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EXPERIMENTAL INVESTIGATION OF TENSILE STRENGTH OF AA 6082 USING TIG WELDING AT DIFFERENT PROCESS PARAMETERS

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ABSTRACT
Welding has wide applications in industry, so it is necessary to optimize the process parameters in order to achieve better results. In this study, effects of various welding parameters in Tungsten Inert Gas welding (TIG) of AA 6082 on tensile strength are investigated. The process parameters considered are current, filler material and shielding gas flow rate. Current is varied from 80 Amp to 120 Amp with increment of 20 Amp. A double side V butt weld joint is made with two different filler material AA 4043 and AA 4047. Argon is used as shielding gas with varied flow rate from 8 lpm to 12 lpm. The results show an average increase of 4.5% in tensile strength when current increases from 80 Amp to 120 Amp. Better results are observed with AA 4043 as compared to AA 4047.

KEYWORDS: Welding, TIG, Current, Tensile Strength, Flow rate, Aluminium Alloy.

INTRODUCTION
Aluminium and its alloys are used in fabrications because of their low weight, good corrosion resistance and weldability. This encourages the use of aluminium and its alloy in aerospace industry, internal combustion engine parts, ship building etc. **[1]**. Welding being most widely used joining method can be used for welding aluminium. Tungsten inert gas welding (TIG) and metal inert gas welding (MIG) are commonly used for aluminium. In this study TIG welding is used since TIG welding process offers great advantages such as cleanliness, deposition rate, heat input etc.**)** Tungsten inert gas welding (TIG) is a process that melts and joins metals by heating them with an arc established between a non consumable tungsten electrode and the metals. The torch holding the tungsten electrode is connected to a shielding gas cylinder as well as one terminal of the power source. The workpiece is connected to the other terminal of the power source through a different cable as shown in Figure 1. The shielding gas goes through the torch body and is directed by a nozzle toward the weld pool to protect it from the air. Generally argon and helium are used **[2]**. A mixture of inert shielding gas and some amount of oxygen or CO_2 can be used, which affects the weld penetration [3, 4]. Experimentation becomes tedious and time consuming if full factorial design is used hence an Taguchi's orthogonal array depending upon number of factors and their corresponding levels can be choose in selecting optimized welding parameters which affects mechanical properties and also factors can be predicted having significant effect [5, 6, 7]. It was found that higher tensile strength in the base metal mainly attributed to the presence of more contents of fine grains and twin boundaries [8]. With the variations in the current, variations in the depth of penetration and bead width can be observed [9, 10]. It is found that the root of welding joint is unwelded when the welding current is lower, so that the strength and elongation of welded joint are inferior [11]. But apart from the variations in the magnitude of current, type of current i.e. RMS and Mean current also affects the weld width and weld penetration thus mechanical properties [12]. It is the rupture present at the fractured surfaces owing to insufficient or excessive heat with slight impurities that prevents the accomplishment of stronger micro-level weld integrity [13]. Besides other welding input parameters, the design of butt weld joint which includes groove angle and bevel height also have a significant effect on tensile strength [14]. Maximum tensile strength of 230 Mpa was observed at 40^0 bevel angle and 1.5 mm bevel height at 0.6 cm/sec [15]. Many researcher have worked on welding with use of same filler material as of base metal but better results can be found by welding with different filler material [16]. Since pores in fusion welding joints seriously reduce the quality and performance of the joint and structure. The results showed that the excitation current of arc-ultrasonic has great effect on the pores distribution and tensile property. When it is

increased to 20 A or 30 A, few pores are in the joint and the tensile strength (about 550 MPa) is also improved [17].

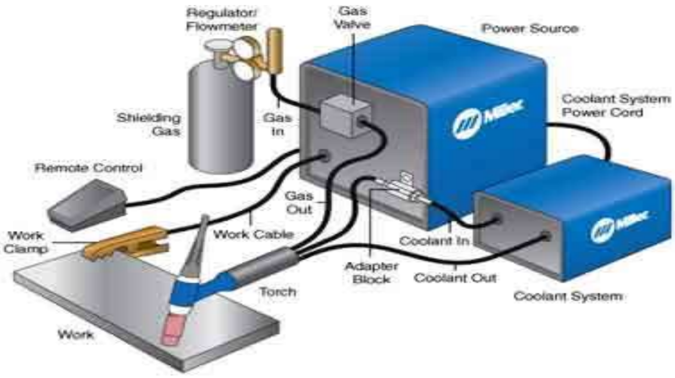

Figure 1: Gas Tungsten Arc Welding Process

Considerable work has been done in investigating the effect of input parameters on tensile strength of various grades of aluminium alloy using TIG welding with different filler material [18, 19, 20]. But limited work has been done on AA 6082 with filler material 4043, 4047. In this work an attempt is made to study the influence of current, shielding gas flow rate and filler material on tensile strength of AA 6082.

