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Performance analysis of TIG welding on al alloy by using taguchi method

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Abstract
In this paper the experiment was carried out for the analysis of Tungsten Inert Gas welding on Aluminum alloy by using Taguchi method. The Taguchi method L9 is used to analyze the TIG welding parameters for maximizing the mechanical properties. The properties affected the welding parameters of the weld joints. TIG welding process is used to analyze the input parameter like welding current, welding voltage, gas flow rate which influence the tensile strength of Aluminum alloy of welding joints. By using Taguchi and Analysis of variance technique find the effect of individual factors which provides optimal results varying condition.

Keywords: Al Alloy, TAGUCHI, ANOVA (Analysis of Variance)

1. Introduction

Aluminum alloy widely used in different industrial application like defense aerospace, ship, marine, automobile application. The quality of weld joint is directly influenced by the welding input parameters during the welding process, so that the welding procedure can be consider as multi input and multi output process. Tungsten inert gas welding is an arc welding process the metals are joined by heating them with an arc between non consume able tungsten electrode and the metal. The TIG welding process is applicable for welding of these alloys and some parameters as constant and others are variable are maintained. Due to the varying of the parameters the optimum welding condition are taken into account the TAGUCHI method is designed to analyze a single performance characteristic. The performance analysis of multiple characteristics is much more complicated than the single performance characteristic. In this paper the gray relational analysis is used to obtained multiple performance characteristic in Taguchi method for performance analysis of TIG welding process. The gray relational analysis based on the gray theory can be used to investigate the inter relationship among multi performance characteristic effectively.

Fig 1: Set-up of GTAW

The TIG welding process relate to AC power supply as compare to DC power supply because aluminum melts at low temperature. The DC power supply prefer 20% energy where as AC power supply the average of the energy output both the terminal are to be same. The process melting the work piece and the filler rod by using the formation of gases. Helium and Argon is used as shielding gas because both are not chemically react. The gases used for better welding. The inert gas preventing oxidation and transfer heat from electrode to metal which helps to start and keep in a constant arc. The TIG welding parameter like welding current, welding voltage, gas flow are to be consider which effect the tensile strength of Al alloy joint. Filler wire are continuously filling into the weld pool for better welding process. Tensile strength is mainly affected by the welding parameter.

Juang *et al.* [1] conducted an experiment to obtain process parameters for optimizing weld pool geometry in the tungsten inert gas welding [TIG] of stainless steels. Here Taguchi method was adopted to analyze the effect of each welding process parameters on the weld pool geometry, and then to determine the process parameters with the optimal weld pool geometry. Durgutlu *et al.* [2] conducted an experimental investigation of the effect of hydrogen in argon as a shielding gas on TIG welding of austenitic stainless steel. Here hydrogen gas is added with the argon gas for welding. The microstructure, penetration and mechanical properties were examined. It was observed that the highest tensile strength was obtained from the sample which was welded under shielding gas of argon with the addition of hydrogen. A. Kumar *et al.* [3] TIG welding process is generally used for welding of Al-Mg-Si alloys. In any welding process, the input parameters have an influence on the joint mechanical properties. By varying the input process parameters combination the output would be different welded joints with significant variation in their mechanical properties. Kumar and Sundarrajan [4] (2009) used Taguchi method to optimize the pulsed TIG welding process parameters of heat-treatable (Al-Mg-Si) aluminum alloy weldment for maximizing the mechanical properties. S.P. Gadewar [5] investigated the effect of process parameters of

TIG welding like weld current, gas flow rate, work piece thickness on the bead geometry of SS304. It was found that the process parameters considered affected the mechanical properties with great extent. K.Kishore *et al*. [6] analyzed the effect of process parameters for welding of AA6351 using TIG welding. Several control factors were found to predominantly influence weld quality. The % contributions from each parameter were computed through which optimal parameters were identified. ANOVA method was used to checking the adequacy of data obtained. The experimental revealed that low current values have created lack of penetration and high travel speed has caused lack of fusion in welding AA6351.

