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Radiographic Analysis and Effect of Butt Angles on Mechanical Properties of TIG Weldments on Aluminium Alloy(Al6061 and Al 2014)

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Abstract-In current industrial sectors, the most predominant used material is aluminium alloy owing to their very less weight and rust constraint. At the outset, an aluminium compounds 6061is amalgamed with Mg & Si alloys possess high strength and high rust constraint nature and no stress corrosion cracking, which are helpful in aerospace industry and marine industry. On other side another aluminium alloy 2014 is amalgamed with Cu which possesses high stress corrosion cracking. TIG welding is one of the exact strategies which is utilized to weld aluminium combinations. From the writing study it has discovered that Welding current, Welding voltage, Welding speed and the gas stream rate are the fundamental info parameters which impact the mechanical properties of aluminium 6061 amalgam. In this paper, authors made investigation on effect of process parameters on weldments of two dissimilar aluminium alloys(Al6061 and Al2014) on mechanical properties and microstructure of weldments were analysed b radiographic analysis.two different groove angles were taken on base metals 30^0,45^0 to assess the trend of morphology and quality of weldments. Finally, conclusions were depicted.

Keywords : *aluminium alloy, TIG welding, welding parameters,Al6061, Al2014*

1. Introduction

Aluminium and its combinations are utilized in manufactures due to their low weight, great erosion opposition and weldability. This supports the utilization[1] of aluminium and its amalgam in aeronautic trade, inner ignition engine parts, craft building and so on. Welding being most broadly utilized joining technique can be utilized for welding aluminium. Tungsten inactive gas welding (TIG) and metal inert gas welding (MIG) are regularly utilized for aluminium. In this examination TIG welding is utilized since TIG welding procedure offers extraordinary points of interest, for example, neatness, metal deposit rate, heat input and so forth Tungsten inactive gas welding (TIG) is a procedure that melts and joins metals by warming them with a bend set up between a non-consumable tungsten anode and the metals. The light holding the tungsten anode is associated with a protecting gas chamber just as one terminal of the power source. The work piece is associated with the other terminal of the power source through an alternate link as appeared in Figure 1. The protecting gas experiences the light body and is coordinated by a spout toward the weld pool to shield it from the air. By and large argon and helium are utilized. A blend of inactive protecting gas and some measure of oxygen or CO_2 can be utilized, which influences the weld infiltration.

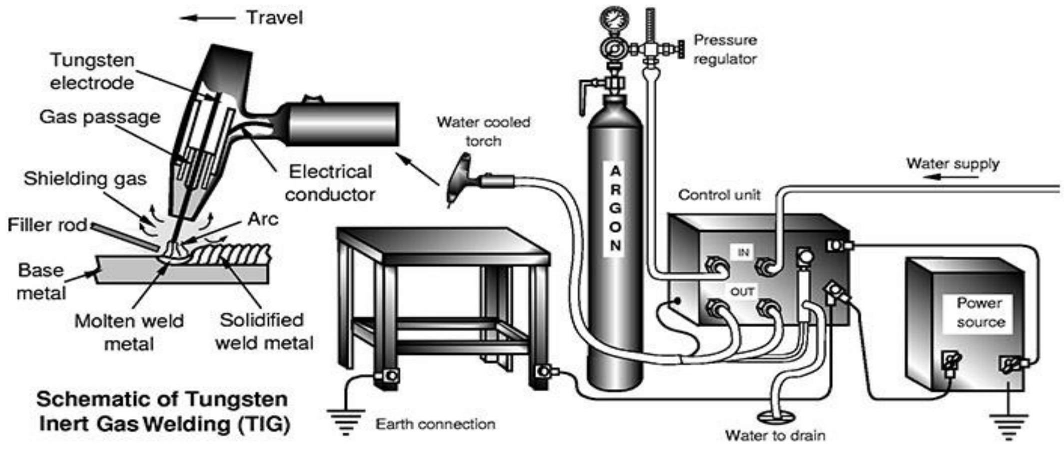

Fig.1 TIG Welding Process

2. Materials and methods

Aluminium

Aluminium is alloyed with a scope of different metals to change its properties to suit explicit applications. 1. Aluminium is light weight and around 33% the heaviness of steel Aluminium has high warm conductivity to multiple times that of steel] which means warmth is effectively directed away from the welding territory. It is fundamental that the warmth source is amazing enough to quickly arrive at aluminium's low softening purpose of 565/650ºC. Welding hot and quick as a rule gives the best outcomes. Overwhelming segments are best preheated to lessen the impact of quick heat misfortune. Aluminium's coefficient of warm development is high [2][twice that of steel] so it is inclined to contortion and stress affectation if the best possible welding methodology isn't followed[3]. Aluminium doesn't change shading when warmed.