MATERIALS AND EXPERIMENTAL

Material

Aluminium alloy 6082 used as material for welding. It is a medium strength with excellent corrosion resistance. Alloy 6082 is known as structural alloy. The chemical composition of specimen (AA 6082) is given in the table 2.1

Table 2.1 Chemical Composition of AA 6082 (% wt)

Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Al
0.7-1.3	0.0-0.5	0.0-0.1	0.4-1.0	0.6-1.2	0.0-0.2	0.0-0.1	0.0-0.25	Balance

In this study, a thoriated tungsten electrode (AWS classification EWTh-2) is used. It contains a minimum of 97.30 percent tungsten and 1.70 to 2.20 percent thorium and are called 2 percent thoriated. To shield the weld pool, pure argon gas is used as a shielding gas. Two filler rods have been used for the TIG welding i.e Aluminium 4043 and Aluminium 4047 alloy. The chemical composition of these two filler rod is described in the table 2.2 and 2.3.

Table 2.2 Chemical composition of aluminium 4043 alloy

Aluminium	Silicon
94.8%	5.20%.

Table 2.3: Chemical Composition of Aluminium 4047 Alloy

Silicon, Si	Iron, Fe	Copper, Cu	Zinc, Zn	Manganese, Mn	Magnesium, Mg	Aluminum, Al
11-13	0.80 max	0.30 max	0.20 max	0.15 max	0.10 max	Remainder

Experimental

The AA6082 plates with the dimensions of 220x40x6 are prepared with the bevel heights of 1.5 mm, bevel angle of 30^0. These specimens are then welded with a root gap distance 1 mm. Based on the literature review, it was found that welding current, gas flow rate and filler material affects the mechanical properties of welded joint. Hence, it is decided to perform experiments by varying the welding current, gas flow rate and filler materials. The levels of different parameters are given in the table 2.4 below. The prepared specimens are welded successfully at given process parameters. Total 18 specimens are prepared and then tensile testing performed on universal testing machine.

Table 2.4: Process Parameters levels

Sr. no.	Parameters	Levels
1	Current	80A, 100A, 120A
2	Gas Flow Rate (LPM)	8, 10, 12
3	Fillers	Al4043, Al4047

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Tensile Testing

The ultimate tensile strength of the welded specimen is calculated in a calibrated Universal tensile testing (UTM) machine which has a maximum capacity of 200 KN. Tensile test is carried out according to the ASTM standards. Specimen according to the ASTM standard is shown in figure 2.1.