Taguchi Method

Genchi Taguchi, a Japanese scientist developed a technique to improve quality of manufacturing goods applied in the engineering achievements during the research and development. The method is based on the orthogonal array. The method can be employing the design of experiment (DOE) to reduce the variability and remain cost effective and robust design for last scale production. The method provide a valuable and systematic way to optimized the design for performance. Optimization process parameters is the main step to gain high quality without increasing cost. A large numbers of experiment has to be taken out due to the number of process parameter increases. To solve this task, Taguchi method use a orthogonal array to analyse complete process parameter with a small number of experiment only. The experiment could help the designer to study the effect of multiple factors in the average quality characteristics by design the orthogonal array. An advantages of Taguchi method is that it gives important to the mean performance characteristics value which close to the target value rather than a value within certain limits. Taguchi suggest that the product should be carried out in a three step approach: System design, Parameter design, Tolerance design. In system design step new idea, concept and knowledge in the area of science and technology are used to determine the perfect combination of materials, part, process and the design factor which satisfy the functional specification. By the design team. Parameter design is used to finding the suitable design factor levels to maintain the system less sensitivity in uncontrollable noise factor. Tolerance design related if the tolerance for the product are provide to minimize the sum of the manufacturing and cost of the product.

2. Experimental Procedure

Materials

In this study the base material is aluminum alloy are to be consider. It is basically applicable for in automobile sectors. The spark test is carried out to investigate and analyze the chemical composition of the both base metal and weld metal.

Finding the working limits of the parameters

A trial runs method have been taken out using 150mm length*20mm width*3 mm thick flat plates of aluminum alloy to obtained the probable working range of TIG welding parameters. In this welding process Al filler material of diameter 2.4mm is used. Different combinations of welding current parameters have been used to carry out the trial runs. The following observations are made to analysis the working levels of welding current, welding voltage and gas flow rate. The working range of the process parameters of current study shown in Table 2.1.

Experimental Procedure

Tungsten Inert Gas Welding is a multi-factor metal fabrication technique. The Various process parameters effect on weld bead geometry, weldment quality and also mechanical-metallurgical properties of the weldment include welding current, welding voltage, gas flow rate electrode diameter, nozzle gap, etc. To find out optimal process conditions through a limited number of experimental runs are undertaking in this study to use three levels of conventional process parameters viz. welding current, welding voltage, gas flow rate.. Taguchi's L9 orthogonal array has been chosen to confine the number of experimental runs. Design matrix has been considered based on Taguchi's orthogonal array design of L9 (3**2) including 9 number of sets.

Experiments have been carried out to create a butt joint of similar aluminum sheet by varying the process parameters in the TIG welding. Prior to welding, the base metal sheets were pickled with a solution of NaOH and HNO3, wire brushed, and degreased using acetone. The sheets to be welded by maintain various parameters and were put on a steel backing bar and the ends were clamped for manage the alignment and gap. The weld joint is completed in single pass. The tensile test specimen were taken at the middle of all the joints and machined to ASTM standards. The configuration of specimen used under tensile testing is shown in Fig and the welded specimens were tested in the UTS machine and the tested specimens are shown in Fig 1.2.

Tensile test was carrying on a computer-controlled universal testing machine which has the maximum capacity of 1000 KN.

Fig 2: Job set up in UTM Machine (After Welding)

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) was measured. The experimental results for UTS (MPa) are shown in Table 2.2. In Taguchi method signal-to-noise(S/N) ratio is calculated to act as the quality characteristic and the largest value of S/N ratio is needed. There are three types of S/N ratio the lower the better, the higher the better, and the nominal the better. The S/N ratio higher the better characteristic can be calculated using the Equation 1)

$$S/N = -10\log\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i^2}\right)$$

Where Yi is the i th experiment and n is the total no of test.

