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Experimental Investigation and Predict the Gas Tungsten Arc Welding Process Parameter of Al6061 for Improving Optimal Parameter

Gopinath T [a]***, Dr.Makesh M*** [b]***, Sathees T*** [c]

[a] *Department of Mechanical Engineering, PG Scholar of Engineering Design, Paavai Engineering college, Namakkal-637018, India.*
[b&c] *Faculty of Mechanical Engineering, Paavai Engineering college, Namakkal-637018*, India.

ABSTRACT

Tungsten Inert gas (TIG) welding is an arc-welding process that produces coalescence of metal by heating them with an arc between a non-consumable tungsten electrode and the base metal. This process was originally developed for hard-to-weld lightweight metals such as aluminum, magnesium and titanium. Many delicate components in aircraft and nuclear reactors are TIG welded and therefore TIG weld quality is of extreme importance. Basically, TIG weld quality is strongly characterized by weld pool geometry. The welding parameters play an important role in joining the work pieces by TIG welding for 6061 aluminum alloy. The process has to be applied to different specimens by varying heat inputs (low, medium and high) This research will present the effect of influence of welding parameters on the weld bead geometry such as Bead width depth of penetration and quality of weld joint. Welding current, Voltage and gas pressure has to be taken into account during experimental work and has to be finding Heat affected zones with minimum mechanical distortion. The weld quality will be strongly characterized by weld bead geometry because the weld pool geometry plays an important role in determining mechanical properties of weld. Maximum quality can be achieved with control of welding parameters.

Key Words**:** TIG, MIG, GMAW, *GTAW, SOLIDWORKS, VCR system, performance improvement.*

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 or 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 forma weld pool of molten material which after solidification gives a strong bond between the materials. 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:

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 the arc welding process could be AC or DC type. The electrode used for arc welding could be consumable or non-consumable. For non- consumable electrode an external filler material could be used.

Gas Welding:

In the 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.

1.2 Gas Metal Arc Welding (GMAW) or metal inert or active gas welding (MIG/MAG):

In this type of welding process a continuous and consumable wire Electrode is used. A shielding gas generally argon or sometimes mixture of argon and carbon dioxide are blown through a welding gun to the weld zone.

1.3 Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas (TIG):

GTAW or TIG welding process is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from the atmosphere with a shielding gas, generally Argon or Helium or sometimes a mixture of Argon and Helium.

1.4 Basic mechanism of TIG welding:

TIG welding is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere by an inert shielding gas (argon or helium), and a filler metal is normally used. The power is supplied from the power source (rectifier), through a hand-piece or welding torch and is delivered to a tungsten electrode which is fitted into the hand piece.

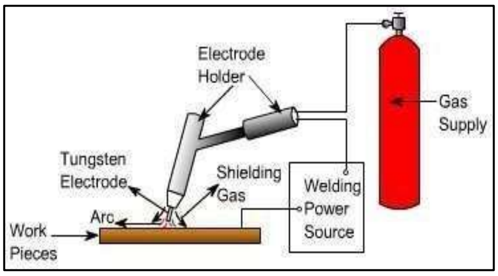

Fig 1.1: Schematic Diagram of TIG Welding System.

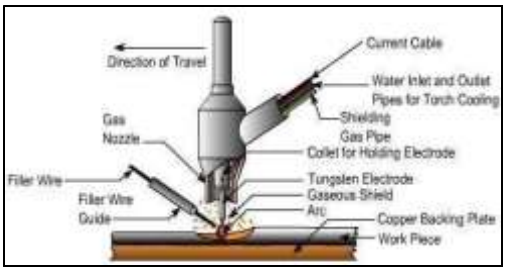

Fig. 1.2: Principle of TIG Welding.

1.5 METALLURGICAL DEFECTS CRACKS:

Cracks are the linear ruptures of the metal under stress. Sometimes they appear large and frequently they are narrow separations. The major classification of cracks is;

- Hot cracking
- Cold cracking
- Micro fissuring
- Base metal cracking
- Crater cracking.

