INVESTIGATION OF TUNGSTEN INERT GAS(TIG) WELDING USING ARGON SHIELDING GAS ON 316 STAINLESS STEEL

Jay Patel, Mo.jafar Imam, Sachin Chaudhari, Surendrasinh Rajpurohit
Ass. Prof.
Mr. Sunil J Patel

[1] *Jay Patel, Mechanical Engineering , Samarth college of engineering & technology, Gujarat, India*
[2] *Mo.jafar Imam, Mechanical Engineering , Samarth college of engineering & technology, Gujarat, India*
[3] *Sachin Chaudhari, Mechanical Engineering, Samarth college of engineering & technology, Gujarat, India*
[4] *Surendrasinh Rajpurohit, Mechanical Engineering , Samarth college of engineering & technology, Gujarat, India*

ABSTRACT

Welding is one of the most popular methods of metal joining processes. The joining of the materials by welding provides a permanent joint of the components. The objective of this research is used to determine the influence of various welding parameters on the weld bead of AISI 316 welded joint. The result shows that speed is most influencing factor to have highest bend strength and current that is to be used while welding is the most influencing factor to get higher tensile strength. In this study, 316 stainless steel were joint using Tungsten Inert Gas (TIG) welding process. Various current settings were used to obtain the optimum joint characteristics and minimize defects that will contribute to cost effective.

Keyword: - Tungsten inert gas (TIG), 316 Stainless steel, penetration, Tensile strength.

1. INTRODUCTION

Welding is one of the fabrication processes that is used for joining the metals, by causing coalescence which replaces other joining processes like bolting, riveting . A good joint will be obtained through TIG welding and a preferred by most of the manufactures for mechanical assemblies . Generally filler material is used in metal joining processes, even in TIG welding [1]. Here is TIG, produces an arc between a non-consumable tungsten electrode and the workpiece. An inert gas shields the arc, electrode, and molten pool from atmospheric contamination. When welding thinner materials, edge joints, and flanges, welders generally do not use filler metals. In TIG welding inert gases like argon, helium are used which acts as shielded gases because they prevent atmospheric contamination of molten weld pool and also they do not react with the base metal. TIG welding results in increase in the weld penetration in the austenitic stainless steel and penetration overcomes as a result of chemical composition [2]. Taguchi method is a powerful tool that uses a special design to study the parameter space with small number of experiments through orthogonal arrays [1,2].

This research studies the influence of various input parameters on the tensile strength and penetration of AISI 316 welded joint. The influence of speed, current, is identified by TAGUCHI method.

1.1 Principle of operation

In the **Tungsten inert gas welding (TIG)** metals are fused together by heating them by an electric arc established between a non-consumable (does not melt) tungsten electrode and the workpiece. A filler metal may not be used depending on the design of the joint. The molten metal, tungsten electrode and the welding zone are shielded from the atmosphere (the air around it) by a stream of inert gas through the welding torch. The resulting welds have the same chemical integrity as the original base metal.

