Comparison of Mechanical Properties of TIG Welded AA 7075 and AA 6061

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Abstract

In this paper a comparison has been done of mechanical properties of two different TIG welded materials AA 7075 and AA 6061. TIG welding of both the materials has been done by changing the values of gas flow rate and welding current. Ultimate tensile strength and hardness of weldments of both the materials has been measured. In addition to that nondestructive test such as dye penetrate test and visual inspection also has been done and compared. By changing the values of both the welding parameters, its effect on weldments of both the materials has been observed and compared.

Keywords: *TIG welding of aluminium alloys, AA 6061, AA 7075, gas flow rate, welding current, UTS, hardness*

1. Introduction

Due to the light weight, high corrosion resistance and non-toxicity, aluminium has very much scope of its application in construction and manufacturing. When a metal has its scope to use in these areas its joining process becomes an important field for researchers. When the metal joining or welding is done, many parameters play a role to decide the mechanical properties of the weldments. Mechanical properties are very much important for any weldments or metal when it is to be utilized in engineering application. This makes the study of effect of various welding parameters on mechanical properties of aluminum alloy of different grades.

2. Work flow

6 mm thick sheets of AA 7075 and AA 6061 were procured and sheared as shown in figure 1 & 2.

Figure 1. Sheared pieces of AA 7075 (1)

Figure 2. Sheared pieces of AA 6061 (2)

From the spectroscopy test it was ensured that the material was AA 7075 and AA 6061. The spectroscopy test was done at Metal heat treaters and engineers, GIDC, V.U.Nagar. After the shearing of sheet material TIG welding was to be done. The welding parameters selected from the literature review were gas flow rate and welding current. 9 weldments were prepared by combinations of parameters as given in table 1 below from AA 7075 and AA 6061 materials each.

Table 1: Combinations of welding parameters (1) (2)

Sr. No.	Welding Current (Ampere)	Gas Flow Rate (Liter/minute)
1	130	15
2	130	17
3	130	19
4	150	15
5	150	17
6	150	19
7	170	15
8	170	17
9	170	19

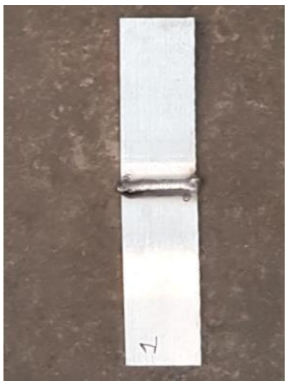

Figure 3.
Prepared Weldment of AA 7075 (1)

Figure 4. Prepared weldments of AA 6061 (2)

Prepared specimens are shown in figure 3 and 4. The filler rod which was used during welding was ER5356. The diameter of filler rod was 2 mm. So in total 9 weldments having double V butt joint were prepared by using TIG welding process parameters as per given table 1 for each material. The welding process was followed by visual inspection test. From the visual inspection by naked eyes in AA 7075 weldments, weldment no. 5 and 6 were observed to have minor cracks. At lower values of welding current minor porosity (weldment no 1 & 2) was observed. While in AA 6061 weldments, weldments no. 2, 4 and 6 were observed to have minor cracks. At lower values of welding current minor porosity (weldments no 1 & 2) was observed same as in AA 7075.

For further inspection another nondestructive test, dye penetrate test was done as shown in figure 5 & 6. DP test was performed on both the sides of weldments. The observations made in visual inspection test were obtained by DP test also. In AA 7075 , weldment no. 1 & 2 had porosity defect. And at moderate value of current and higher values of gas flow rate cracks had been found in weldments. In AA 6061, weldment no. 1 & 2 had porosity defect. And cracks had been found in weldments 2, 4 & 6.

After the nondestructive tests such as visual inspection and dye penetrate test, Rockwell hardness test using B scale was done on weldments on the Rockwell hardness tester available at civil engineering department, CHARUSAT, Changa

Figure 5. Dye penetrate test samples for AA 7075 (1)

