Optimization of Process Parameters Affecting TIG Welding of AA 6082 by Grey Relational Analysis

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***Abstract*: Aluminum alloy has excellent corrosion properties and ease fabrication. In the construction of pressure vessel and storage tanks, the weld ability play unique role in selection of materials from the various materials. It has the highest strength among the 6000 series alloys. The preferred welding process of aluminum alloy is TIG welding due to its comparatively easily applicability and better economy. in this experiment welding parameter current was optimized for AA6082.As per this experiment with butt joint of aluminum alloy 6082 has weld by TIG welding process. To find out the tensile stress.**

Key words: GTAW system, AA6082 plate, Grey relational analysis, Tensile strength

I. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting this is the most rapid and easiest way of fabrication and assembly of metal parts. The research carried out in this field has given various ways and methods to weld practically all metals. One beauty of welding in comparison to other processes of joining metals is that by this process we can have more than 100% strength of joint and it is very easy process. We shall be dealing with all the various processes of welding in use these days, the equipment used for each process and the ways of preparation of joint and the various operations necessary

Welding is now a days extensively used in the following fields: automobile industry, aircraft machine frames, structural work, tanks and machine repair work..

Aluminum alloys have been more and more extensively utilized in structural applications and transportation industry for their light weight and attractive mechanical properties achieved by thermal treatments. Wrought heat-treatable alloys develop high specific strength thanks to age-hardening and have been widely used for airframes. In the utilization of these alloys, one of the difficulties to overcome is the general reduction of mechanical properties of welded joints as compared to the parent material.

Gas tungsten arc welding (GTAW) uses a non consumable electrode and a separate filler metal with an inert shielding gas. GTAW process welding set utilizes suitable power sources, a cylinder of organ gas, a welding torch having connection of cable for current, tubing for shielding gas supply, and tubing for water for cooling the torch. It is an important joining technique for high strength aluminum alloys. GTAW was a multi objective and multi process parameter metal fabrication technique. Several process parameters interact in a complex manner resulting direct or indirect influence on weld bead geometry. Some of the important GTAW process parameters and their effects on Mechanical properties of welds such as tensile strength, hardness are determined by using Grey relational analysis by the integration of S/N ratio.

II. EXPERIMENTAL PROCEDURE

A. Material

The base material used in the investigation is aluminum alloy of 6082 grade. It is widely used in automobile sectors and aero space. The chemical composition of the grade is obtained by spark test. The spark ignited at various location of the base metal sample and their spectrum was analyzed the chemical composition of base metal and weld metal is given in table

B. Finding the working limits of the parameters

Trial runs have been carried out using 6mm thick flat plate of AA6082 to find out the feasible working limit of TIG welding perameters.AA4043 al of different types diameters is used as filler materials. Different combinations of base current parameters have been used to carry out the trail runs the working range of the process parameters as shown in table2.

C. Procedure

Tungsten Inert Gas Welding is a multi-factor metal fabrication technique. Various process parameters influencing weld bead geometry, weldment quality as well as mechanical-metallurgical characteristics of the weldment include pulse current, base current, pulse frequency, pulse width, welding speed, electrode diameter, nozzle gap, etc. To search optimal process conditions through a limited number of experimental runs, the present study has been planned to use three conventional process parameters like travelling speed, base current and filler rod diameter varied at three levels. Taguchi’s L9 orthogonal array has been selected to restrict the number of experimental runs. Design matrix has been selected based on Taguchi’s orthogonal array design of L9 (3*3) consisting of 9 sets.

Experiments have been conducted with these process parameters to obtain butt joint of two Aluminum alloy 6082 sheet by TIG welding. The sheets to be welded were kept on steel backing bar and ends were clamped to maintain the alignment and gap. In between the two work pieces gap are 1.5mm. The weld joint is completed in single

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pass. Specimens for tensile testing were taken at the middle of all the joints and machined to ASTM E8M standards. The configuration of specimen used under tensile testing is shown in Fig .And the welded specimens were tested in the UTM and the tested specimens are shown in Fig.