Composition & Properties of Aluminium alloys

Here two alloys of aluminium is considered for work, those are Al 6061 and Al2014, the following are the compositions and properties of Al 6061 and Al2014

Table 1: composition of Al6061

S.no	Composition	Minimum(%)	Maximum(%)
1	Silicon	0.4	0.8
2	Iron	0	0.7
3	copper	0.15	0.4
4	manganese	0	0.15
5	magnesuim	0.8	1.2
6	chromium	0.04	0.35
7	zinc	0	0.25
8	Titanium	0	0.15
9	Other elements	0.05	0.15
10	Aluminium	95.85	98.56

Table 2: Physical, Mechanical and Thermal Properties of 6061

Physical properties	**Density**	**2.70g/cm3**
Mechanical Properties	**Young's Modulus**	**68.9GPa**
	Tensile Strength	124–290 MPa
	Elongation (ε) at break	12–25%
	Poission's Ratio	0.33
Thermal Properties	**Melting Temperature(T_m)**	585 °C (1,085 °F)
	Thermal Conductivity(k)	151–202 W/(m·K)
	Specific Heat Capacity©	897 J/ (kg·K)

Table 3: composition of Al2014

S.no	**Composition**	**Minimum(%)**	**Maximum(%)**
1	Silicon	0.5	1.2
2	Iron	0	0.7
3	copper	3.9	5
4	manganese	0.4	1.2
5	magnesuim	0.2	0.8
6	chromium	0	0.1
7	zinc	0	0.25
8	Titanium	0	0.15
9	Other elements	0.05	0.15
10	Aluminium	90.45	94.95

Table 4: Physical, Mechanical and Thermal Properties of 2014

Physical properties	**Density**	2.80g/cm3
Mechanical Properties	Young's Modulus	73GPa
	Tensile Strength	190–480 MPa
	Electrical conductivity	34 to 50%IACS
Thermal Properties	Thermal Conductivity(k)	130-190 W/m-K
	Thermal Expansion	23 µm/m-K.

3. Non Destructive Methods

The six most frequently used NDT methods [4] are

- Magnetic-particle inspection,
- Radiographic inspection,
- Ultrasonic inspection, etc

Among the above authors have used Radiographic Inspection to diagnose the porous hole in TIG Weldments

4. Results and Discussions

Weldments and Welding Parameters

Welding equipment MILLER 160 semiautomatic TIG equipment with direct current, power source with a 160 A capacity was used to join the AL- plates of size 100 mm *70mm *14 mm .

Fig 2 : MILLAR 160 Semi Automatic TIG Welding Machine

Fig 3: weldments for 30- and 45-degree angles

Deposition Rate

The deposit rate of a welding consumable (terminal, wire or pole) is the rate at which weld metal is stored (softened) onto a metal surface. deposit rate is communicated in kilograms per hour (kg/hr).Deposition rate depends on nonstop activity, when welding current is expanded so does the deposit rate[5],[6],]7]. At the point when electrical stick out is expanded for the situation the deposit rate will likewise expanded.

Table 5 Shows Deposition Rate (Kg/hr)

Experiment No(Work Samples)	Deposition Rate		Deposition Mean Value	Deposition S/N Ratio
	1st Run	2nd Run		
1	0.257	0.249	0.253	-11.941

2	0.140	0.149	0.145	-16.815
Average			0.199	-14.378
Maximum			0.253	-11.941
Minimum			0.145	-16.815