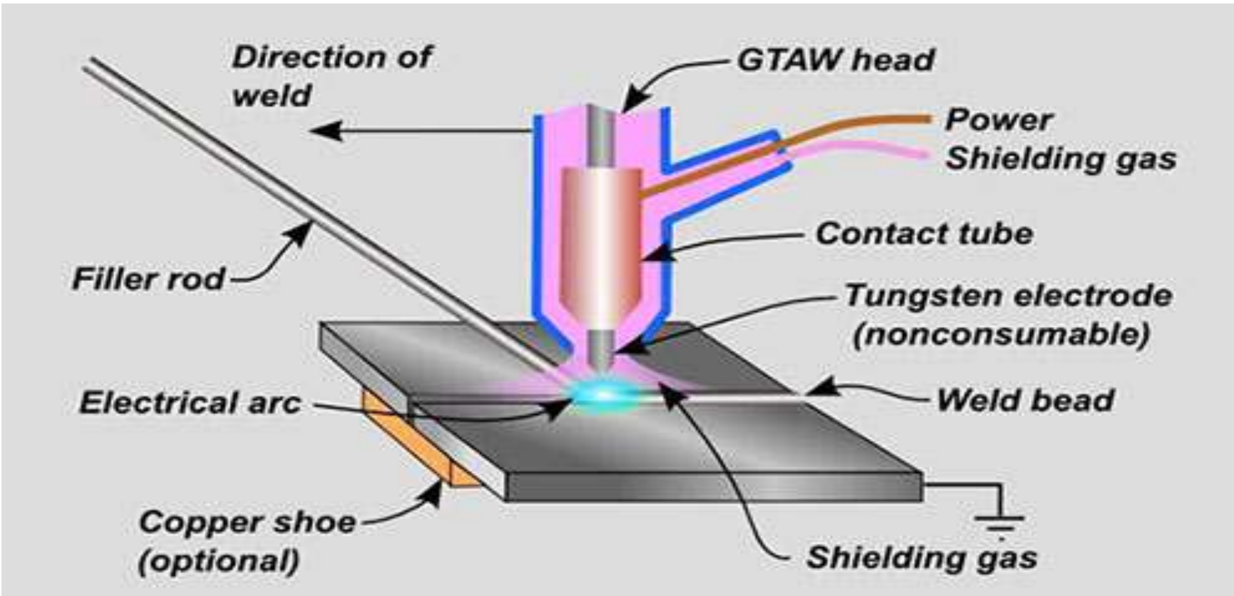

Figure 1.1 Principle of TIG welding

The melting temperature necessary to weld materials in the **Tungsten inert gas welding (TIG)** process is obtained by maintaining an arc between a tungsten alloy electrode and the workpiece. Weld pool temperatures can approach 2500 °C (4530 °F). An inert gas sustains the arc and protects the molten metal from atmospheric contamination. The inert gas is normally argon, helium, or a mixture of helium and argon.

1.2 Welding Equipment

In TIG welding, the arc is formed between the end of a small diameter tungsten electrode and the workpiece. The main equipment components are:

- power source
- torch
- backing system
- protective equipment

2.Experimental Setup & methodology

2.1 Machine specification

Basic Information

- Company: Lorch Automation
- Model No.: Lorch V50
- Type: ARC/TIG Welders
- Current: Direct Current

Figure 2.1 Welding machine

3. Material selection

3.1 316 Stainless steel

Excellent weldability by all standard fusion methods, both with and without filler metals. AS 1554.6 pre-qualifies welding of 316 with Grade 316 and 316L with Grade 316L rods or electrodes (or their high silicon equivalents). Heavy welded sections in Grade 316 require post-weld annealing for maximum corrosion resistance. This is not required for 316L. Grade 316Ti may also be used as an alternative to 316 for heavy section welding.
Subject to pitting and crevice corrosion in warm chloride environments, and to stress corrosion cracking above about 60 °C. Considered resistant to potable water with up to about 1000 mg/L chlorides at ambient temperatures, reducing to about 500 mg/L at 60 °C.
Good oxidation resistance in intermittent service to 870 °C and in continuous service to 925 °C. Continuous use of 316 in the 425-860 °C range is not recommended if subsequent aqueous corrosion resistance is important.

3.2 Chemical composition

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
316	Min	-	-	-	0	-	16.0	2.00	10.0	-
	Max	0.08	2.0	0.75	0.045	0.03	18.0	3.00	14.0	0.10

Table 3.1 Chemical composition

3.3 Mechanical Properties

Grade	Tensile Str (MPa) min	Yield Str 0.2% Proof (MPa) min	Elong (% in 50 mm) min	Hardness	
				Rockwell B (HR B) max	Brinell (HB) max
316	515	205	40	95	217

3.4 Properties of 316 stainless steel

- Stainless steel 316 has excellent corrosion resistance.
- Cannot be hardened by heat treatment.
- Excellent weldability by all standard fusion methods.
- Good general corrosion resistance
- Easily machining.

4. Design of Experiment

4.1 Taguchi Method

Taguchi Technique is applied to plan the experiments. The Taguchi method has become a powerful tool for improving productivity during research and development, so that high quality products can be produced quickly and at low cost. Dr. Taguchi of Nippon Telephones and Telegraph Company, Japan has developed a method based on "ORTHOGONAL ARRAY" experiments which gives much reduced "variance" for the experiment with "optimum settings" of control parameters. Thus the marriage of Design of Experiments with optimization of control parameters to obtain best results is achieved in the Taguchi Method. "Orthogonal Arrays" (OA) provide a set of well balanced (minimum) experiments and Dr.Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as an objective functions for the optimization, help in data analysis and prediction of optimum results.

4.2 Parameter considering for experiment

There are various parameters considering in the GTAW welding. When some changes occurred in different parameter its effect on the welding process.

PROCESS PARAMETER	CONSTANT PARAMETER
Current (A)	Electrode size
Shielding Gas(Ar)	Filler rod
Welding speed(mm/sec)	Welding technique
Arc Voltage (V)	DCSP

Table 4.1 Process parameter

Figure 4.1 Test specimens

5. Measurement of penetration & Tensile strength

The measurement of penetration and Tensile strength consist of first cutting the section of material of the welded piece and then the polishing of the section obtained the work piece. The etchant are applied to the polished portion of the joint. After application of the etchant the weld bead is clearly visible. Now penetration and Tensile strength of weld bead can be measured.

