

Investigation and Optimization of TIG Welding Parameters Using Taguchi and Annova

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Abstract: Welding process is widely used by manufacturing engineers and production personnel to obtain efficient products rapidly. In the present work, welding on plate of Stainless Steel 317 were carried out using Tungsten Inert Gas (TIG) welding process. The input process variables taken were - welding current, voltage & gas flow rate. Total nine experiments were conducted on the basis of Taguchi technique. The analysis for signal-to-noise (S/N) ratio was done using MINITAB-18 software with considering the 'larger-the-better' criteria. The significance of each parameter was studied by using the ANOVA (Analysis of Variance). At last, the confirmation tests were performed. Thus, with the proposed optimal parameters it is possible to increase the efficiency of welding joint by which tensile strength of joint can be increased with suitable set of parameters. The experimental values confirm its effectiveness in the analysis of tensile strength of the joint.

Keywords: Tensile strength, Taguchi method, Orthogonal array (L9), ANOVA, TIG

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I. INTRODUCTION

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. [7] Tungsten Inert Gas welding is also known as Gas tungsten arc welding (GTAW), is an arc welding process that uses a non-consumable tungsten electrode to produce arc. The welded area is protected from atmospheric contamination by an inert shielding gas (argon or helium), and a filler is normally used to weld thick plate. The electrode is no consumable since its melting point is about 34000C. The schematic diagram of GTAW or TIG process is shown in Figure.[10]

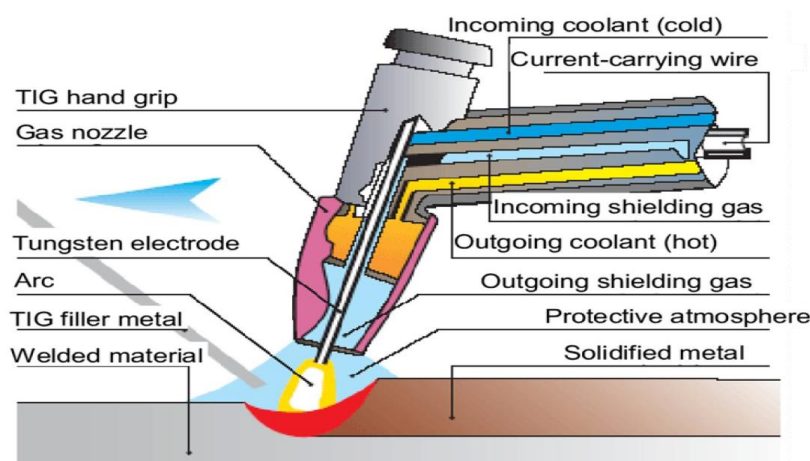


Fig.1 Schematic Diagram of TIG Welding

Both the direct current (DC) and alternating current (AC) may be used for TIG welding. When the work is connected to the positive terminal of DC welding machine and the negative terminal to an electrode the welding set up is said to have straight polarity. When work is connected to negative and electrode to positive terminal then the welding set up is said to have reversed polarity.

A. Principle of Tungsten Inert Gas (TIG) welding

In TIG welding process, the electrode is non consumable and purpose of it only to create an arc. The heat-affected zone, molten metal and tungsten electrode are all shielded from atmospheric contamination by a blanket of inert gas fed through the GTAW torch. Fig. 1 shows schematic diagram of the working principle of TIG welding process. Welding torch consist of light weight handle, with provision for holding a stationary tungsten electrode. In the welding torch, the shielding gas flows by or along the electrode through a nozzle into arc region. An electric arc is created between electrode and the work piece material using a constant current welding power source to produce energy and conducted across the arc through a column of highly ionized gas and metal vapours. The electric arc produce high temperature and heat can be focused to melt and join two different parts of work piece

B. Advantages of TIG welding process

- 1) Concentrated arc produced for control heat input to the workpiece. It resulting in a narrow heat-affected zone.
- 2) This process is done without use of flux, therefore no slag formation during welding process.
- 3) No Sparks or Spatter because of no transfer of metal across the arc during TIG welding.
- 4) Compared to other arc welding processes like flux cored welding, fewer amounts of fumes or smokes are produced.
- 5) Welding of thin material is possible.
- 6) Welding dissimilar type material is possible.
- 7) Welding of different types of metal and metal alloys are possible by proper control

