

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

Analysis on Mechanical Properties of Gas Tungsten arc Welded Aluminium Alloy (Al6063-T6)

R. Ramesh Babu¹, R.Ganesh², G. Gunaseelan³, M. Harish⁴, J. Kingsley⁵, B. Senthil Kumar⁶,

Assistant Professor, Department of Mechanical Engineering, Indra Ganesan College of Engineering, Tiruchirappalli,
Tamilnadu, India.^{1,2}

UG Students, Department of Mechanical Engineering, Indra Ganesan College of Engineering, Tiruchirappalli,
Tamilnadu, India.^{2,3,4,5}

ABSTRACT: The aluminium alloy (Al6063-T6) is used in a wide range of applications due to its weldability, surface smoothness and lightweight allowing complex shapes to be formed and welded with ease. This report investigates the variation in mechanical properties due to the alteration in parameters when the aluminium alloy is welded using gas tungsten arc welding (GTAW). The welding is carried out by varying the welding parameters to document various samples in each trial. Then the weld bead samples are then tested for its mechanical strength of the weld is compared to the structure of the parent metal. We also analyze how the welding process parameters would affect the microstructure of the weld bead when compared to the parent metal of the aluminium Alloy (Al6063-T6).

KEYWORDS: Gas Tungsten Arc Welding (GTAW), Mechanical Properties, Microstructure Analysis, Aluminium alloy (6063- T6), Tungsten Inert Gas (TIG), Weld Penetration.

I. INTRODUCTION

Aluminium combinations are notable for their applications in manufacturing industries. Al6063-T6 is an aluminium alloy with magnesium and silicon as the alloying components. It has commonly great mechanical properties and is heat treatable and weld able too. Welding is a joining process used to join different materials like metals, composites or plastics, together at their achieving surfaces by usage of warmth or possibly weight.

Weld limit of a material depends upon different segments like the metallurgical changes that occur in the midst of welding, changes in hardness in weld zone in light of speedy solidifying, level of oxidation on account of reaction of materials with natural oxygen and tendency of split game plan in the joint position. In TIG welding, the electric arc is produced between a non-consumable tungsten electrode and the work piece. There is an electrode holder in which the non-consumable tungsten electrode is fixed. By supplying the electric power between the electrode and the work piece, the insert gas from the cylinder passes through the nozzle of the welding head around the electrode.

The insert gas surrounds the arc and protects the weld from atmospheric effects and hence defect free joints are electrode. The insert gas (argon) surrounds the arc and protects the weld from atmospheric effects and hence defect free joints are made. This process is also called as Gas Tungsten – Arc welding (GTAW)

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

Tungsten inert gas welding

Tungsten Inert Gas (TIG) shown in (Fig. 1.1) welding utilizes the heat created by an electric flux between a non-Consumable tungsten terminal and the work piece in contact metal in the joint region and produce a liquid weld pool. The weld zone is covered in an inactive or diminishing gas shield to ensure the weld pool and the non-consumable cathode. The procedure might be worked autogenously, that is, without filler to the built up the weld pool. TIG creates extremely top notch welds over a wide scope of materials with thicknesses up to around 3 Or 5 mm. It is especially appropriate for sheet material.



Fig 1.1 TIG welding machine

Chemical composition

Elements	% of composition
Silicon	0.2–0.6
Iron	0.35
Copper	0.10
Manganese	0.45–0.9
Magnesium	0.10
Chromium	0.10
Zinc	0.10
Titanium	0.10
Aluminium	Remaining

Table 1.1. Chemical Composition

Al 6063 is an aluminium alloy, with magnesium and silicon as the alloying elements. The standard controlling its

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

composition is maintained by Association. It is generally have good mechanical properties and is heat treatable and weld able. The Alloying composition of Aluminium 6063 is shown in (Table 1.1).

Physical properties

Properties	Values
Density	2.69g/cm ³
Young's modulus	6.38 GPa
Tensile strength	145-186 MPa
Elongation of break	18-33%
Poisson ratio	0.3
Melting temperature	615°C
Thermal conductivity	201-218 w/mk
Specific heat capacity	900 J/Kgk
Volume resistivity	30-35Ωm

Table 1.2. Physical Properties

AL 6063-T6 temper has an ultimate tensile strength of at least 190 MPa and yield strength of at least 160 MPa. If the thickness of the material is 3.15mm or less, then it has an elongation of 8% or more and in its thicker sections it has an elongation of 10%.

II. EXPERIMENTAL PROCEDURE

The Aluminium alloys (Al 6063-T6) of dimension 100*100*3 mm has been taken and welded in butt joint by using gas tungsten arc welding process. A non-consumable tungsten carbide rod of 2.4mm is used as the welding electrode to perform the weld. The base metal is prepared by removing the surface impurities prior to the welding process.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020



Fig 2.1. Al 6063-T6 Base Metal

2.1. Penetration Test

Weld penetration is the formation of weld bead in the distance that the fusion line extends below the surface of the material being welded. Welding current is of primary importance to penetration. The weld penetration parameters for the test in Al6063- T6 is as shown in (Table2.1).