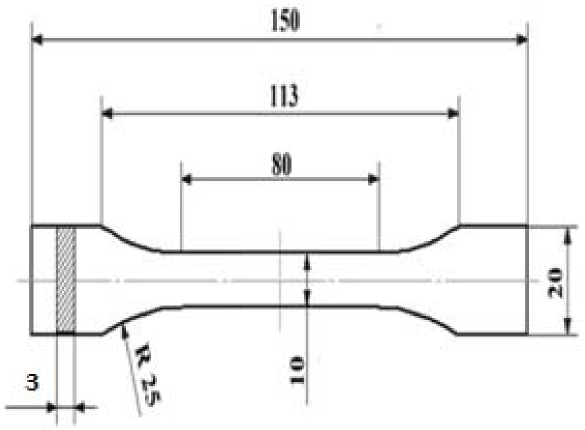

Fig 3: Tensile specimen according to ASTM standard (all dimensions are in mm.)

Fig 4: Configuration of Tensile Specimen by GTAW

Table 1: Working range of process parameters:

Process Parameters	Units	Level1	Level 2	Level 3
Welding current	Amps	170	180	200
Welding voltage	V	18	20	22
Gas flow Rate	Lt/min	7	8	9

Table 2: Design matrix based on orthogonal array L9 and tensile strength measured by UTM machine

Exp No	Welding Current (amp)	Welding Voltage (v)	Gas flow Rate (lt/min)	Ultimate tensile strength (MPA)
1	1	1	1	130.71
2	1	2	2	120.93
3	1	3	3	119.60
4	2	1	2	131.30
5	2	2	3	128.65
6	2	3	1	121.80
7	3	1	3	135.46
8	3	2	1	131.80
9	3	3	2	131.65

3. Results and Discussion

Analysis of variance (ANOVA)

This method was developed by Sir Ronald Fisher as a way to interpret the results from actual experiments. ANOVA is a mathematical technique which breaks total variation down into accountable sources. Sum of squares is calculated by the magnitude of each error value can be squared to provide a measurement of total variation present. Error variance, usually termed just variance, is equal to the sum of squares of error divided by the degree of freedom of error. Error variance is a measure of the variation due to all the uncontrolled parameters, including measurement error involved in a particular experiment. The DOE and ANOVA table were calculated by MINITAB16 software.

Table 3: S/N Ratio

Exp no	S/N ratio
1	42.32
2	41.65
3	41.55
4	42.36
5	42.18
6	41.71
7	42.63
8	42.39
9	42.58

Table 4: Response Table for UTS

Level	A	B	C
1	41.84	42.44	42.15
2	42.09	42.08	42.20
3	42.54	41.95	42.13
Delta	0.70	0.49	0.07
Rank	1	2	3

The F-test is simply a ratio of sample variances as shown in below equation. When this ratio becomes large enough, the two sample variances are accepted as being unequal at some confidence level. To determine whether an F ratio of two sample variances is statistically large enough, three pieces of information are considered. These are the confidence level, degree of freedom associated with the sample variance in the numerator and degree of freedom associated with the sample variance in the denominator. F-test values are found from F-test table. In the table A represents the welding current, B represents the welding voltage, and C represents Gas flow rate. ANOVA results are shown in Table 1.5

Table 5: ANOVA Table for UTS

Source	DF	Sum of square	Mean square	F	Probability (P)
Welding Current	2	161.948	80.974	1.28	0.05
Welding Voltage	2	82.901	41.4505	0.65	0.09
Gas flow Rate	2	1.890	0.945	0.014	0.236
Error	2	126.527	63.2635		
Total	8	373.266			

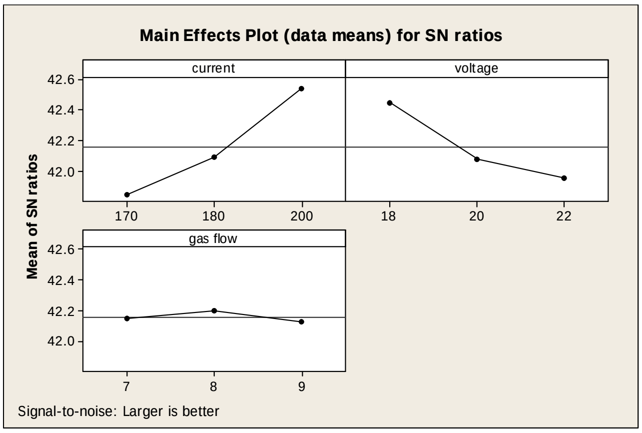

Fig 5: S/N Ratio Graph

From the ANOVA table F test value is very significant. The analysis of variance was accomplish for a 95%confidence level. In this we make an acceptance that value of P <0.5 are found to be important parameter.