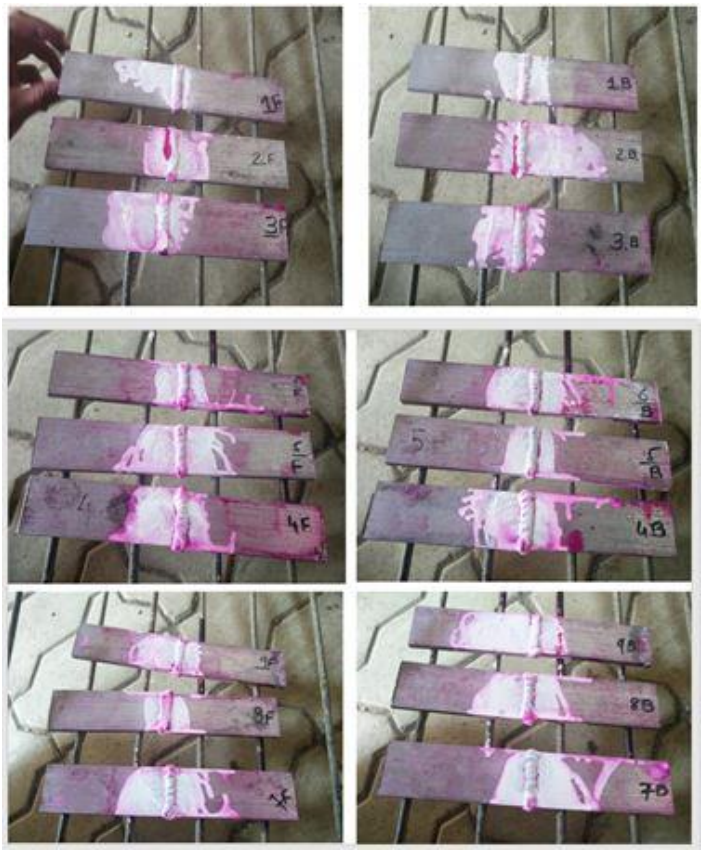

Figure 6. Dye penetrate test samples for AA 6061 (2)

Hardness of weldments was measured on front side welding as well as back side welding. The result of hardness test has been shown in below table 2 for AA 7075 and in table 3 for AA 6061. From these both tables we can compare the values of hardness for weldments of

both the material AA 7075 and AA 6061. From this comparison it is found that highest value of hardness has been achieved at 170 Ampere current and 15 liter/minute gas flow rate.

Table 2. Results of Rockwell hardness test for all weldments AA 7075 (1)

Weldment No.	HRB for front side	HRB for back side
1	33	35
2	31	33
3	43	41
4	44	43
5	38	42
6	43	42
7	47	51
8	36	43
9	41	40

Table 3. Results of Rockwell hardness test for all weldments AA 6061 (2)

Weldment No.	HRB for front side	HRB for back side
1	37	35
2	38	36
3	36	39
4	39	38
5	40	39
6	42	40
7	45	44
8	39	40
9	38	37

After the Rockwell hardness test the important tensile testing was performed on all weldments as per ASME E8 standards. The tensile specimens were prepared in dumbbells shape from weldments as per the size given in figure no. 7 as per ASTM E8 standards. Prepared tensile specimens are shown in figure no. 8 for AA 7075 and in figure no. 9 for AA 6061.

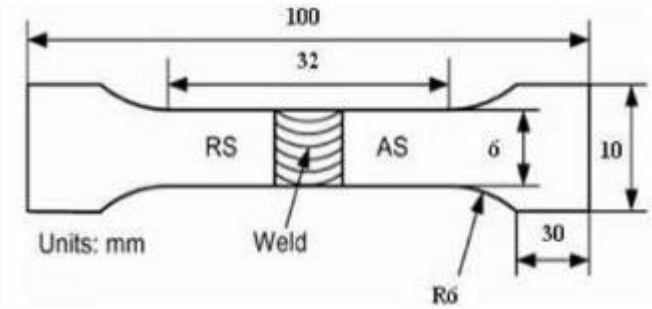

Figure 7: Dimensions of tensile specimen as per ASTM E8 Standard

Figure 8. Prepared tensile specimen of AA 7075 as per ASTM E8 Standard (1)

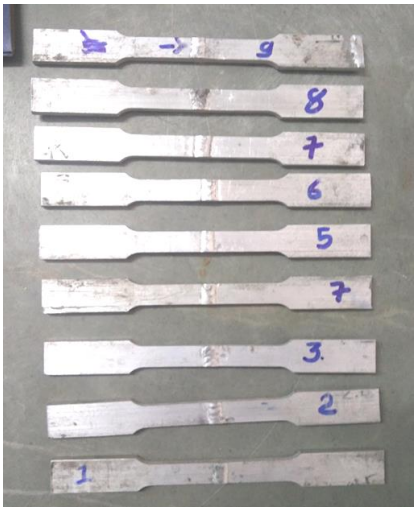

Figure 9. Prepared tensile specimen of AA 7075 as per ASTM E8 Standard (2)

The tensile test was performed on tensile testing machine available at department of mechanical engineering, CHARUSAT, Changa. Figure 10 and figure 11 shows the tensile specimen after tensile test for AA 7075 and AA 6061 respectively.

Figure 10. Tensile specimens AA 7075 after tensile testing (1)

Figure 11. Tensile specimens AA 6061 after tensile testing (2)

The tensile test results has been shown in table 3 for AA 7075 and AA 6061 in terms of ultimate tensile strength.

Table 3: Ultimate tensile strength for AA 7075 and AA 6061 after tensile testing (1) (2)

Weldment number	UTS (MPa) AA 7075	UTS (MPa) AA 6061
1	140	44
2	143	43.8
3	112	40
4	164	56.2
5	176	45.9
6	164	47.8
7	115	46
8	112	43
9	100	44.4

For AA 7075 highest UTS is available at 150 ampere current and 17 liter per minute gas flow rate, while for AA 6061 highest UTS is available at same current and 19 liter per minute of gas flow rate. From the results one can observe that the highest ultimate tensile strength is available near to 150 ampere of current and higher gas flow rate nearer to 19 liter per minute.

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