

**WELDING LIMITATION ON TIG WELDING OF AA6061-T6 WITH FILLER
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ABSTRACT:- To develop welding quality of Aluminum Alloy (AA6061-T6) plate, an programmed TIG welding system has been developed, by which welding speed could be control as welding procedure. Tungsten Inert Gas welded joints find application in many areas like ship Building, offshore constructions and transportation industries Welding of AA6061-T6 plate with filler rod ER4043 has been performed. Optical microscopic investigation has been done on the weld area to appraise the effect of welding sample on welding value. The joining of the AA6061-T6 with filler wire ER4043. The assuasive of the weld is comparatively more comparing to the hardness of the cross sections. We have recognized the appropriate range of current, the thickness of the base metal, the gauge of electrode, the opus of electrode and filler wire, the gas flow rate required for extremely good TIG welding method.

KEY WORDS: Filler Rod ER4043, Tungsten Inert Gas Welding, AA6061-T6.

1. Introduction:- Wrought Al–Mg alloys are used as structural materials in marine, automotive, aircraft and cryogenic applications. These materials exhibit their strength mainly from solid solution strengthening by Mg, which has a substantial solid solubility in aluminium. Al–Mg–Si alloy, one of the widely used heat-treatable alloys, is choice for medium-to-high-strength requirements and has good toughness characteristics. The major alloying elements magnesium (Mg) and silicon (Si) increase the strength of the alloy through precipitation hardening. In the TIG welding process, the arc and the weld are protected from atmospheric contamination by a gas shield and an electric potential is established between the electrode and the work piece causing a current flow, which generates thermal energy in the partially ionizes inert gas. Defects like porosity, loss of strain hardening in the fusion zone, as cast-coarse microstructure, hot cracking in the fusion zone due to segregation of alloying elements during solidification, result in the decrease of mechanical properties. Generally, 6xxx alloys are easily welded by conventional arc welding processes, metal inert gas (MIG) welding and tungsten inert gas (TIG) welding. However, some important characteristics, such as solidification cracking, porosity, heat-affected zone (HAZ) degradation and so on must be considered during welding, due to the greater amount of alloying elements used in commercial alloys. The alloys of the 6xxx series alloys are, for instance, more sensitive to hot cracking. Use of thicker plates due to low strength of the weld metal results in behavior structures. If the yield strength of the weld metal can be increased by some means it will be of use in increasing the payload.

2. EXPERIMENTAL PROCEDURE:- Aluminium alloy AA6061-T6 plate of thickness 3 mm was selected as work piece material for the present experiment. Al plate was cut with dimension of 150 mm x 50 mm with the help of band-saw and grinding done at the periphery to soft the surface to be joined. After that surfaces are polished for remove impurities or external material. After that, Aluminium plates are attach in the working table with movable clamp side by side and welding done hence a butt join could be formed. The electrode tip configuration was a blunt point with a 90degree included angle, the diameter of the electrode is 3.4mm. The argon shielding gas flow rate was (8-10 L/min. Welding current and welding speed have been chosen in such a way that the heat input results in through thickness melting of the plate. After performing the welding, welded work piece be cut into I shape with 100 mm x 25 mm dimension for tensile test. Tensile test is done with universal tensile testing machine (ASTM-600) with load capacity of 5- 600 KN. Further, a 25mm x10mm work piece was cut at the cross section for microstructure observation and micro-hardness measurement from each sample. Micro-hardness was calculated with Vickers micro-hardness tester (ASM 4081 micro hardness tester). Optical image of the cross section of the welded region was taken with an optical microscope. The welding parameters shown in Table.1

Table.1. Welding parameters

Frame-work	Range
Welding current	(100-140) A
Voltage	50 v
Speed	(3.5-4) mm/s
Distance of tip from weld centre	5 mm
Gas flow rate	(8-10) l/min.
Current type	AC
Dimension	150mm*50mm*5mm

The chemical composition of the base metals AA6061-T6 is given in Table.2. The chemical composition of filler rod ER 4043 is shown in Table.3.