REASON FOR CRACKING

- Base metal composition
- Welding process characteristics
- Defective welding filler materials
- Welding environment
- Joint design

2. LITERATURE REVIEW

K. M Eazhil,1[et al], analysis the Taguchi method is used for the Optimization of Tungsten Inert Gas Welding on 6061 Aluminum Alloy. The Taguchi method L27 is used to optimize the pulsed TIG welding process parameters of 6061 aluminum alloy weldments for maximizing the mechanical properties. Analysis of Variance is used to find the impact of individual factors. Then the optimal parameter of the TIG welding process is determined and the experimental results illustrate the proposed approach.

Dr.BrajeshVarshney,2[et al], investigated Aluminum metal matrix composites (AMMCs)are becoming more popular as structural materials and joining them is therefore of paramount importance.. As these new materials become available it is necessary to define and optimize joining techniques, and a thorough understanding of the process. The present work first deals with the fabrication of SiC reinforced AMMCs (AL6061/15 percent SiCp) with Liquid Processing Technique, i.e. Stir casting method and later to seek for possibilities of successful joining with TIG process, for possible structural applications. The present study deals with an experimental study carried out in order to optimize the process parameters namely Frequency (Hz), Current (A), Shielding gas flow rate (l/m), Percentage time electrode positive (µs). The performance measures evaluated are namely Micro- hardness,(VHN)and Impact strength, (Joule), for TIG welding ofAL6061/15%SiCp. The results have been analyzed using Taguchis methodology.

Mr.Nilesh Landge,3[et al], verified ship, aerospace and in process industry aluminum and its alloys are commonly used because of their valuable properties such as light weight, better corrosion resistance and weld ability. The current study aim to compare mechanical properties of AL6061 and AL2024 for different groove angle and bevel heights keeping root opening, voltage and current constant. In this work the gas tungsten arc welding process has been selected because TIG welding is the process of joining different materials with high quality in the presence of inert gas. Alternating current power source has been selected because of better cleaning action and due to alternating current the high heat concentration on the material can be avoided. Mechanical tests such as tensile test, impact test, and hardness test have been conducted to find out the mechanical properties such as tensile strength, impact strength, and toughness of HAZ.

Pankaj.C,4[et al], analysis Aluminum alloys are alloys in which Aluminum is the predominant metal. The typical alloying elements are copper, magnesium, magnese, silicon, tin and zinc. Al and Aluminum alloys plays an important role in engineering and metallurgy field because of fabrication and formability.TIG welding technique is one of the precise and fastest processes used in aerospace industries, ship industries, automobile industries, nuclear industries and marine industries.TIG welding process is used to analyzed the data and evaluate the influence of input parameters on tensile strength and hardness of Aluminum specimen .Welding current, gas flow rate and welding speed are the input parameters which affect output responses of Aluminum welded joints .

Parthiv T.5 [et al], had investigated Gas tungsten arc welding, GTAW, is one of the widely used techniques for joining ferrous and non-ferrous metals. In this study experiments were carried out as per central.

3. PROBLEM IDENTIFICATION AND OBJECTIVE OF THE WORK

For a given change in temperature Aluminum expands or contracts about twice as much as steel and this can give rise to considerable distortion as a weld cools. Precautions therefore need to be taken to control this otherwise the welded structure may well be unusable. Typical types of distortion include longitudinal shrinkage, transverse shrinkage, angular distortion and bowing.

Following three basic rules when welding can minimize distortion. Rule 1 - Reduce the effective shrinking force: Do not over weld. The use of excessive weld metal over and above thatneeded to meet the service requirements of the weld is not only wasteful but increases distortion. Ensure proper edge preparation and fit up. This will allow the minimum amount of weld metal to produce a strong joint. Use a few passes. The use of many small passes increases lateral distortion. Use of fewer passes with a large diameter electrode minimizes lateral distortion. Place welds near the neutral axis of the device. This minimizes the effective shrinkage force since the weld does not have sufficient leverage to pull the plates out of alignment. Use intermittent welds. This also reduces the amount of weld metal and can result in significant cost savings as well as minimizing distortion.

