EFFECT OF WELDING GEOMETRY PARAMETER ON HARDNESS FOR AISI304 TIG

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ABSTRACT

Welding is an area in which technological developments out match the developments in its science base which is primarily driven by the phenomenal industrial demand for welded structure. Reliability, Reproducibility and Viability requirements are forcing Technologists to look at weld defects such as distortion, hot cracking, in a systematic and logical approach than on experimental basis. Distortion is an unwanted physical change from specifications in a fabricated structures is caused by non-uniform expansion and contraction of the weld metal during heating and cooling cycle of the welding process many factors viz., material properties, welding process and procedures adopted make accurate prediction of distortion difficult. Groove angle, Root gap and root face was taken to analyze Hardness in butt weld joints

Keyword: - *TIG, Welding processes, Hardness, Groove angle, Root gap and root face*

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1. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and pressure. During welding, the work-pieces to be joined are melted at the interface and after solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification shows strong bond in the joint. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

1.1 Different Type of Welding Processes

Based on the heat source used welding processes can be categorized as follows:

I) Arc Welding

In arc welding process an electric power supply is used to produce an arc between electrode and the work-piece material to joint, so that work-piece metals melt at the interface and welding could be done. Power supply for arc welding process could be AC or DC type. The electrode used for arc welding could be consumable or non-consumable. Fornon-consumable electrode an external filler material could be used.

II) Gas Welding

In gas welding process a focused high temperature flame produced by combustion of gas or gas mixture is used to melt the work pieces to be joined. An external filler material is used for proper welding. Most common type gas welding process is oxyacetylene gas welding where acetylene and oxygen react and producing some heat.

III) Resistance Welding

In resistance welding heat is generated due to passing of highamount current (1000–1, 00,000 A) through the resistance caused by the contact between two metal surfaces. Most common type's resistance welding is spot-welding, where a pointed electrode is used. Continuous type spot resistance welding can be used for seam-welding where a wheel-shaped electrode is used.

IV) High Energy Beam Welding

In this type of welding a focused energy beam with high intensity such as laser beam or electron beam is used to melt the work pieces and join them together. These types of welding mainly used for precision welding or welding of advanced material or sometimes welding of dissimilar materials, which is not possible by conventional welding process.

V) Solid-State Welding

Solid-state welding processes do not involve melting of the work piece materials to be joined. Common types of solid-state welding are ultrasonic welding, explosion welding, electromagnetic pulse welding, friction welding, friction-stir-welding etc.

2. LITERATURE SURVEY

G. Magudeeswaran[1] quenched and tempered (Q&T) steels are widely used in the construction of military vehicles due to its high strength to weight ratio andhigh hardness. These steels are prone to hydrogen induced cracking (HIC) in the heat affected zone (HAZ) after welding. The use of austeniticstainless steel (ASS) consumables to weld the above steel was the only available remedy because of higher solubility for hydrogen in austeniticphase.

M. Ericsson[2] Fatigue strength of friction stir (FS) welds is influence by the welding speed, and also to compare the fatigue results with results for conventional arc-welding methods: MIG-pulse and TIG. The Al–Mg–Si alloy 6082 was FS welded in the T6 and T4 temper conditions, and MIG-pulse and TIG welded in T6. The T4weldedmaterial was subjected to a post-weld ageing treatment.

S.C. Juang[3] selection of process parameters for obtaining optimal weld pool geometry in the tungsten inert gas (TIG) welding ofstainless steel is presented. Basically, the geometry of the weld pool has several quality characteristics, for example, the front height, front width, back height and back width of the weld pool.

G. Magudeeswaran[4] Optimize the Process Parameters of Activated Tungsten Inert Gas welding. The activated TIG (ATIG) welding process mainly focuses on increasing the depth of penetration and the reduction in the width of weld bead has not been paid much attention. The shape of a weld in terms of its width-to-depth ratio known as aspect ratio has a marked influence on its solidification cracking tendency.

Bhawandeep Singh[5] Observed the Performance of activated TIG process in mild steel welds. Gas tungsten arc welding is fundamental in those industries where it is important to control the weld bead shape and its metallurgical characteristics. However, compared to the other arc welding process, the shallow penetration of the TIG welding restricts its ability to weld thick structures in a single pass thus its productivity is relativity low.