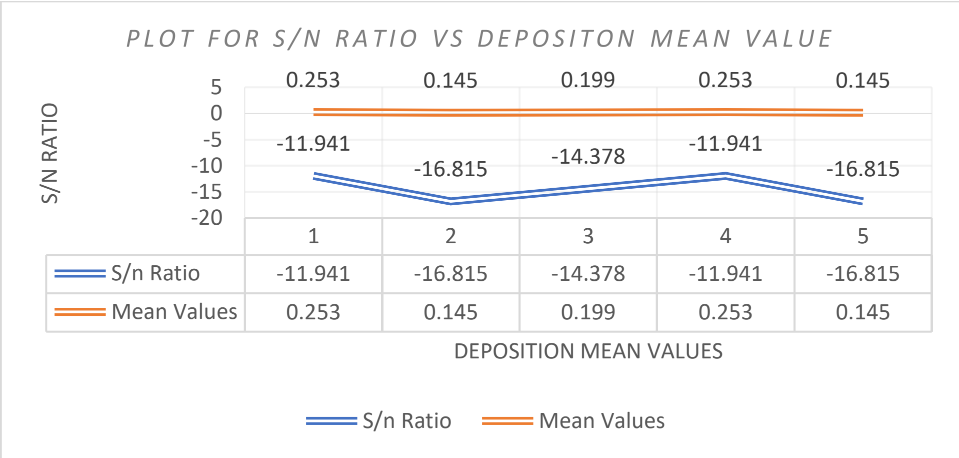

Fig 3: S/N Ratio v/s Deposition mean values

Table 6 Weld Parameters For Joining of AL-Plates

Run Order	Welding Speed (cm/min)	Current (Amps)	Gas flow rate (lit/min)
	S	I	F
1	25.0	274	15.0
2	22.5	259	15.0
3	20.0	274	20.0
4	22.5	259	20.0

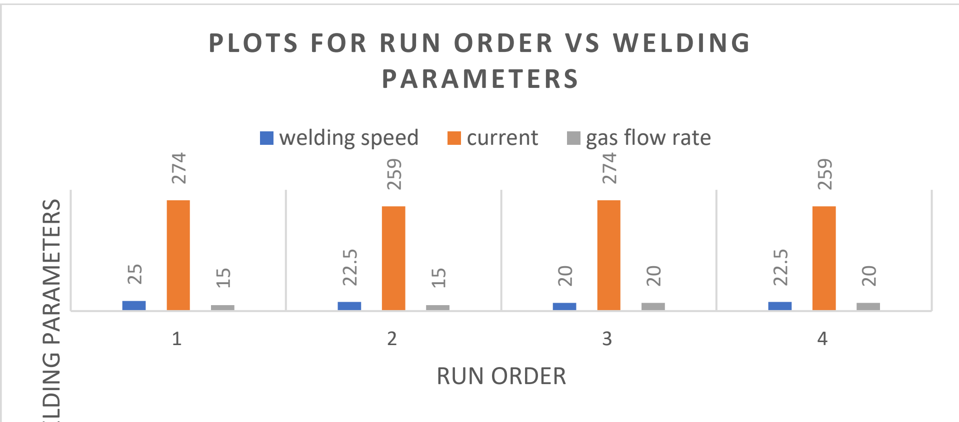

Fig4: Run order vs weld speed, Current, Gas flow rate

Inferances: From table 5 and 6 and fig 3 and 4 it is observed that Deposition rates on work material is calculated by two trials with deposition mean value. Further Signal to noise ratio also determined for two welding samples.