4. ALUMINUM WELDING

Aluminum can be joined in many ways - a critical requirement in fabrication as whole products are usually formed from a number of parts. Joining methods include demountable systems such as bolting as well as more permanent methods including welding, especially where continuity of joining is required. Aluminum welding is a discipline that can and needs to be learned. Correctly applied, fabricators find that an Aluminum welded product is quicker to manufacture than the equivalent performing steel fabrication - and it offers a 40% mass advantage. Aluminum welding opens opportunity in fabrication.

a. The skill levels required for Aluminum welding are higher but the number of hours per volume are significantly lower.

b. While the hours required per ton for Aluminum welding are higher, the metal is three times lighter than steel with the result that overall, Aluminum fabrication is cheaper.

c. Aluminum fabrication uses commonly available tools.

d. Welded Aluminum fabrications can be repaired.

e. The South African Institute of Welding has programmes to advance Aluminum welding skills of welders, supervisors and welding engineers.

4.1 The Welding Aluminum

The most common commercial Aluminum and Aluminum alloy welding methods use an electric arc with either a continuously fed wire electrode [with DC current, with and without pulsed current] or a permanent tungsten electrode plus filler wire [with AC current]. The arc is protected by argon gas (or argon- helium gas mix) to shield the weld pool and the electrode from the surrounding atmosphere. Arc welding is easy to use, attains a high temperature, provides high heat input and is easy to regulate.

4.2 Notes about Aluminum

Aluminum is alloyed with a range of other metals to change its properties to suit specific applications. Aluminum is lightweight [about one- third the weight of steel].

- Aluminum has high thermal conductivity [3 to 5 times that of steel] which means heat is easily conducted away from the welding area. It is essential that the heat source is powerful enough to rapidly reach Aluminum's low melting point of 565 / 650ºC. Welding hot and fast usually gives the best results.
- Aluminum's coefficient of thermal expansion is high [twice that of steel] - so it is prone to distortion and stress inducement if the proper welding procedure is not followed.
- Aluminum does not change color when heated. Be careful!
- Aluminum is a reactive metal that quickly forms a surface oxide layer.

4.3 CLASSIFICATION OF ALUMINUM ALLOY

1xxx Series: Pure Aluminum (> 99,5% Al) with only trace elements. This material is soft with low mechanical strength, but high conductivity. Used mainly in packaging and electrical applications [e.g. cables and bus bars]. Common alloys are 1050, 1070, 1100, 1200 and 1350. Welding filler metal is usually chosen to match the high purity so AWS ER 1050 or ER 1100 is commonly used though AWS ER 4043 is sometimes specified.

2xxx Series: Contains copper additions up to 6%, which allows hardening by heat treatment. Developed as a high strength alloy typically used for aircraft components, it can only be welded if the copper content is below 1%. The most common alloys are 2011, 2014, 2017 and 2024 and are rarely welded.

3xxx Series: Contains manganese additions of up to 1.5%. Used for roof sheeting, vehicle paneling and general sheet metal work. Commonly used alloys are 3003, 3004 and 3103. Welding filler material normally used is AWS ER 4043.

4xxx Series: Contains silicon up to 13% and widely used in casting and filler materials. Common casting alloys are A413/CEN 47100/ LM 20, and A380/LM 24, CEN 44100/LM6, and A357/CEN 42100/ LM25. Filler

metals normally used are AWS ER 4043 or ER 4047 being 6% and 12% silicon respectively. ER 4047 is commonly used for brazing Aluminum alloys because of its low melting temperature.

5xxx Series: Contains up to 5% magnesium and widely used for engineering components, pressure vessels and transport equipment in road, rail and shipping applications. The common alloys are 5083, 5454 and 5251. Filler materials normally match the base material and can be of types AWS ER 5356, ER 5183 and ER 5554.

6xxx Series: Contain additions of silicon and manganese up to 1,7 % and 1,2% respectively. Used extensively for extruded sections of all shapes and sizes. Common alloys are 6063, 6082 and 6061. Filler materials normally used are AWS ER 4043 which give the highest degree of ease of welding, and ER 5356 which gives a better color match where the welded assembly is to be anodized.

7xxx Series: Contains additions of zinc, magnesium and sometimes copper. Used typically for aircraft structures, military bridges, armored vehicles and drilling rods where high strength to mass ratio is important alongside weld ability. Alloys with less than 1% copper are weldable. Common alloys are 7017, 7020 and 7075. Filler material normally used is AWS ER 5356.

8xxx Series and 9xxx Series: Special alloys, rarely used in South Africa.

