is generates between non consumable electrode and work [4]. Arc is shielded with the helium or argon gas to protect with atmospheric oxidation.

316stainless steel is selected over other materials because of its distinct properties. This grade has high corrosion resistance and can be operated at elevated temperature [3]. It is used for storage application where the problem of corrosion, like for storage of milk, milk silo in milk industry etc.

Taguchi is most useful method for to optimize the parameter. It is use orthogonal array to study the process parameter. In this research three levels and two factors are used for preparing DOE. S/N ratio is used to transform result. It is categorized by three levels normal is best, minimum is best and maximum is best [3].

Juang explain that Weld pool contains the characteristic like front height and width, back height and width.

2. METHODOLOGY

2.1 material selections

SS316 material is selected because of its various properties. It is highly corrosion resistance property. It is used in manufacturing milk silo in dairy industry. The chemical composition of SS316 is given in table no 1

Table - 1 chemical composition of SS316

Elementa	Result
% carbon	0.037
% silicon	0.428
% manganese	1.130
% phosphorus	0.042
% sulfur	0.016
% chromium	16.425
% molybdenum	2.106
% nickel	10.174
% copper	0.404

Material specification is

Material : 316 austenitic stainless steel
Thickness : 6 mm
Width : 20 mm
Length : 100 mm

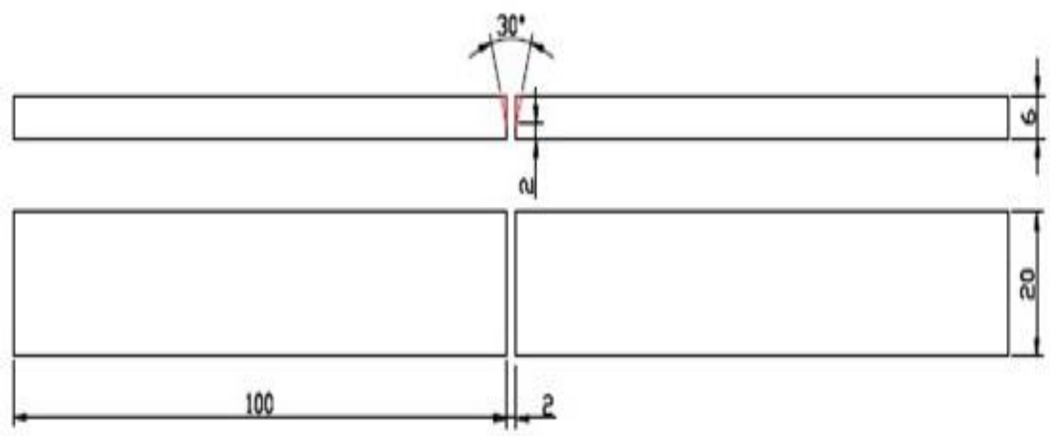

Fig -1 Geometry of work piece

Included angle of 30, 45, 60 are made on shaping m/c by moving the head at particular degree. Suppose if I want to made angle of 30 degree than head is set an angle of 60 degree (90-30=60), because head axis is at vertical position, so originally it has 90 degree.

2.3 DOE

DOE is mad by taguchi method using Minitab 16

Table - 2 DOE

Experiment no.	Current	Included angle
1	80	30
2	80	45
3	80	60
4	100	30
5	100	45
6	100	60
7	120	30
8	120	45
9	120	60

No of factor considered 2 and no of levels are three. L9 orthogonal array is taken to evaluate experimental data. This DOE is used for carryout experiments to optimize welding process parameter. Minitab is one type of tool used to prepare different types of optimization model.

3. TESTING AND RESULT

3.1 Tensile test

Tensile test is done as per ASTM standard. As per standard work piece is prepare for tensile test. Size of the work piece is decided as per ASTM A370. Prepared work piece after machining is shown in fig no 2

Fig -2 specimen for tensile test

Fig -3 specimen under tensile test

After preparing specimen tensile test is done on UTM-Model: TUTE-40/SR NO: 20145/405 as per fig no 3 Fig no 3 shows the specimen under tensile load. Tensile test is used to determine the strength of the material. Elongation percentage is also known from the tensile test. Experimental result of tensile strength are shown in table no 3

Table - 3 result of tensile test

Experiment no	Current (AMP)	Included angle (degree)	Tensile strength (N/MM^2)
1	80	30	454.77
2	80	45	489.43
3	80	60	521.54
4	100	30	476.11
5	100	45	478.25
6	100	60	439.63
7	120	30	601.55
8	120	45	452.24
9	120	60	553.23

Chart 4 shows the graph of load vs. displacement generated during the tensile testing it show the displacement at which the fracture start and the point of breaking.