M. A. Bodude[6] Using two welding processes: Oxy-Acetylene Welding (OAW) and Shielded Metal Arc Welding (SMAW). Two different edge preparations on a specific size, 10-mm thick low-carbon steel, with the following welding parameters: dual welding voltage of 100 V and 220 V, various welding currents at 100, 120, and 150 Amperes and different mild steel electrode gauges of 10 and 12 were investigated. The tensile strength, hardness and impact strength of the welded joint were carried out and it was discovered that the tensile strength and hardness reduce with the increase in heat input into the weld. However, the impact strength of the element increases with the increase in heat input.

S. I. Talabi[7] Were discussed the effect of welding variables on the mechanical properties of welded 10 mm thick low carbon steel plate, welded using the Shielded Metal Arc Welding (SMAW) method. Welding current, arc voltage, welding speed and electrode diameter were the investigated welding parameters. The welded samples were cut and machined to standard configurations for tensile, impact toughness, and hardness tests.

M. K. Abbass[8] Studed the influence of the joint design of Tungsten Inert Gas welding (TIG) on the corrosion resistance of low carbon steel. A single V-butt joints of a low carbon steel plates are performed by the V- angles 30°,45°,60° and square butt joint (angle 90°). Corrosion behavior of welded specimens in 3.5% NaCl solution was examined using Tafel polarization measurements.

3. MATERIAL SELECTION FOR WORK PIECE

3.1 AISI 304 Stainless Steel

The experimental work is to be carried out to investigation and compare TIG and SMAW welding for tensile test, hardness and distortion of V grooves butt weld joint of AISI 304stainless steel material. Focus of this project work to identify strength of welded joint by changing the welding process. The austenitic grades have well to excellent corrosion resistance, good formability and weldability. Their good impact strength at low temperatures is often exploited in cryogenic application. The austenitic grades are non-magnetic in the solution annealed condition *due* to the austenitic microstructure. This type is selected for the experimentation purpose because it is highly corrosion resistance and mostly used for aerospace application and can be used from both high temperature applications to cryogenic one. The table 3.1 shows chemical composition of AISI 304 stainless steel.

Table: 3.1 Chemical Compositionsof AISI 304 Stainless Steel

C	Mn	S	P	Si	Ni	Cr	N
0.057	1.02	0.003	0.036	0.27	8.04	18.29	0.045

3.2 AISI 308L Stainless Steel

Stainless steel 308L has excellent corrosion resistance in wide variety of environments and when in contact with different corrosive media. Pitting and crevice corrosion can occur in environments containing chlorides. Stress corrosion cracking can occur at temperature over 60^0 C.Fusion welding performance for stainless steel 304 is excellent both with and without fillers. Recommended filler rods and electrodes for stainless steel 304 is grade 308L stainless steel. The chemical compositions of AISI 308 L electrodesare given in table 3.2.

Table: 3.2 Chemical Composition ofAISI 308 Filler Rod used in TIG

C	Mn	Si	S	P	Cr	Ni	N
0.08	2.5	0.65	0.03	0.05	19.50	10.50	11

3.3 Process Parameters and their Level for Experimentations

The table 3.3 shows the values of the selected process parameters, three parameters with three levels. All these values are selected on the basis of literature review, machine specification. By using Design of Experiments by Taguchi Method, L_9 orthogonal array is selected for experiments. The columns of L_9 orthogonal array are shown in table 3.3.[12,13,14]

Table 3.3 Process Parameters and their Level for Experimentations TIG

Levels	Groove Angle (Degree)	Root Face (mm)	Root Gap (mm)
Level 1	30	1	0
Level 2	45	1.5	1.5
Level 3	60	2	2

4. RESULTS OF EXPERIMENTS

After performing all the experiments with predetermined values of process parameters, the tensile strength is measured and the micro hardness is measured. The results are given in the table 3.5.

Table: 4.1 Micro hardness of TIG for Experimentation

Exp. No	Groove Angle (Degree)	Root Face (mm)	Root Gap (mm)	TIG Vickers Hardness ($Hv_{0.1}$)
1	30	1	0	220
2	30	1.5	1	221
3	30	2	1.5	227
4	45	1	1	226
5	45	1.5	1.5	230
6	45	2	0	226
7	60	1	1.5	236
8	60	1.5	0	228
9	60	2	1	231

5. RESULT AND DISCUSSION.

5.1 Analysis of Micro hardness for TIG Joint

The micro hardness taken by Vickers micro hardness tester. The average micro hardness value of 227 ± 5 Hv is obtained for TIG joints. The micro hardness testing of TIG joints to take 0.1 kg load and dowel time 10 sec. The fig. 5.1 shows sample of indentation micro hardness testing and fig. 5.2 shows graph of micro hardness for TIG joints sample.