4.4 Welding Filler material Selection

One must consider what the most important characteristic is for a particular weld - and then carefully select the correct filler material accordingly. When welding dissimilar alloys such careful selection becomes even more important as the required strength, ductility, corrosion resistance.

5. EXPERIMENTAL WORK

5.1 TIG WELDING MACHINE SPECIFICATION; Tig Welding Machine

Amps : 20 -300-AT/TIG

TIG : 16 Amps /415v

Cooling : Air cooling

Frequency : 50Hz

It has a good surface finish; high corrosion resistance is readily suited to welding and can be easily anodized. Most commonly available as T6 temper, in the T4 condition it has good formability.

Applications of 6061 Aluminum

Aluminum alloy 6061 is typically used in:

- Architectural applications
- Extrusions
- Window frames
- Doors
- Shop fittings
- Irrigation tubing

5.2 CHEMICAL PROPERTIES

Table 5.1 Typical chemical composition for Aluminum alloy 6061 and 6061A

ELEMENT	PERCENTAGE
Si	0.2 to 0.6
Fe	0.0 to 0.35
Cu	0.0 to 0.1
Mn	0.0 to 0.1
Mg	0.45 to 0.9
Zn	0.0 to 0.1
Ti	0.0 to 0.1
Cr	0.1
Al	Balance

5.3 PHYSICAL PROPERTIES

Table 5.2 Physical properties

Density	2700 kg/m^3
Melting Point	600°C
Modulus of Elasticity	69.5 GFRa
Electrical Resistivity	0.035x10^{-6} Ωm
Thermal Conductivity	200 W/mK
Thermal Expansion	23.5 x 10^{-6} /K

5.4 TAGUCHI APPROACH

Basically ,experimental designs were developed or finished . However experimental design methods are too complex and not easy to use. Furthermore, a large number of experiments have to be carried out when the number of the process parameters increases, to solve this problem, the Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only.

Fig no 5.1 Taguchi approach

5.5 INPUT PARAMETER

Table 5.3 Input parameters

PEAK CURRENT Amps	**BASE VOLTAGE Volt**	**GAS PRESSURE Kg/cm^2**
130	20	4
130	25	5
130	30	6
150	20	5
150	25	6
150	30	4
170	20	6
170	25	4
170	30	5

6. DESTRUCTIVE TEST AND ITS TAGUCHI ANALYSIS

6.1 INTRODUCTION OF HARDNESS

There are three types of tests used with accuracy by the metals industry; they are the Brinell hardness test, the Rockwell hardness test, and the Vickers hardness test. Since the definitions of metallurgic ultimate strength and hardness are rather similar, it can generally be assumed that a strong metal is also a hard metal. The way the three of these hardness tests measure a metal's hardness is to determine the metal's resistance to the penetration of a non-deformable ball or cone.

ROCKWELL HARDNESS TEST

1. Rockwell Hardness systems use a direct readout machine determining the hardness number based upon the depth of penetration of either a diamond point or a steel ball. Deep penetration indicated a material having a low Rockwell Hardness number.

2.However, a low penetration indicates a material having a high Rockwell Hardness number. The Rockwell Hardness number is based upon the difference in the depth to which a penetrator is driven by a definite light or "minor" load and a definite heavy or "Major" load.

Table 6:1 After welding-Tig

PEAK CURRENT	BASE CURRENT	GAS PRESSURE	HRB VALUE
130	20	4	65
130	25	5	80
130	30	6	79
150	20	5	86
150	25	6	62

150	30	4	78
170	20	6	82
170	25	4	85
170	30	5	78

6.2 HARDNESS RESPONSE FOR EACH LEVEL OF THE PROCESS PARAMETER

Response Table for Signal to Noise Ratios

Smaller is better

Response Table for Signal to Noise Ratios

Smaller is better

Table 6.2 level of the process parameter

LEVEL	PEAK BASE	BASE	GFR
1	-37.42	-37.74	-37.31
2	-37.46	-37.50	-38.45
3	-38.24	-37.88	-37.36
DELTA	0.81	0.38	1.13
RANK	2	3	1