Table.2. Chemical Composition of Base metals

Base Metal	Mg	Mn	Fe	Si	Cu	Cr	Zn	Ti	Zr	Al
AA6061-T6	0.812	0.061	0.323	3.01	1.142	0.184	0.072	0.02		94.31

Table.3. Filler Rod Chemical Composition

Filler Rod	Mg	Mn	Fe	Si	Cr	Cu	Zn	Ti	Al
ER4043	0.05	0.05	0.8	4.5 ~ 6	-	0.3	0.1	0.2	Rest

3. RESULTS AND DISCUSSIONS

3.1 Welding width: Welding width of Weld sample is different each sample, when welding current is 100A, 120A, and 140A and welding speed is 3.5mm/s welding width is 4.93mm, 7.94mm, and 10.47mm respectively. If welding speed 4mm/s then welding width is 5.042mm, 8.16mm, and 9.256 respectively. It's clear welding width is directly proportional to welding current and welding speed.

3.2 Surface roughness: Roughness value found in the range 1.2 to 3.5 micron is quite low for a welded sample. Thus it could be say that using an automated system good quality of welding is possible which may not require any further finishing operation.

3.3 Optical microscopic image of HAZ: The weld microstructures were taken at three distinct locations such as weld top, weld middle and weld bottom and also in Figures (c) (d) and (e) The microstructures at the weld top are fine collage to the other two microstructures shown by Figure.(d) and (e). The weld microstructure of middle joint shown by Figure. (d), Is contain rude decorative collage to weld top. The weld microstructure at the bottom of the weld is shown by Figure (e). This microstructure is a coparatively rude than the other two. This microstructure also contain weld defect like cavities and pores.

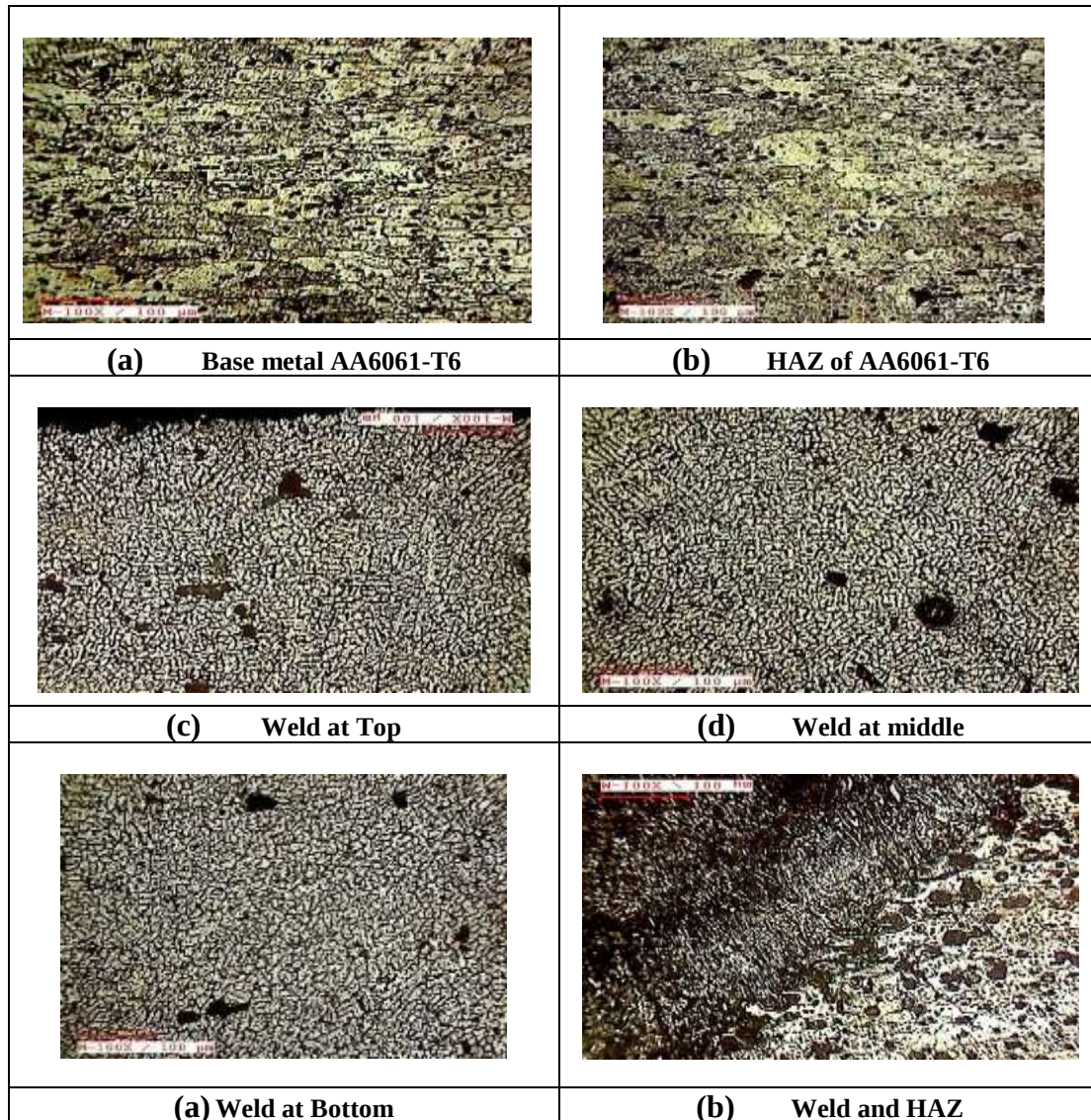
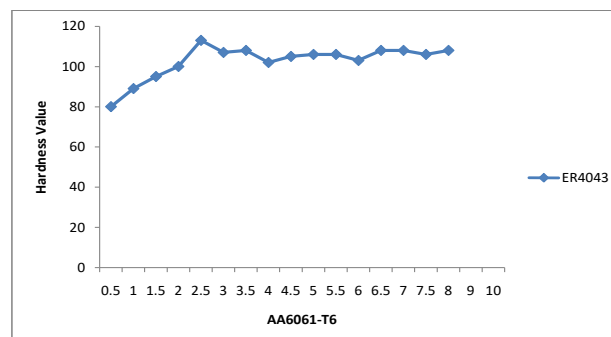