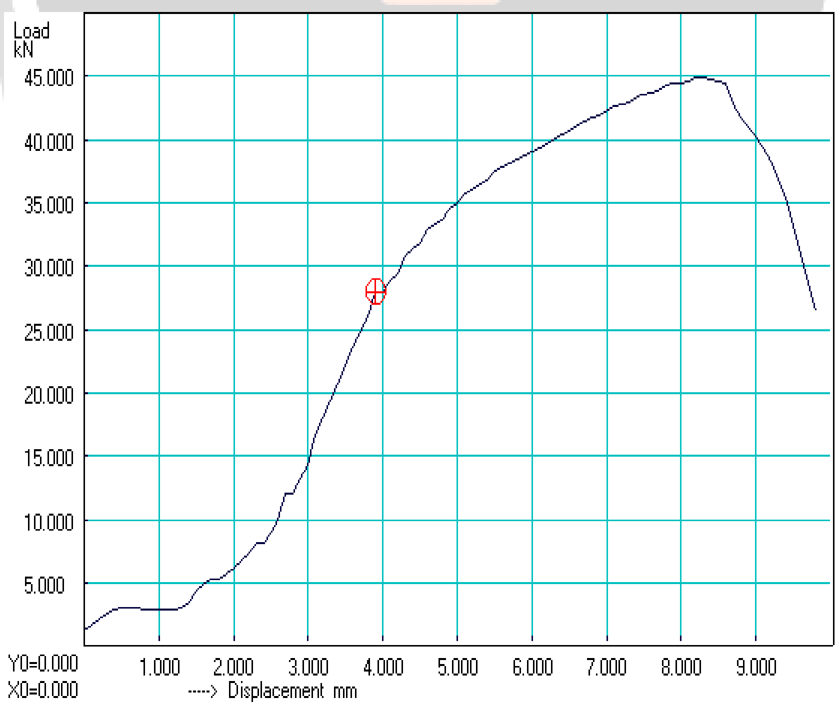

Chart -1 load vs. displacement graph

3.2 hardness test

Hardness test is done on hardness tester m/c as shown in fig no 4. Specification of hardness tester is as per below.
Rockwell hardness tester
Pointer used 1/16"
Force applied 100 kgf

Fig - 4 hardness testor

Experimental data of hardness test are shown in table no 4

Table -4 hardness test results

			Hardness (HRB)		
Sr. no.	Current	Included angle	Base metal	HAZ	Weld metal
1	80	30	96	98	102
2	80	45	95	99	101
3	80	60	96	102	106
4	100	30	96	99	107
5	100	45	96	101	105
6	100	60	95	102	112
7	120	30	95	103	109
8	120	45	96	102	113
9	120	60	96	105	115

Graph is plotted from the hardness test results are shown in chart no 2, 3 and 4

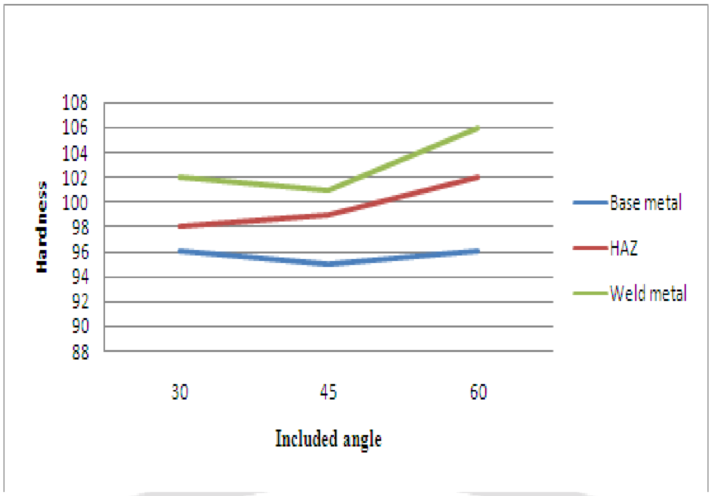

Chart - 2 Hardness vs. included angle of 80 amp current.