Tensile test was conducted using a universal testing machine. All the welded specimens were failed in the weld region. The ultimate tensile strength of the weld joint is the strength of the weld. Ultimate tensile strength (Mpa), and percent elongation (%) of the tensile specimens was measured. The experimental results for UTM (Mpa) and EL (%) are listed in Table.

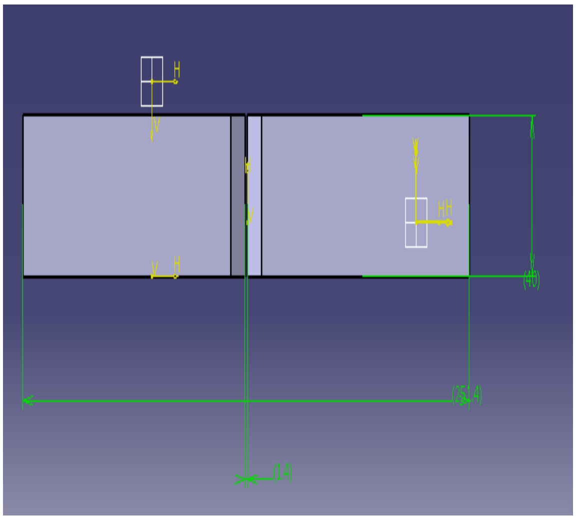

Fig 1: Design of work piece

Fig 2: Work pieces for Testing

Fig 3: Universal testing machines

Fig 4: After testing

Table 1: Chemical composition of base metals

Variables	Travelling speed[Mm\min]	Current [Amp]	Filler rod dia. [mm]
Level-1	35	120	2
Level-2	38	150	3
Level-3	41	190	5

Table 2: Level of control parameters

	Base material	Filler material
Si	0.7-1.3	5.25
Mg	0.6-1.2	0.04
Mn	0.4-1	0.04
Cr	0-0.25	-----
Zn	---	0.08
Ti	0-0.1	---
Cu	0-0.1	----
Al	96-97.5	93.5
Fe	----	0.8

Table.3: Mechanical properties from testing

Sample	Travelling speed	Current	Filler rod diameter	Tensile strength(Mpa)	Yield strength(Mpa)
1.	35	120	2	120	97.08
2.	35	150	3	52.5	42.5
3.	35	190	5	127.5	120.83
4.	38	120	3	70	52.08
5.	38	150	5	115.83	95
6.	38	190	2	145.85	140
7.	41	120	5	116.6	110.83
8.	41	150	2	115.83	109.16
9.	41	190	3	69.16	63.3

III. STATISTICAL ANALYSIS

1. Grey Relational Analysis

The Grey theory established by Dr. Deng includes Grey relational analysis, Grey modelling, prediction and decision making of a system in which the model information is incomplete .It provides an efficient solution to the multiple input data problems. The relation between machining parameters and machining performance can be found out using the Grey relational analysis.

Table4: S\N ratio of all levels for tensile and yield strength

Tensile strength	Travelling speed	current	Filler rod dia.
Level-1	118.09	119.81	126.13*
Level-2	121.45*	116.95	108.03
Level-3	119.39	122.16	124.71*
Sum	358.93	358.87	358.87
Yield strength			
Level-1	113.94	114.96	123.42*
Level-2	116.8	112.87	102.97
Level-3	117.71*	120.59*	122.08
Sum	348.45	348.42	349.42

IV. RESULTS

Optimization of Tungsten Inert Gas Welding on AA6082 by using grey relational analysis. Rey relational analysis is a very effective tool for process optimization under limited number of experimental runs. Essential requirements for all type of welding processes are higher tensile strength with low elongation.

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V. CONCLUSION

The following conclusion are drawn from the analysis of collected data of input and output parameters

1. Maximum tensile strength of 145.85 MPA obtained at travelling speed 35mm/min, current 190 Amp and filler rod dia. 2mm
2. The optimum range of input parameters are evaluated as 190Amp of current, 35mm\min travelling speed and 2mm filler rod diameter by which efficient weld joint is produced with good tensile strength of weld joint.
3. By the integration of Grey regression analysis with s/n ratio it was founded that travelling speed has much more effect on tensile strength and filler rod diameter has more effect on yield strength.

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