Phase/Trail	Current (A)	Voltage (V)	Travel speed (mm/sec)	Gas flow rate (kg/sec)	
I	1	60	14.3	200	15
	2	80	14.7	200	15
	3	100	14.2	200	15
II	4	60	14.2	150	15
	5	80	13.2	150	15
	6	100	13.6	150	15
III	7	60	13.3	100	15
	8	80	12.7	100	15
	9	100	13.33	100	15

Table 2.1. Weld penetration

The current and travel speed of the welding process are varied in order to obtain the parameter at which the proper weld penetration occurs. From the penetration test we find that the weld parameters at phase III/trail 9 gives us a properly penetrated weld bead.

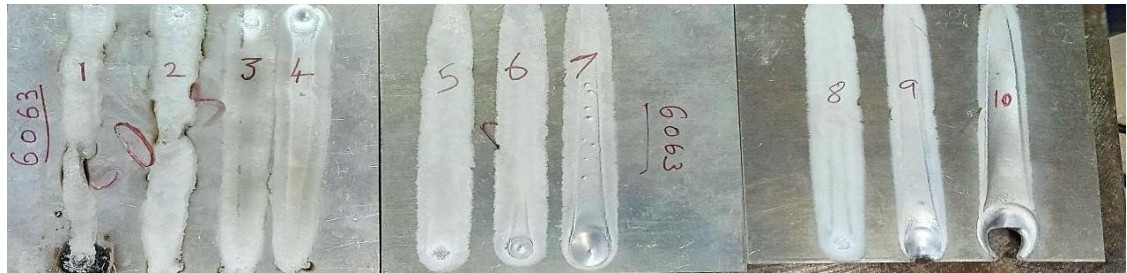


Fig 2.1. Penetration of weld specimen

Weld parameters

The initial parameters of the welding process are obtained from the analyzed values of the penetration test. The aluminium alloy of Al6063-T6 shown in (Fig. 2.2) has been welded in butt joint. Argon gas is used as the inert gas shield for the weld bead to be protected from oxidation during the welding process. The welding process is proceeded by varying the parameters such as current, inert gas flow rate and voltage applied. After the welding process carried out, the welded sample is carried out with different mechanical behavior and microscopic structure analysis such as hardness test, tensile test and microstructure analysis.



Fig 2.2. Weld Sample 1



Fig 2.3. Weld Sample 2



Fig 2.4. Weld Sample 3

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

The above welded samples are made by changing the various welding process parameters. For each samples different current, voltage and inert gas flow rate are varied. The various changes for each sample is shown in (Table 3).

Sample	Current (A)	oltage (V)	ravel speed (mm/sec)	s flow rate (kg/sec)
1	100	13.33	100	15
2	130	14.4	100	20
3	150	18.9	100	25

Table 2.2 Weld samples parameters

III. EXPERIMENTAL WORK

In this work various samples of weld parameters of TIG welded Aluminium alloy are examined by conducting the following tests.

- Hardness Test with Vickers Hardness Testing Machine.
- Tensile test by using Universal Testing Machine.
- Microstructure analysis

Hardness test (Micro Vickers hardness test)

Micro Vickers hardness test was conducted by less than 1N value of load and the indentation depth of <70-100µm. generally the above test conducted only when the result have great accuracy and precision. The measurement of hardness value generally expressed by HV.

$$HV = 1854.4 (P/d^2) N/mm^2$$

The diamond indenter was used and the angle of square base 136 degree between the opposite faces subjected to a load of 1 - 100 N .the full load normally applied between the 10-15 seconds. The depth of indenter was converted into a HV value. The main purpose of the test was identified the hardness value of the material.

Tensile test

Tensile test is performed on welded sample as shown (Figs. 3.1). The after effects of malleable tests are utilized in choosing materials for designing applications. Malleable properties much of the time are incorporated into material details to guarantee quality. Ductile properties frequently are estimated amid advancement of new materials and forms, with the goal that various materials and procedures can be looked at. At last, elastic properties regularly are utilized to foreseen the conduct of a material under types of stacking other than uniaxial strain. These proportions of solidarity are utilized, with suitable alert (as security factors), in designing structure. Likewise, of intrigue is the material's pliability, which is a proportion of the amount it very well may be twisted before it cracks. The dimensions of the dogbone specimen are taken as overall length of 160mm, gauge length of 60mm, grip section width of 20mm and fillet radius of 10mm.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020



Fig 3.1. Tensile Test Samples

IV. RESULT AND DISCUSSIONS

Micro Vickers hardness test analysis

The test samples are subjected to Hardness test using the diamond indenter. Each sample was tested at three locations with the test specimen being subjected to a load of 0.05 MPa for a dwell time of 10 s for each location and the results are shown in (Table 4.1)

Amb.temp:25.4 °C

Properties	Parameter	Location	Sample 1	Sample 2	Sample 3
HV 0.05	Parent metal	1	27.9	19.4	22.6
		2	25.5	33	23.8
		3	22	29.3	30.2
	Average		25.13	27.23	25.53
	Weld metal	1	33.4	47.9	44
		2	31.6	43.4	45.1
3		38.5	50.7	44.5	
Average		34.5	47.33	44.53	

Table 4.1

From the above observation of various samples values the sample 2 have greater average hardness value than other samples. We conclude that the sample 2 have more indent to penetration.

