Journal of Experimental & Applied Mechanics
ISSN: 2230-9845 (Online), ISSN: 2321-516X (Print)
Volume 8, Issue 3
www.stmjournals.com

Experimental Investigation of Welding Process Parameters on Mechanical Properties for TIG Welded Austenitic Stainless Stell 304 Joints

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Abstract
Austenitic stainless steels have been used widely by the fabrication industry owing to their excellent high temperature and corrosion resistance properties. Some of the typical applications of these steel include their use as nuclear structural material for reactor coolant piping, valve bodies, vessel internals, chemical and process industries, dairy industries, petrochemical industries etc. Out of 300 series grade of these steels type 304 SS is extensively used in industries due to its superior low temperature toughness and corrosion resistance. This work aims at analysis for effect of selected welding process parameters on mechanical properties of TIG welded Austenitic stainless steel 304 plate butt joints. After TIG welding; mechanical tests are done on welded joints.

Keywords: *TIG welding, tensile strength, hardness, groove angle, analysis*

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INTRODUCTION

Austenitic stainless steels have been used widely by the fabrication industry owing to their excellent high temperature and corrosion resistance properties. Some of the typical applications of these steel include their use as nuclear structural material for reactor coolant piping, valve bodies, vessel internals, chemical and process industries, dairy industries, petrochemical industries etc. Out of 300 series grade of these steels type 304 SS is extensively used in industries due to its superior low temperature toughness and corrosion resistance [1].

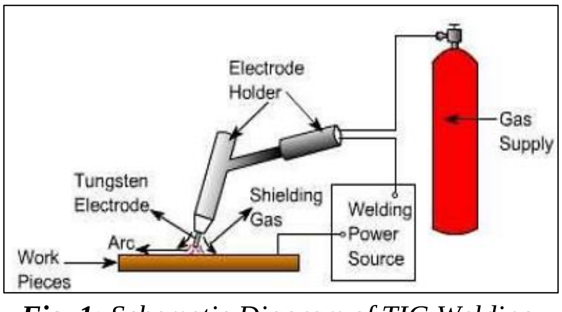

Fig. 1: *Schematic Diagram of TIG Welding System [2].*

Tungsten electrodes are commonly available from 0.5–6.4 mm diameter and 150–200 mm length. The current carrying capacity of each size of electrode depends on whether it is connected to negative or positive terminal of DC power source.

The power source required to maintain the TIG arc has a drooping or constant current characteristic which provides an essentially constant current output when the arc length is varied over several millimetres. Hence, the natural variations in the arc length which occur in manual welding have little effect on welding current. The capacity to limit the current to the set value is equally crucial when the electrode is short circuited to the work piece, otherwise excessively high current will flow, damaging the electrode. Open circuit voltage of power source ranges from 60–80 V [3].

APPLICATIONS OF TIG WELDING

The TIG welding process is extensively used in the so-called high-tech industry applications such as:

- Nuclear industry

- Aircraft
- Food processing industry
- Maintenance and repair work
- Precision manufacturing industry
- Automobile industry [4]

METHODOLOGY

Design of Experiments

Table 1: *Design of Experiments.*

Experiment No.	Groove Angle	Current	Gas flow rate (LPM)
1	45	80	10
2	45	100	12
3	45	120	15
4	60	80	12
5	60	100	15
6	60	120	10
7	75	80	15
8	75	100	10
9	75	120	12

Experiments

Fig. 2: *Welded Specimen.*

Tensile Test

Fig. 2: *UTM Machine.*

Fig. 2: *Tensile Test Specimen.*

Table 2: *Result of Tensile Test.*

Experiment no.	Groove angle	Current (A)	Gas flow rate (LPM)	Tensile strength (MPa)
1	45	80	10	642.09
2	45	100	12	652.04
3	45	120	15	633.16
4	60	80	10	640.34
5	60	100	12	557.85
6	60	120	15	626.91
7	75	80	10	630.81
8	75	100	12	631.22
9	75	120	15	706.68

Hardness Test

Fig. 3: *Rockwell Hardness Tester.*

Table 3: *Result of Hardness Test.*

Experiment no.	Groove angle	Current (A)	Gas flow rate (LPM)	Hardness (BHN)		
				BASE METAL	WELD	HAZ
1	45	80	10	210	162	195
2	45	100	12	210	172	190
3	45	120	15	210	153	185
4	60	80	10	210	162	169
5	60	100	12	210	162	185
6	60	120	15	210	165	162
7	75	80	10	210	156	165
8	75	100	12	210	153	195
9	75	120	15	210	159	195

Analysis of Result

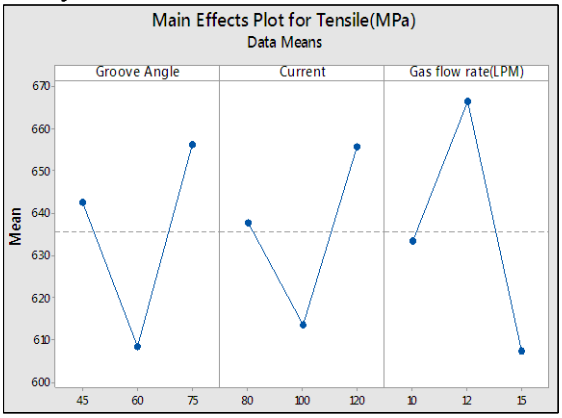

Fig. 3*: Main Effect Plot for Tensile.*

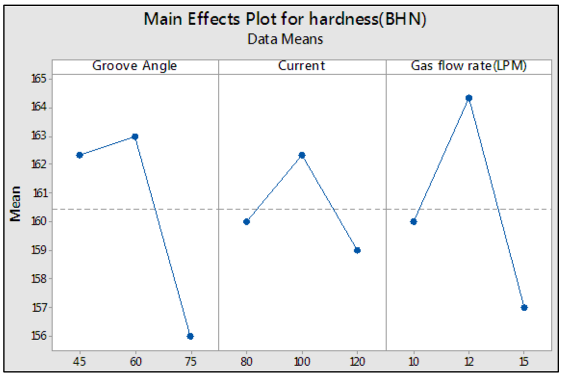

Fig. 4*: Main Effect Plot for Hardness.*
(Software Used :- Minitab-17)

CONCLUSIONS

- Range of Tensile strength is 557 – 706 Mpa.
- Higher tensile strength obtained at 75 groove angle, 120 A current and 15 LPM gas flow rate.
- Range of hardness for weld zone is 153–172 BHN.
- Lower hardness obtained at 45 and 75 groove angle, 120 and 100 A current, 15 and 12 LPM.
- Future work can be done with other type of welding processes like MIG, SMAW etc.

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Jadav Ravikumar, G.D. Acharya, Pratik Kikani. Experimental Investigation Of Welding Process Parameters on Mechanical Properties for TIG Welded Austenitic Stainless Stell 304 Joints**.** *Journal of Experimental & Applied Mechanics*. 2017; 8(3):