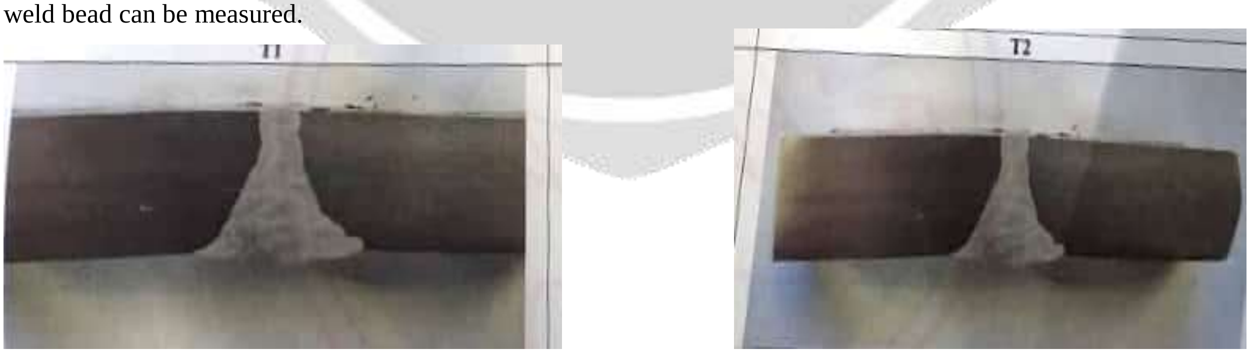

Figure 4.2 Penetration of workpiece

For penetration:-
Instrument used : Digital portable Measuring Microscope.
Test Method : ASME Sec IX
Test Performed at : Hertz Testing centre, Ahmedabad.

For Tensile strength:-
Instrument used : Computerized Universal Testing machine TUF-C-1000.
Servo Sr. No. 2015/27
Test Method : ASME Sec IX
Test Performed at : Hertz Testing centre, Ahmedabad.

6. Results & Analysis

6.1 Experiment Results

The results of 9 best possible combinations are shown in the table here with available Tensile strength and penetration of those combinations of all three welding parameters are shown in Table 4.1. These results are measured at the Hertz Testing centre, Ahmedabad.

Sr no.	**Welding current(Amp)**		**Voltage (Volt)**		**Gas flow (L/min)**		**Welding speed (mm/sec)**		**Welding Penetration (mm)**	**Tensile Strength (N/mm^2)**
	Root	**Hot pass**	**Root**	**Hot pass**	**Root**	**Hot pass**	**Root**	**Hot pass**		
1.	110	140	7.9	8.7	12	15	60	46	11.30	588.93
2.	110	140	8.1	8.5	12	15	65	45	11.50	585.96
3.	110	140	7.7	8.0	12	15	70	40	11.63	580.53
4.	120	150	8.1	8.8	10	12	64	56	10.15	508.96
5.	120	150	8.2	8.6	10	12	65	42	10.25	506.50
6.	120	150	7.9	9.0	10	12	75	45	10.40	512
7.	90	160	7.7	9.2	15	18	120	38	11.50	575.25
8.	90	160	7.5	9.5	15	18	110	35	11.56	590.23
9.	90	160	7.4	9.8	15	18	115	40	11.36	564.24

7. Conclusion & Future Scope

7.1 Conclusion

This research work has presented on the optimization of "INVESTIGATION OF TIG WELDING USING ARGON SHIELDING GAS ON 316 STAINLESS STEEL". Input parameters selected for study were Welding speed, Welding current the response was weld penetration and Tensile strength. The level of importance of the welding parameters on the weld penetration and Tensile strength is determined by using TAGUCHI method. Various conclusions obtained were:

- High strength at low cost
- Obtain good penetration at low travel speed
- Best welding can be obtained using TIG welding
- Good corrosion resistance

7.2 Future Scope

The current work can be extended as:

- Using different optimization techniques for optimum result and comparing the results in TIG welding.
- Thickness of the work piece can be changed and the process for optimization can be repeated.
- More number of process parameters can be considered for this work.
- Material selected can be changed.
- Other response such as HAZ and FZ, Hardness can be considered for study.
- Different shielding gas can be used for the process and results can be compared.
- Apply this technique to optimize other welding processes, such as filler rod diameter, types of gas and flow and types of electrode materials

8. References

- **P. Bharath,V.G. Sridhar, M. Senthil kumar** Welding is one of the most popular methods of metal joining processes. The joining of the materials by welding provides a permanent joint of the components.
- **Navid Moslemi, Norizah Redzuan , Norhayati Ahmad, Tang Nan Hor** Gas Metal Arc Welding (GMAW) process is a clean and cost effective process in arc welding which is higher productivity and good in quality. In this study, 316 stainless steel pipes with outside diameter is 73mm and 7.0mm thickness were joint using Tungsten Inert Gas (TIG) welding process.
- **Gurdev Singh, Aman Bansal** The main objective of thispaper to find out near optimal solution for welding parameters in TIG (tungsten inert gas) welding. The mechanicals properties like Tensile strength, Impact force, Hardness of the welded joints are influenced by many welding process parameters.
- **Hongbin Dai , Xiuqiang Shen , Haoran WangaI** the paper, the 5A03 aluminium alloy was employed to study the influence of TIG arc on the penetration and the weld width. And the split anode method with water-cooled copper plate was used to measure and record the distribution of arc current, under different flow ratio of argon and helium conditions.
- **Varma Prasad V.M, Joy Varghese V.M., Suresh M.R., Siva Kumar D.** This paper deals with the effects of weld parameters on residual stress developed during TIG welding of pipes. Circumferential TIG welding is widely used in industries such as piping, oil refineries, power stations, etc.