Regression Equation

HARD = 77.22 - 2.56 PC_130 - 1.89 PC_150 + 4.44 PC_170 + 0.44 BC_20 -

1.56 BC_25 + 1.11 BC_30 - 1.22 GP_4 + 4.11 GP_5 - 2.89 GP_6

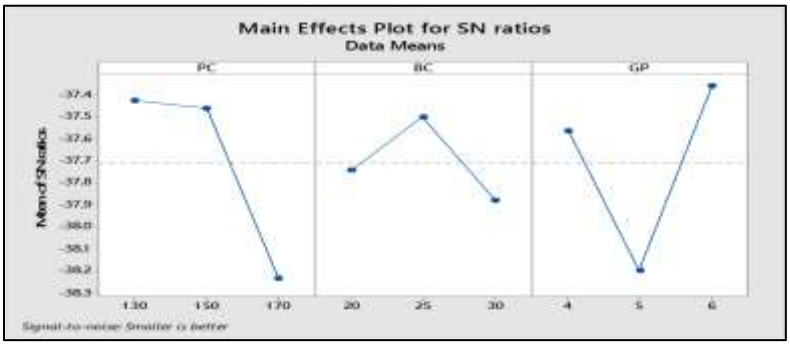

Fig no 6.1 Main Effects Plot for SN ratios

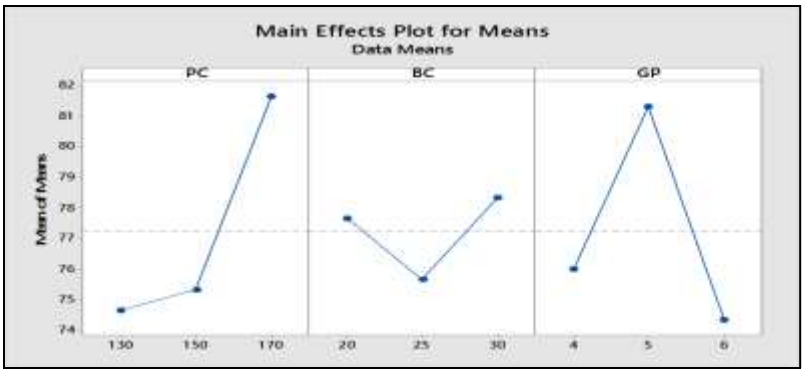

Fig no 6.2 Main Effects Plot for Means

Model Summary Taguchi Analysis: HARD versus PC, BC, GP

Response Table for Signal to Noise Ratios Smaller is better

Level	PC	BC	GP
1	-37.42	-37.74	-37.56
2	-37.46	-37.50	-38.20
3	-38.24	-37.88	-37.36
Delta	0.81	0.38	0.84
Rank	2	3	1

Response Table for Means

Level	PC	BC	GP
1	74.67	77.67	76.00
2	75.33	75.67	81.33
3	81.67	78.33	74.33
Delta	7.00	2.67	7.00
Rank	1.5	3	1.5

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
PC	2	14.22	7.111	0.37	0.732
BC	2	38.22	19.111	0.98	0.504
GP	2	113.56	56.778	2.92	0.255
Error	2	38.89	19.444		
Total	8	204.89			

S R-sq	R-sq(adj)	R-sq(pred)
13.6423 32.76%	0.00%	0.00%

Coefficients

Term	Coef	SE	Coef	T-Value	P-Value	VIF
Constant	77.22		4.55	16.98	0.003	
PC 130	-2.56		6.43	-0.40	0.729	1.33
150	-1.89		6.43	-0.29	0.797	1.33

IMPACT TEST

Impact strength testing is an ASTM standard method of determining impact strength. A notched sample is generally used to determine impact strength. Impact is a very important phenomenon in governing the life of a structure. In the case of aircraft, impact can take place by the bird hitting the plane while it is cruising, during take - off and landing there is impact by the debris present on the runway

IMPACT STRENGTH

In our Project Impact Strength determined through impact testing machine by charpy method. Specification of the machine and Size of the specimen

Energy Range	=	0 – 300 J
Least Count (1 Division)	=	2J
Specimen size	=	10 X 10 X 55 mm
Notch	=	V NOTCH