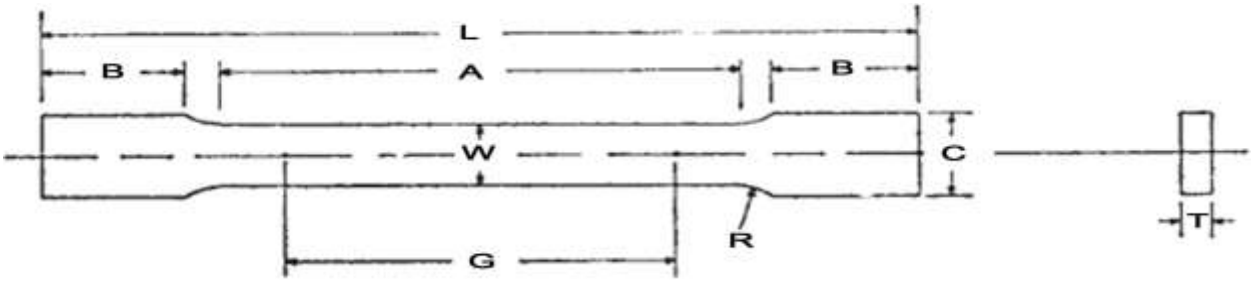


Figure 2.1: Specimen according to ASTM standard

RESULTS & DISCUSSION

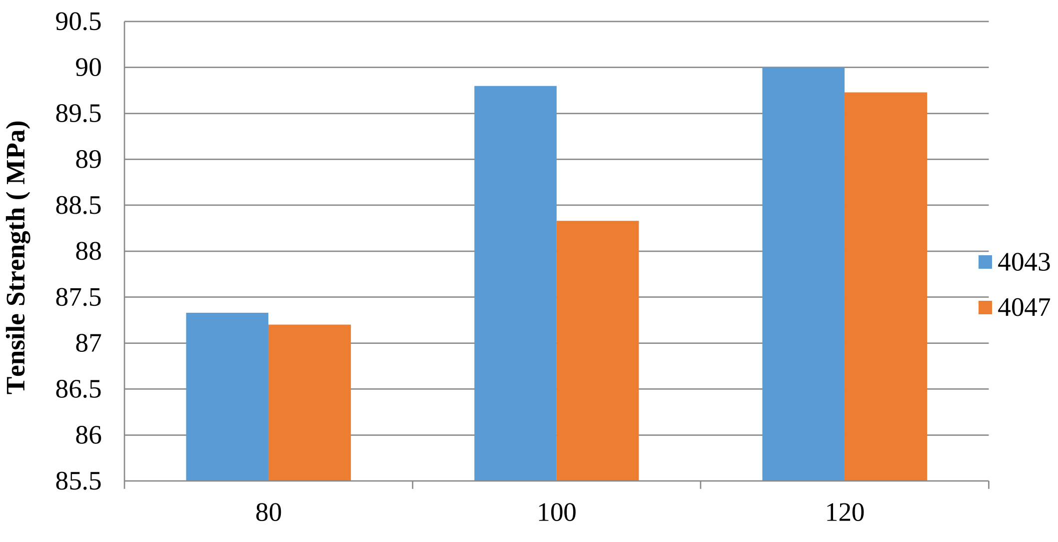
Some interesting results have been found after tensile testing. Tensile strength of welded specimen is determined according to equation 3.1.

$$\text{Tensile Strength (MPa)} = \frac{Breaking\ load(KN)}{Cross\text{−}Section\ area\ of\ weld\ pool(mm^2)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

Experiments are conducted by taking three levels of current (80, 100,120), two filler material (4043, 4047) and flow rate of shielding gas as 8 Lpm. The results found after tensile testing is described in table 3.1. The results of these experiments are shown in graph 3.1.

Table 3.1: Tensile Strength at Flow rate 8 Lpm

Piece no.	Current(A)	Filler	Tensile Strength(MPa)
1.	80	4043	87.33
2.	80	4047	87.2
3.	100	4043	89.8
4.	100	4047	88.33
5.	120	4043	90
6.	120	4047	89.73