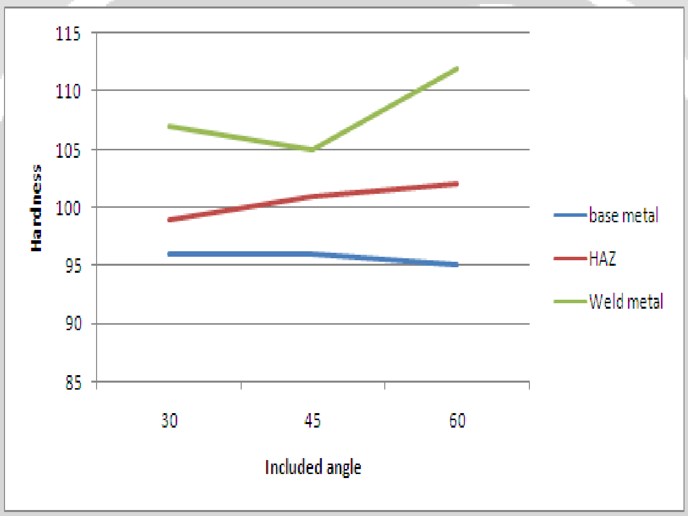

Chart -3 Hardness vs. included angle of 100 amp current.

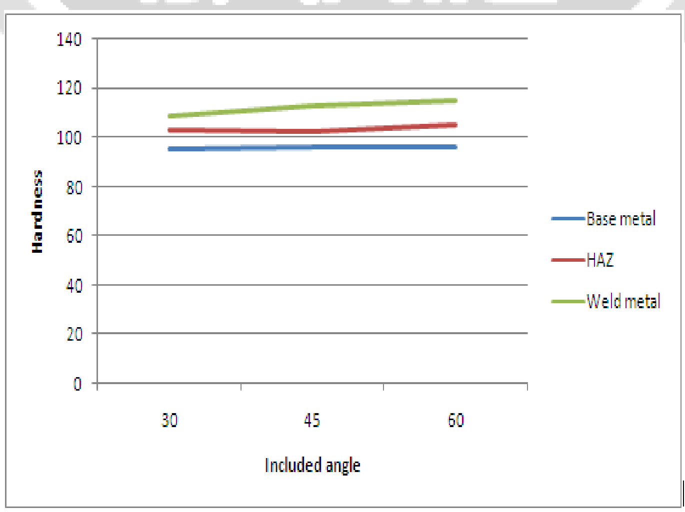

Chart -4 Hardness vs. included angle of 120 amp current.

4 RESULTS AND DISCUSSION

4.1 Taguchi analysis for tensile test

A main effects plot is a plot of the means at each level of a factor. One can use these plots to compare the magnitudes of the various main effects and compare the relative strength of the effects across factors

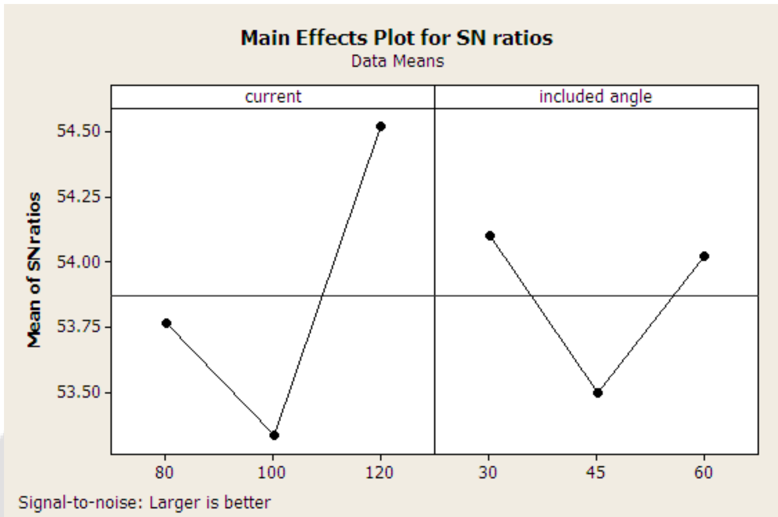

Chart -5 Main effects plot for S/N ratio for tensile strength

Chart 5 shows main effects plot for S/N ratio for tensile strength vs. all input factors. Since it is always desirable to maximize the tensile strength larger is better option is selected. From the above graph it can be seen that highest tensile strength is achieved at 120 current and 30 degree of included angle.