Notch Depth	=	2mm

6.3 IMPACT RESPONSE FOR EACH LEVEL OF THE PROCESS PARAMETER

Response Table for Signal to Noise Ratios Larger is better

Table 6.3 level of the process parameter

Level	PEAK	BASE	GFR
1	23.57	24.30	23.98
2	25.50	23.99	23.50
3	25.44	26.22	27.04
Delta	1.93	2.23	3.54
Rank	3	2	1

Table 6.4 Response Table for Means

Level	PEAK	BASE	GFR
1	16.33	17.00	16.33
2	19.00	16.33	15.33
3	19.00	21.00	22.67
Delta	2.67	4.67	7.33
Rank	3	2	1

Table 6.5 General Linear Model: IS versus PEAK, BASE, GFR

Factor	Type	Levels Values
PEAK	Fixed	3 130, 150, 170
BASE	Fixed	3 20, 25, 30
GFR	Fixed	3 4, 5, 6

Table 6.6 Analysis of Variance for IS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	adiMS	F	P	% OF CONTRIBUTION
PEAK	2	14.22	14.22	7.11	0.30	0.768	7
BASE	2	38.22	48.76	24.38	1.04	0.491	19
GFR	2	105.42	105.42	52.71	2.24	0.308	52

Error	2	47.02	47.02	23.51			22
Total	8	204.89					100

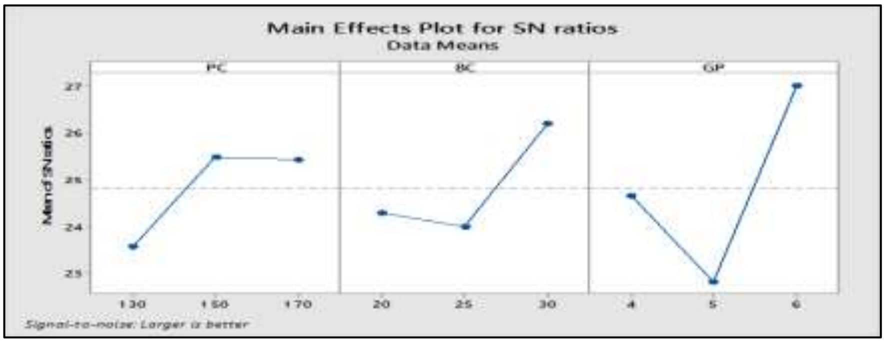

Fig no 6.3 Main effects plot for SN ratios

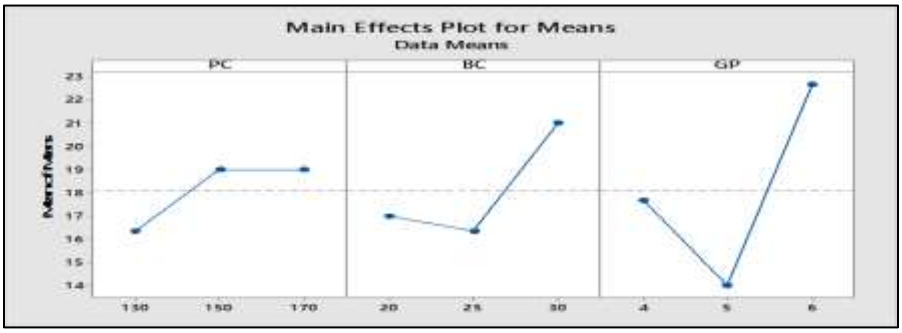

Fig no 6.4 Main effects plot for means

Taguchi Analysis: IMPACT versus PC, BC, GP

Response Table for Signal to Noise Ratios Larger is better

Level	PC	BC	GP
1	23.57	24.30	24.67
2	25.50	23.99	22.81
3	25.44	26.22	27.04
Delta	1.93	2.23	4.23
Rank	3	2	1

Response Table for Means

Level	PC	BC	GP
1	16.33	17.00	17.67
2	19.00	16.33	14.00
3	19.00	21.00	22.67
Delta	2.67	4.67	8.67
Rank	3	2	1

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
PC	2	14.22	7.111	0.37	0.732
BC	2	38.22	19.111	0.98	0.504
GP	2	113.56	56.778	2.92	0.255
Error	2	38.89	19.444		
Total	8	204.89			