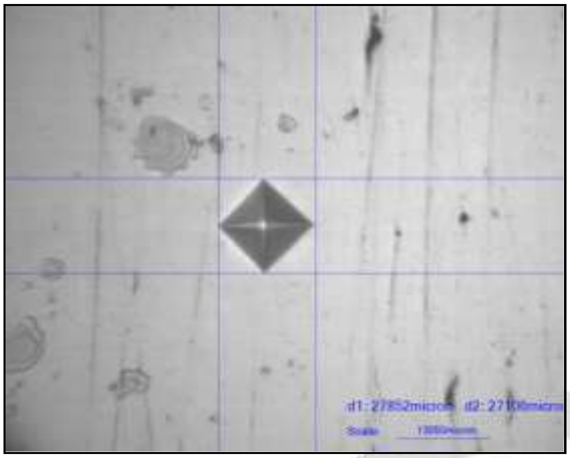

Fig. 5.1 Indentation of Micro hardness Testing for TIG Weld Joints

Fig. 5.2 Micro hardness Sample of TIG Weld Joints

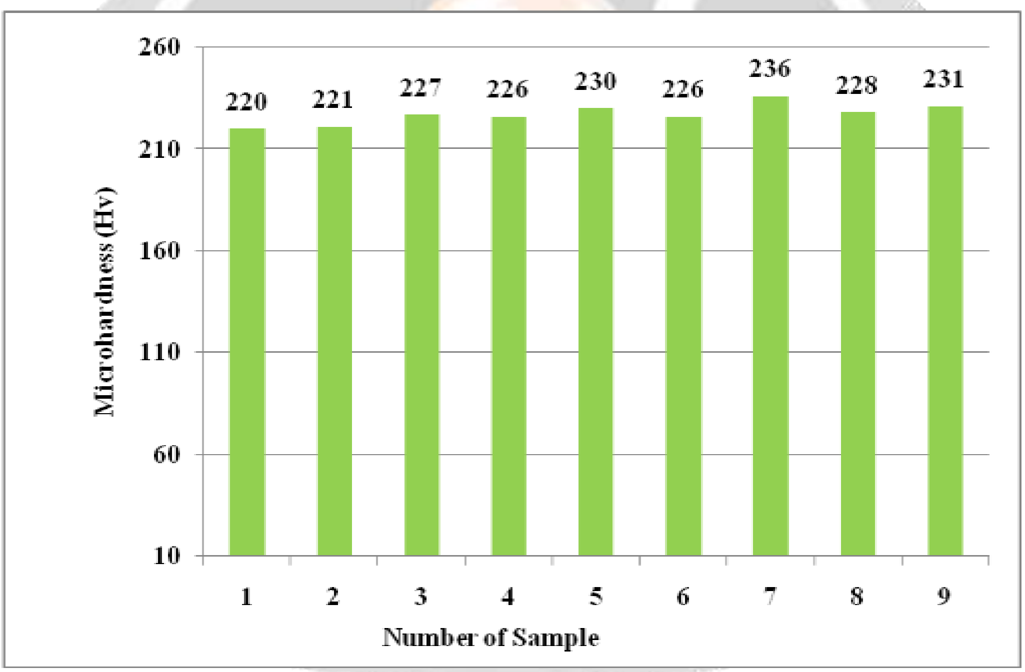

Fig. 5.3 Graph of Micro hardness for TIG Joints

Average micro hardness of TIG weld joints = 227 ± 5 Hv. After performing final experiments, analysis of experimental data is done by using MINITAB-17 software. The effect of various input parameters on output responses will be analysed using analysis of variance (ANOVA). The table 5.5 indicates that two process parameter significant and influencing hardness at 97% confidence level.

Table: 5.1 ANOVA for Micro hardness of TIG Joints

Source	DF	Adj SS	Adj MM	F- Value	P- Value
Groove Angle (Degree)	2	160.222	80.111	28.84	0.034
Root Face (mm)	2	6.222	3.111	1.12	0.472
Root Gap (mm)	2	24.889	12.444	4.48	0.182
Error	2	5.556	2.778		
Total	8	196.889			
S=1.66667 R-sq=97.18 % R-sq=88.71 %					

The micro hardness distribution profile on the transverse cross-section of the joint welded L_9 specimen. The micro hardness values of base metals 203 ± 2Hv. The micro hardness of nugget was higher than that of base metal due to HAZ. The occurrence could be probably attributed to the dendritic grain of the TIG welding process. An inhomogeneous distribution of micro hardness values was observed in the weld nugget zone (WNZ). The higher the hardness value in the WNZ relative to base metal was primarily associated with the formation of solid to liquid transformation dendritic grains observation. The higher values at the weld zone of reached 236 Hv and lower value 220 Hv.