C. Autogenous TIG welding

A weld joint produced by melting the contact edge surfaces and subsequently solidifying it at room temperature (without addition of any filler metal) is called “autogenous weld”. Thus, the composition of the autogenous weld metal corresponds to the base metal only. However, autogenous weld is crack sensitive when solidification temperature range of the base metal to be welded is significantly high. TIG welding process performed without application of filler material is known as autogenous TIG welding process. Autogenous TIG welding is preferred especially for less than 5 mm thick plate. The advantages of this process are that, it is economical process as compare to heterogeneous or homogenous welding process as no edge preparation and filler material are Require.

EXPERIMENTDETAILS

A number of experiments were conducted to study the effect of various machining parameter on welding process. These studies have been undertaken to investigate the effects of current, voltage and gas flow on tensile strength of welded joints.

Table1 -Welding parameter and their levels

Levels	Current	Voltage	Gasflow
1	90	20	10
2	120	27	12
3	160	35	14

Table2-Experiment result of Tensile strength and S/N ratio

Experiment No	Current	Voltage	Gas Flow	Tensile (KN)	S/N Ratios
1	90	20	10	154.20	43.761
2	90	27	12	200.70	46.051
3	90	35	14	235.70	47.447
4	120	20	12	211.45	46.504
5	120	27	14	280.45	48.957
6	120	35	10	381.80	51.636

7	160	20	14	221.50	46.907
8	160	27	10	299.40	49.525
9	160	35	12	397.70	51.991

Table3-Mean response table for Ultimate Tensile Strength (UTS)

Level	A	B	C
1	196.9	195.7	278.5
2	291.2	260.2	269.9
3	306.2	338.4	245.9
Delta	109.3	142.7	32.6
Rank	2	1	3

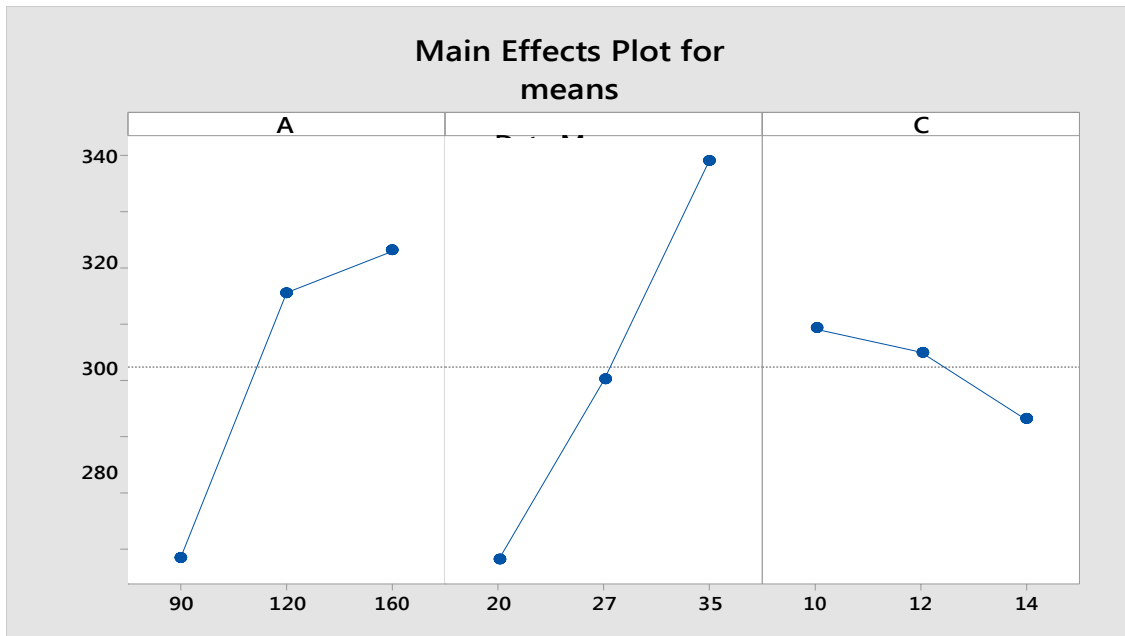


Fig 2-Means of response

Table 4 S/N Ratio response table for Ultimate Tensile Strength (UTS)