Model Summary

S R-sq		R-sq(adj)		R-sq(pred)		
4.40959 81.02%			24.08 %	0.00%		
Term Constant PC	Coef 18.11	S E	Coef 1.47	T-Value 12.32	P-Value 0.007	VIF
130	-1.78		2.08	-0.86	0.483	1.33
150	0.89		2.08	0.43	0.711	1.33
BC						
20	-1.11		2.08	-0.53	0.646	1.33
25	-1.78		2.08	-0.86	0.483	1.33
GP						
4	-0.44		2.08	-0.21	0.851	1.33
5	-4.11		2.08	-1.98	0.187	1.33

Regression Equation

IMPACT = 18.11 - 1.78 PC_130 + 0.89 PC_150 + 0.89 PC_170 - 1.11 BC_20 - 1.78 BC_25

+ 2.89 BC_30 - 0.44 GP_4 - 4.11 GP_5 + 4.56 GP_6

7. DEPTH OF PENETRATION

Inadequate weld bead dimensions such as shallow depth of penetration may contribute to failure of a welded structure since penetration determines the stress carrying capacity of a welded joint .To avoid such occurrences the input or welding process variables which influence the weld bead penetration must therefore be properly selected and optimized to obtain an acceptable weld bead penetration and hence a high quality joint.