Tensile test analysis

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

The results from testing the samples using the universal testing machine to perform tensile test under continuous load are shown in table 4.2

Sample	Parameter	Observed values
1	Ultimate tensile strength(MPa)	14.09
2		38.82
3		74.78

Table 4.2

From the above observation of various samples value of ultimate tensile strength. The sample 3 has more ultimate tensile strength than other samples.

Microstructure analysis

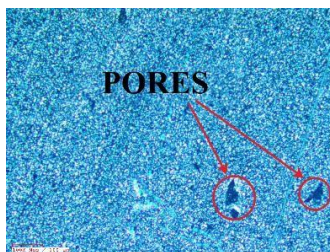


Fig 4.1. Porosity of Base Metal

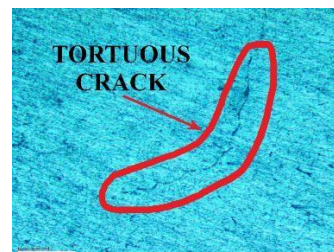


Fig 4.2. Tortuous Crack in Weld Bead

From the observed samples of the parent metal we can find a number of pores present on the surface of the metal in higher volume. Whereas in the weld bead the presence of pores is comparatively lower hence resulting in a higher surface hardness in the weld bead. The formation of tortuous crack in the weld bead after the welding process is the result of reduced volume of pores. This can in turn affect the weld bead by reducing its tensile strength.

V. CONCLUSION

- The tensile strength of the AL6063-T6 samples are directly proportion to the current with which the materials are welded having sample 3 achieve the highest tensile strength in the samples.
- The surface hardness value in the experiment results in the highest reading in sample 2 and the hardness of the forthcoming sample is reduced due to the further increase in the weld current.
- Due to the reduction of pores in the weld samples when compared to the parent metal which contain a higher volume of pores increases the surface hardness of the weld bead.
- The formation of tortuous cracks in the weld bead reduces the tensile strength of the weld sample. The increase in weld current reduces the tortuous crack formation thus increasing the tensile strength of the weld sample.

REFERENCES

1. S. Vijay, S. Rajanarayanan and G. N. Ganeshan, Analysis on mechanical properties of gas tungsten arc welded dissimilar aluminium alloy (Al2024 & Al6063).
2. T. Watanabe, H. Takayama, A. Yanagisawa, Joining of aluminum alloy to steel by friction stir welding, J. Mater. Process. Technol. 178 (2006) 342–349.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

3. Peng Liu, Yajiang Li, Haoran Geng, Juan Wang, Microstructure characteristics in TIG welded joint of Mg/Al dissimilar materials.
4. W.S. Miller, L. Zhuang, J. Bottema, A.J. Wittebrood, et al., Recent development in aluminum alloys for the automotive industry, Mater. Sci. Eng. A 280 (2000)37–49.
5. M.Srivatsava, Gopal Vanga, G. Narendra Santosh Kumar, Experimental Study of Mechanical Properties of 5083 Aluminium Alloy Using Gas Tungsten Arc Welding.
6. X. Luo, J. Ren, D. Li, Y. Qin, et al., Int. J. Adv. Manuf. Technol. 87 (2016) 1105– 1113.
7. W.H. Jiang, R. Kovacevic, Feasibility Study of Friction Stir Welding of 6061-T6 Aluminium Alloy with AISI 1018.
8. R.S. Mishra, Z.Y. Ma, Friction stir welding and processing, Mater. Sci. Eng. R50 (2005) 1–78.
9. Swapnil Verma, Sidharth Singh, Shubham Govil, Neha Bhadauria, A Review on the Optimization of Parameters of Gas Tungsten Arc Welding of Aluminium and Aluminium Alloys.
10. N. Karunakaran, V. Balasubramaniam. Effect of pulsed current on temperature distribution, weld bead profiles and characteristics of gas tungsten arc welded aluminum alloy joints, Trans Nonferrous Mat. Soc., China 21, 2011, 278-286.
11. Ahmad Khalid Hussain, et.al. Influence of Welding Speed on Tensile Strength of Welded Joint in TIG Welding Process, International Journal of Applied Engineering Research, Dindigul 1(3), 2010, 518-527.
12. Rahul varshney, Experimental investigation for process optimization during Gas metal arc welding of Al-6063 alloy.