Radiography Results For Aluminium Welded Paltes

Plate 1: At 30^0

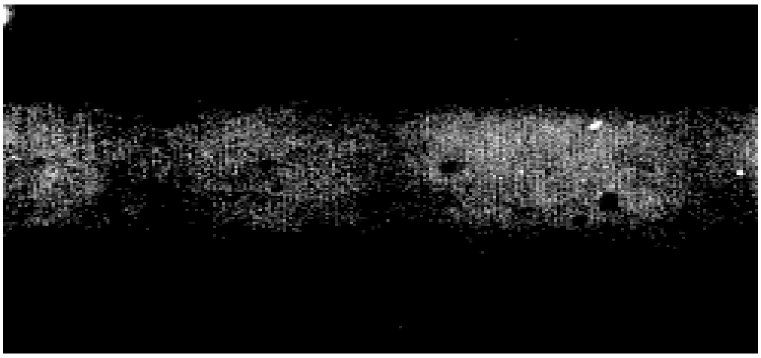

Fig 5: 2 Pores per Sq. Inch

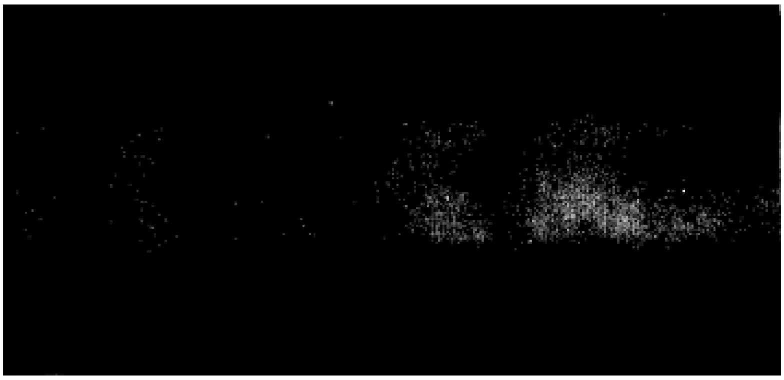

Fig.6: 4 Pores per Sq. Inch

Plate 2 : At 45

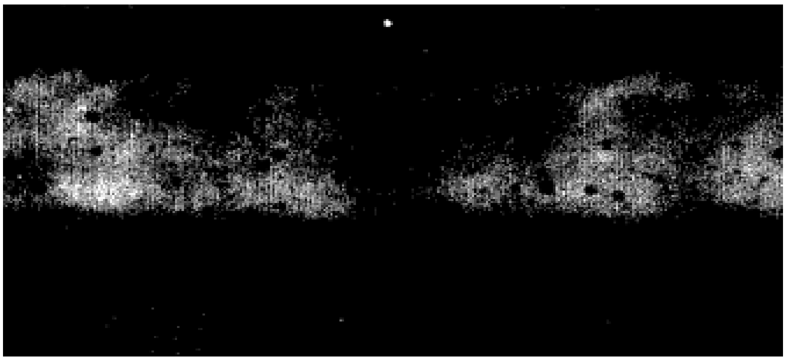

Fig 7: 8 Pores Per Sq. Inch

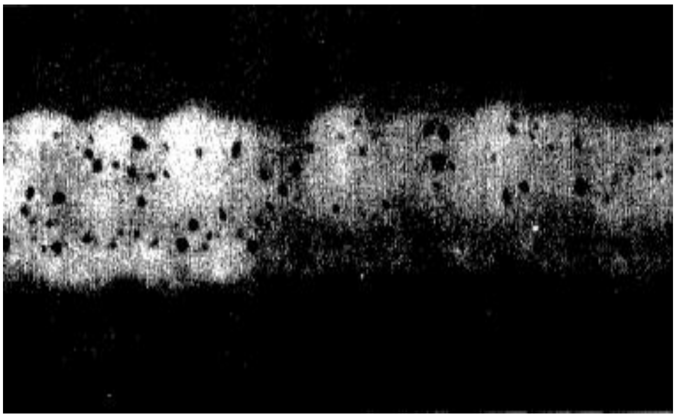

Fig 8: 16 Pores Per Sq. Inch

Inferances: Radiography test results are depicted thru fig 5,6,7 & 8 and it is observed that for angle 30 degree pores per square inch is less than for a angle 45 degrees because the air entrapment during welding is more for large dove tail angle which is required for accumulation filler materials. From the above radio graphic images , it is evident that the porosity for smaller angle is minimum per sq.in and maximum for larger angle

Load Testing (Tensile Strength)

Uniaxial tensile test is known as a basic and universal engineering test to achieve material Parameters such as ultimate strength, yield strength, % elongation, % area of reduction and Young's Modulus. These important parameters obtained from the standard tensile testing are useful for the selection of engineering materials for any applications required. The tensile testing is carried out by applying longitudinal or axial load at a specific extension rate to a standard tensile specimen with known dimensions (gauge length and cross sectional area perpendicular to the load direction) till failure.