VIEW OF TEST PLATE -1

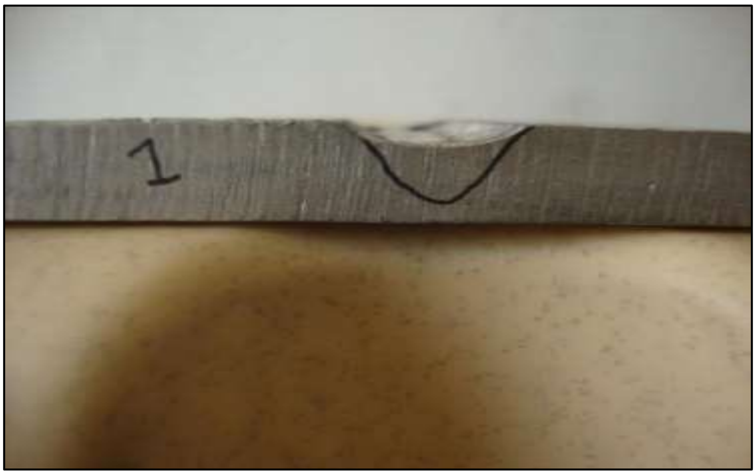

Fig no 7.1 view of test plate-1

PEAK CURRENT-130 BASECURRENT-20 GAS PRESSURE-4

VIEW OF TEST PLATE -2

Fig no 7.2 view of test plate-2

PEAK CURRENT-130 BASECURRENT-2 5 GAS PRESSURE-5

VIEW OF TEST PLATE -3

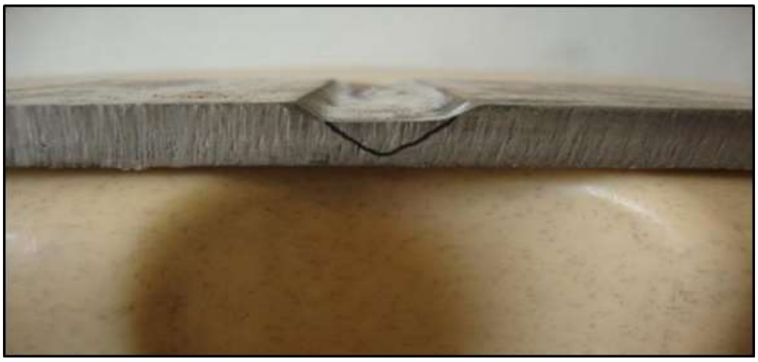

Fig no 7.3 view of test plate-3

PEAK CURRENT-130 BASECURRENT-30 GAS PRESSURE-6

VIEW OF TEST PLATE -4

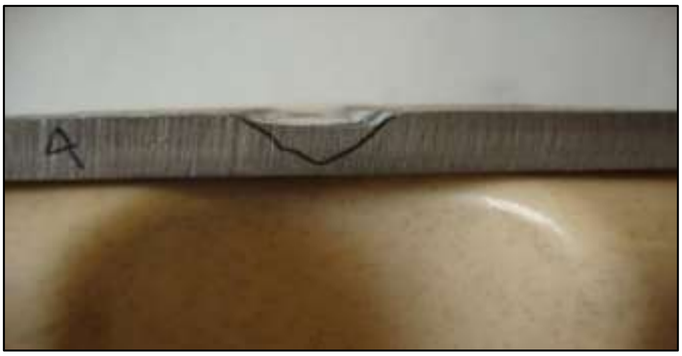

Fig no 7.4 view of test plate-4

PEAK CURRENT-150 BASECURRENT-20 GAS PRESSURE-5

VIEW OF TEST PLATE -5

Fig no 7.5 view of test plate-5

PEAK CURRENT-150 BASECURRENT-25 GAS PRESSURE-6

VIEW OF TEST PLATE -6

Fig no 7.6 view of test plate-6

PEAKCURRENT-150 BASECURRENT-30 GASPRESSURE-4

VIEW OF TEST PLATE -7

Fig no 7.7 view of test plate-7

PEAK CURRENT-170 BASECURRENT-20 GAS PRESSURE-6

VIEW OF TEST PLATE -8

Fig no 7.8 view of test plate-8

PEAK CURRENT-170 BASECURRENT-25 GAS PRESSURE-5

7.1 NON-DESTRUCTIVE TESTING

Non-destructive Test and Evaluation is aimed at extracting information on the physical, chemical, mechanical or metallurgical state of materials or structures. This information is obtained through a process of interaction between the information generating device and the object under test. The information can be generated using X-rays, gamma rays, neutrons, ultrasonic methods, magnetic and electromagnetic methods, or any other established physical phenomenon. The process of interaction does not damage the test object or impair its intended utility value.

7.2 NON –DESTRUCTIVE TESTING TECHNIQUES

NDT Methods range from the simple to the intricate. Visual inspection is the simplest of all. Surface imperfections invisible to they may be revealed by penetration or magnetic methods. If serious surface defects are found, there is often little point in proceeding further to the more complicated examination of the interior by other methods like ultrasonic or radiography.

The principal NDT methods are Visual or optical inspection, Dye penetrant testing, Magnetic article testing, Radiography testing and Ultrasonic testing.

ASNT - American Society for Nondestructive Testing

ISNT - International Society for Non destructive Testing

CWI - Certified Welding Inspector

NDT - Non Destructive testing

NDE - Non Destructive Evaluation

NDI - Non Destructive Inspection

Level –I work under the supervision.

Level-II Calibrate, Test, Interpret and evaluate with respect to code and standard.

Level –III Establish techniques and procedures for specific processes.

7.3 ULTRASONIC RESULT

MACHINE SPECIFICATION UT INSTRUMENT : PX20

Transducer angle: 70º Technique: pulse echo Material: D3 Thickness: 10mm

Table.7.1 Ultrasonic result

S.NO	PEAK CURRENT	BASE CURRENT	GAS PRESSURE	INDICATIONS
1.	130	20	4	ICP &Por
2.	130	25	5	ICP
3.	130	30	6	Cr

4.	150	20	5	ICP &Por
5.	150	25	6	NI
6.	150	30	4	EP
7	170	20	6	Sl
8	170	25	4	Cr
9	170	30	5	Cr

8. CONCLUSION

TIG welding can be used successfully to join AL6061 .The processed joints exhibited better mechanical and metallurgical characteristics. The joints exhibited 90-95% of parent material's Hardness value. The specimen failures were associated depending upon the improper changes of heat value; it creates so many metallurgical defects and it is identified by using NDT testing. In our experiment we found out the input parameter value 150 PC/25 BC &Gas pressure 6 Kg/cm² is the best value and it does not create any major changes and failures in the testing process .Finally we concluded the suitable input parameter for AL 6061 material of 10 mm thickness in GTAW welding process According to the Taguchi design optimized parameter for maximum tensile strength.

OPTIMAL CONTROL FACTOR

1.Impact strength- A3(Peak current -170AMPS)B2(Base current -25 AMPS)C1(Gas pr- 4Kg/cm²)

According to the Taguchi design optimized parameter for minimum Hardness

2. Hardness-A2 (Peak current -150AMPS) B1(Base current -20)C3(Gas flow rate-6Lit/min)

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