Fig.1 Optical microscopic image of HAZ on welding of AA6061-T6 with ER4043 Filler Rod

3.4 Micro-hardness test: Micro-hardness rate of the welded region was measured for all the welded work piece sample at the cross section to appreciate the transition in mechanical property of the welded region. it is found that for almost all the sample micro hardness value increases in the welding region than the base material and these values are in the range of 80 to 117 HV in the welded region. After then it is reduce a definite distance these value reduces to the hardness of the base material for the sample method with welding speed 3.5 mm/s and unusual current setting



Hardness Survey of TIG welded joints of AA6061-T6 Aluminium Alloy

3.5 Tensile test: The tensile properties of the AA6061-T6 aluminium alloy plates with ER4043 filler rod was found out and listed in Table.4. The welded joint ultimate tensile strength is around 44 MPa. The welded joint efficiency is $(180/325) \times 100 = 55.49\%$.

Table.4. Tensile Properties of AA6061-T6 welded joints

Sample no	Yield Stress, MPa	Actual tensile strength (MPa)
Base Metal- AA6061-T6	265.99	325.08
1		22.92486
2		38.37904
3		39.03343
4		17.48841
5		44.09860
6		18.49082
Avg.		180.41516

CONCLUSIONS: From the experiment of TIG welding of Aluminium alloy AA6061-T6 with ER4043 following conclusion could be made

- The Increase in the hardness on the AA6061 might be owed to formation of large number of Mg_2Si precipitates.
- The hardness values are 5% above the AA6061 base metal values.
- A 45% reduction in tensile strength was observed from the experiment.
- Welding width is vary with 4.9 to 10.47mm.
- Roughness value found in the range 1.2 to 3.5 micron is for a welded sample.

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