Fig 8 : Universal Testing machine

Table 7: shows Weld Strength At Different Bead Angles

Material	LOAD	Total deformation	max stress	max strain
Plate1 – 30^0	60	0.13185	41.5	0.000181
Plate 2 – 45^0	60	0.4004	42.38	0.000616

Fig 9: specimens after tensile testing

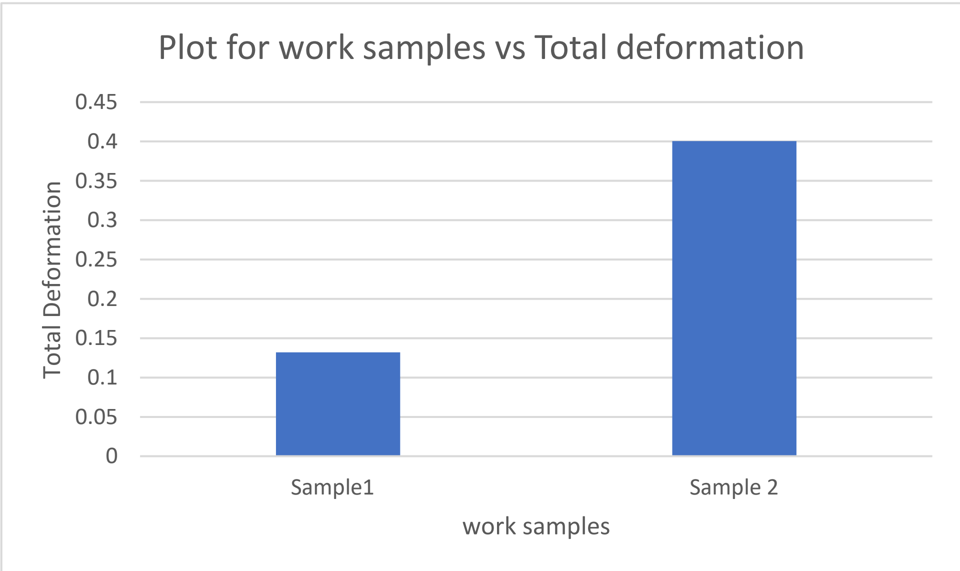

Fig 9: Plot for work samples vs Total deformation

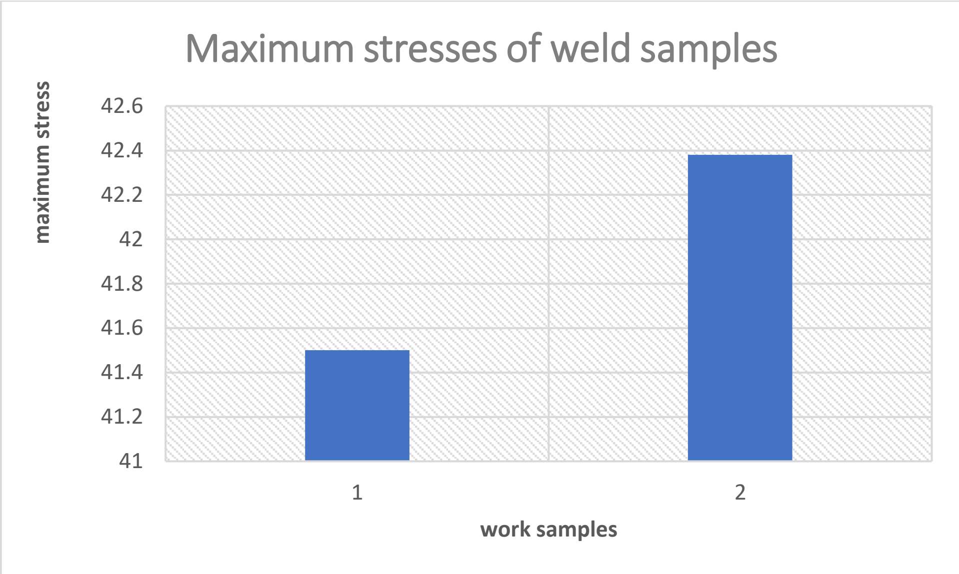

Fig 10 : Plots for maximum stresses induced in each sample

Inferances: Tensile strength results were shown in table 7 and Fig 9 and 10, here it is understood that total deformation is less and maximum stress is more for sample 1(30^0 than sample 2(45^0). Hence sample 1 is best due to less porosity with minimum butt dove tail angle(30^0).

5. Conclusion

The experimental work is focused on radiographic analysis of Tig weldment along with mechanical properties like deformation, maximum stress induction. By experimental investigation it is conclude that for little butt angle , porus holes per square inch is minimum. Further total deformation and maximum stress is also minimum for Sample 1 which has butt angle 30^0 due to less pores per sq.inch in weldment.

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