4.2 Taguchi analysis for Hardness test

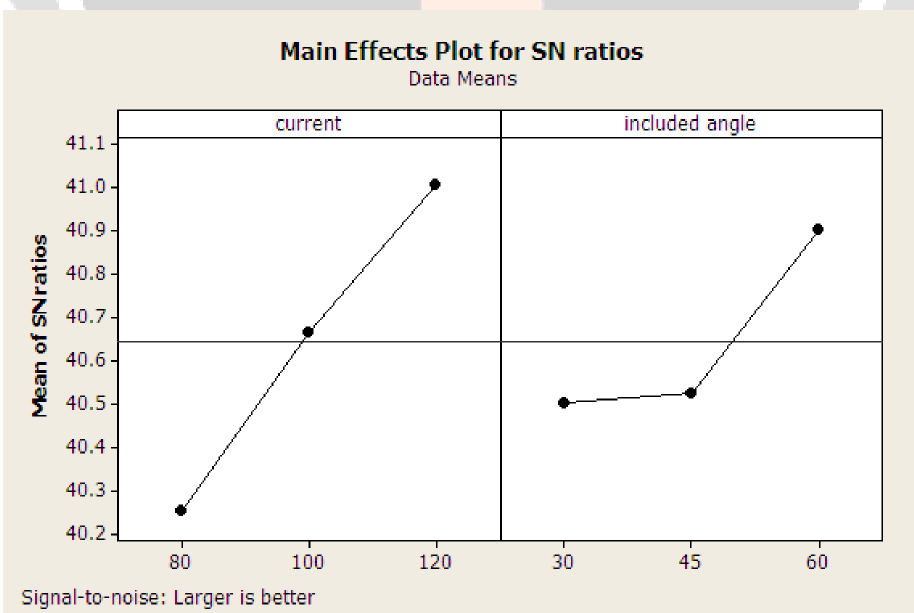

Chart -6 Main effects plot for S/N ratio for hardness of weld metal

Chart 6 shows main effects plot for S/N ratio for hardness vs. all input factors. Since it is always desirable to maximize the hardness larger is better option is selected. From the above graph it can be seen that highest tensile strength is achieved at 120 current and 30 degree of included angle.

5 CONCLUSIONS

5.1 Tensile test

As per result it is clear that as the current increase the tensile test is also increase and if the included angle increase tensile test is also increases. As per result maximum tensile test is indicated in specimen no 7. So above result clarify that at 120 current and 30 degree of included angle we find maximum tensile test. And the load vs. displacement graphs for specimen no 7 is Shawn in fig no 4.

5.2 hardness test

Hardness is measured on weld metal, base metal and HAZ. At 80 amp current hardness of base metal is decrease up to 45^0 of angle and then increase. For hardness is increase with increasing angle. And for weld metal hardness is decreasing with increasing in angle. From above graph it is clear that hardness is increase at increasing in angle and current both. And also it clear that hardness is more at weld metal compare to both base metal and HAZ and hardness of HAZ is more than base metal.

REFERENCES

[1]. Kiaee N, Aghaie-Khafri M. Optimization of Gas Tungsten Arc Welding Process by Response Surface Methodology.
[2]. Anand Rao V, Deivanathan R. Experimental Investigation for Welding Aspects of Stainless Steel 310 for the Process of TIG Welding.
[3]. Juang SC, Tarng YS. Process Parameter Selection for Optimizing the Weld Pool Geometry in the Tungsten Inert Gas Welding of Stainless Steel.
[4]. Bharath P, Sridhar VG, Senthilkumar M. Optimization of 316 Stainless Steel Weld Joint Characteristics using Taguchi Technique.
[5]. Patel Chandresh N, Sandip Chaudhary. Parametric Optimization of Weld Strength of Metal Inert Gas Welding and Tungsten Inert Gas welding By Using Analysis of Variance and Grey Relational Analysis.
[6]. Ahmed Khalid Hussain, Abdul Lateef, Mohd. Javed, et al. Influence of Welding Speed on Tensile Strength of Welded Joint in TIG Welding Process.
[7]. Kishore K, Gopal Krishna PV, Veladri K. Analysis of Defects in Gas Welding Arc Welding of AISI1040 Steel Using Taguchi Method.
[8]. Tarng YS. Process Parameter Selection for Optimizing the Weld Pool Geometry in the Tungsten Inert Gas Welding of Stainless Steel.
[9]. Nirmalendhu Choudhury, Asish Bandyopadhyay, Ramesh Rudrapati. Design Optimization of Process Parameters for TIG Welding based on Taguchi Method.
[10]. Sudhakaran R, Velmurugan V, Sivasakthivel PS. Optimization of Process Parameters to Minimize Angular Distortion in Gas Tungsten Arc Welded Stainless Steel 202 Grade Plates Using Particle Swarm Optimization.