Main effect plots for micro hardness are as shown in fig. 5.21. In order to see the effect of process parameter on micro hardness using L_9 orthogonal array and experiments are performed and the experimental data are given in table 5.5. It is clear that as groove angle goes on increasing, hardness also goes on increasing. It was observed that as root face up to 1.5 mm micro hardness goes on decreasing after that 1.5 mm to 2 mm micro hardness goes on increasing. It was observed that as root gap goes on increasing so hardness also goes on increasing.

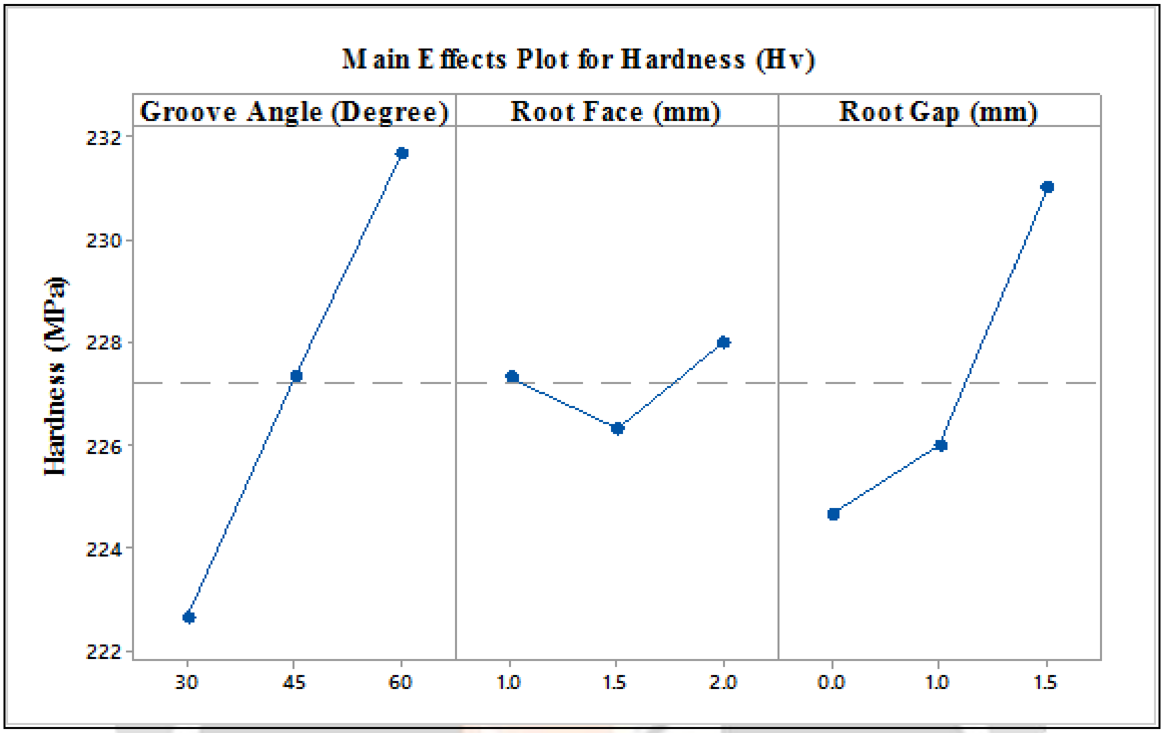

Fig: 5.4 Main Effects Plot for Micro hardness of TIG Joints

6. CONCLUSION

In this study, AISI 304 stainless steel materials were successfully achieved by butt joints. Analysis of tensile strength and micro hardness of TIG of AISI 304butt joints are performed and following conclusions are drawn.

- It is observed that groove angle goes on increasing, hardness also goes on increasing.
- It is also observed that as root face up to 1.5 mm micro hardness goes on decreasing after that 1.5 mm to 2 mm micro hardness goes on increasing.
- Root gap goes on increasing so hardness also goes on increasing.
- Higher micro hardness 236 Hv produced at 60 groove angle, 1 mm rib thickness and 1.5 root gap in TIG welding.

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