Level	A	B	C
1	45.75	45.72	48.31
2	49.03	48.18	48.18
3	49.47	50.36	47.77
Delta	3.72	4.63	0.54
Rank	2	1	3

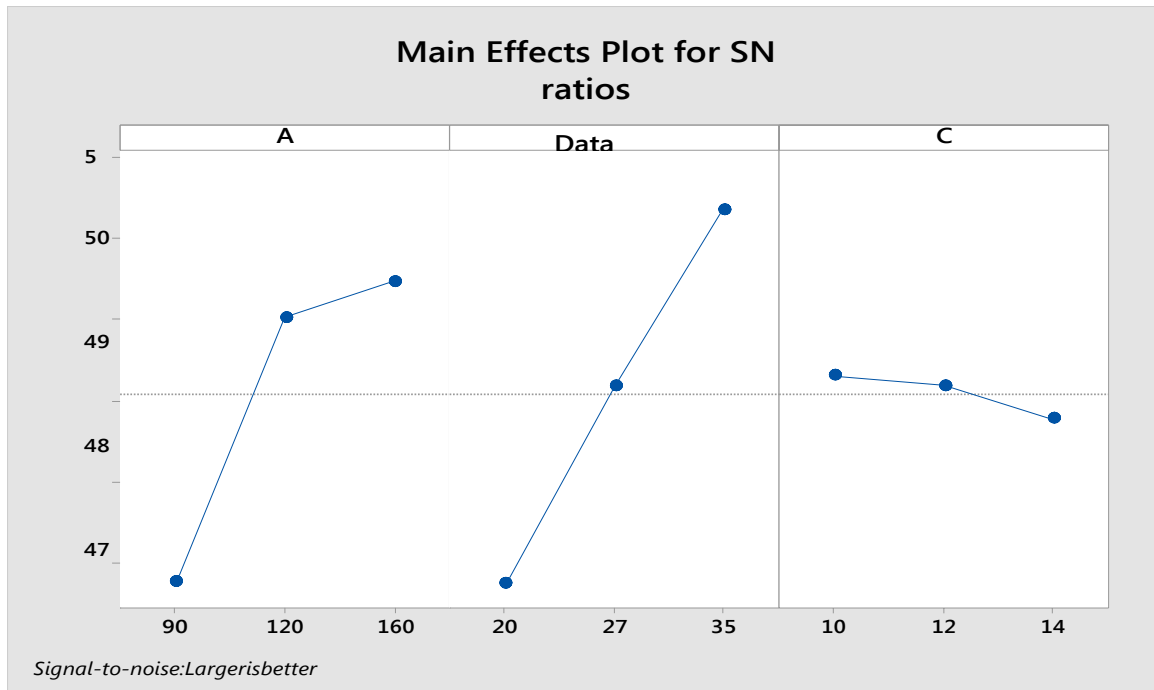


Fig 3 Means of S/N Ratio

THE ANOVA ANALYSIS

The ANOVA analysis for ultimate tensile strength versus gas pressure, current and voltage by using Minitab18 software are shown in Table

Table5-ANOVA Table

Source	DF	Adj SS	Adj MS	F	P
Current	2	20373	10187.6	15.54	0.059
Voltage	2	31082	15541.8	22.92	0.043
Gas Flow	2	1521	762.5	1.07	0.464
ERROR	2	1327	659.7		
TOTAL	8	54303			

The ANOVA analysis shows the percentage contribution of given input parameters on measurable output parameter with help of Minitab18 software.

Table 6 -Percentage Contribution of input parameter on Tensile strength

Input parameter	Percentage contribution (%)
Current	18.10
Voltage	74.56
Gas flow	1.65
Error	5.69

II. CONCLUSIONS

The target of this examination was to build up the impact of the Tungsten Inert Gas welding strategy that is utilized for good quality of joints and high production rate. In light of this investigation of Tungsten Inert Gas welding the accompanying end might be watched.

- The optimization parameter is determined to the sake of various advancement procedures like Taguchi technique, statistical strategy, Mathematical strategy.

- The welding boundary is the input role of welding process which is control the weld quality and strength.
- Design of test can be utilized the significant programming situated in MINI TAB, MATA LAB, and ANSYS.
- Shielding gas is preventing the oxidization during the welding procedure

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