Taguchi experimental design was successfully conducted for maximize weld strength of aluminum alloy specimen of TIG welding parameters. In this study Taguchi orthogonal array, signal to noise ratio, analysis of variance were used to optimize the welding parameters. The study can be concentrated on the application of Taguchi method by using the two way ANOVA method for solving the optimization problem.

4. Conclusion

All the experiments runs are analyzed by safely measured in order to maintain the low error factor and to determined the result to produce the efficient weld joint with Al alloy specimen. The following conclusion are consider from the collected data by investigate the input and output parameter.

Maximum tensile strength of 135.46MPA is obtained at welding current of 200AMP, welding voltage of 18V of gas flow rate 9lt/min.

The tensile strength of weld joint of Al alloy increasing by increasing welding current 200AMP forvoltage18V and after that tensile strength decreases by again increasing welding current.

The flow 9lt/min should be affect the maximum tensile strength was observed. From this we conclude that the flow required to prevent the oxidation and shielding but more flow could be detrimental as could cause cooling.

5. References

1. Juang S. Process parameter selection for optimizing the weld pool geometry in the tungsten inert gas welding of stainless steel, Journal of Materials Processing Technology. 2002; 122:33-37.
2. Durgutlu. Experimental investigation of the effect of hydrogen in argon as a shielding gas on TIG welding of austenitic stainless steel, Materials & Design 2004; 25:19-23.
3. Kumar, Sundarrajan S. Effect of welding parameters on mechanical properties and optimization of pulsed TIG welding of Al-Mg-Si alloy, The International Journal of Advanced Manufacturing Technology. 2008; 42:118-125.
4. Kishore K, Gopal Krishna PV, Veladari K, Syed Qasim Ali. Analysis of Defects in Gas Shielded Arc Welding of AISI1040 Steel Using Taguchi method, APRN Journal of Engg & Applied Science. 5, 37-41.
5. Mohd. Shoeb, Prof. Mohd. Parvez, Prof. Pratibha Kumari. Effect of MIG welding input process parameters on weld bead geometry on HSLA Steel, International Journal of Engineering Science and Technology (IJEST) 2013; 5(01):200-212.
6. Hsuan-Liang Lin. The use of the Taguchi method with grey relational analysisand a neural network to optimize a novel GMA welding process, J Intell Manuf. 2010.
7. Munoz G, Ruckert B, Huneau X, Sauvage, Marya S. Comparison of TIG welded and friction stir welded Al–4.5Mg–0.26Sc alloy, Journal of Materials Processing Technology. 2008; 197:337-343.
8. Modenesi P. TIG welding with single-component fluxes, Journal of Materials Processing Technology. 2000; 99:260-265.
9. Madusudhan Reddy G, Gokhale AA, Prasad Rao K. Weld microstructure refinement in a 1441 grade Al–Lithium alloy, J Mater Sci. 1997; 32:4117-21.
10. Yarmuch MAR, Patchett BM. Variable AC polarity GTAW fusion behaviour in 5083 aluminium, Welding Research Journals. 2007; 86(2):196-s-200-s.
11. Oates WR. American welding society eighth edition, Welding Handbook 1996; 3:37-38.
12. O’Brien RL. American welding society eighth edition, Welding Handbook 1991; 2:86.
13. Fuerschbach PW. Cathodic cleaning and heat input in variable polarity plasma arc welding of aluminum, Welding Journals. 1998; 77(2):76-s.
14. Zhang YM, Zhang SB. Welding aluminum alloy 6061 with the opposing dual-torch GTAW process, Welding Research Supplement 1999; 83:202s-206s.
15. Ghosh A, Chattopadhyaya S, Sarkar PK. Effect of input parameters on weld bead geometry of SAW process, Proceeding of International Conference, 2007.