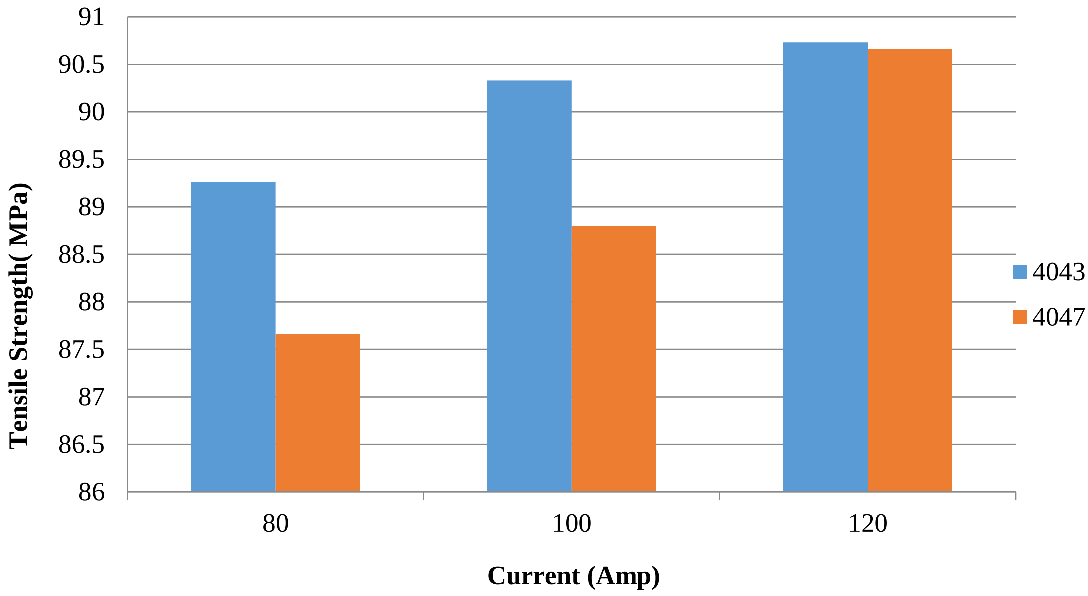


Graph 3.1: Tensile strength at flow rate 8 Lpm

Experiments were conducted by taking three levels of current (80, 100,120), two filler material (4043, 4047) and flow rate of shielding gas as 10 Lpm. The results found after tensile testing is described in table 3.2. The results of these experiments are shown in graph 3.2.

Table 3.2: Tensile Strength at Flow rate 10 Lpm

Piece no.	Current(A)	Filler	Tensile Strength(MPa)
1.	80	4043	89.26
2.	80	4047	87.66
3.	100	4043	90.33
4.	100	4047	88.8
5.	120	4043	90.73
6.	120	4047	90.66



Graph 3.2: Tensile strength at flow rate 10 Lpm

Experiments were conducted by taking three levels of current (80, 100,120), two filler material (4043, 4047) and flow rate of shielding gas as 12 Lpm. The results found after tensile testing is described in table 3.3. The results of these experiments are shown in graph 3.3.

Table 3.3: Tensile Strength at Flow rate 12 Lpm

Piece no.	Current(A)	Filler	Tensile Strength(MPa)
1.	80	4043	90.66
2.	80	4047	89.33
3.	100	4043	90.66
4.	100	4047	89.66
5.	120	4043	91.2
6.	120	4047	91

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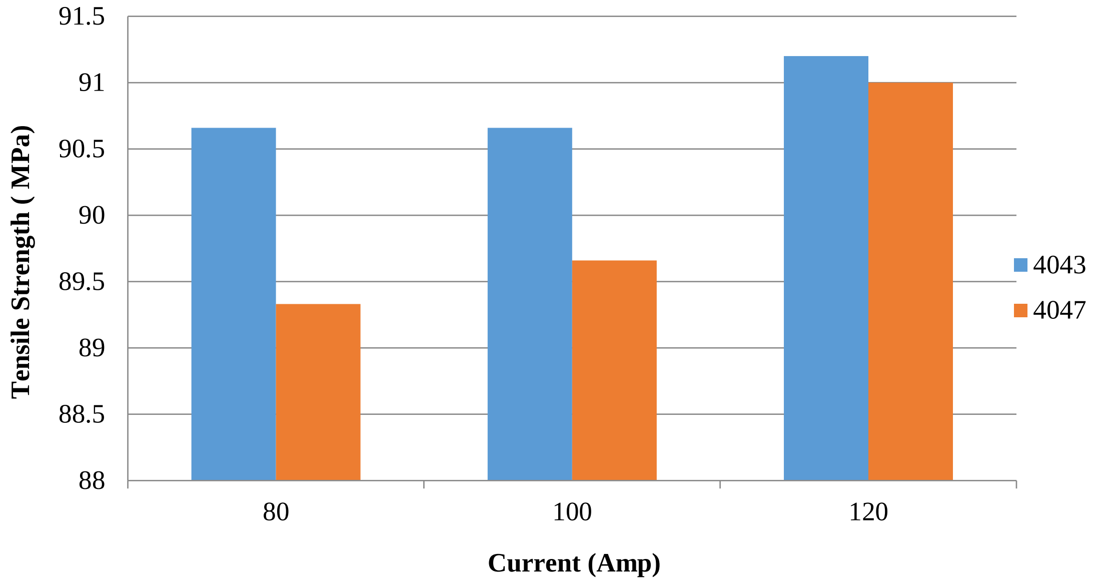

Graph 3.3: Tensile strength at flow rate 12 Lpm

It has been observed that from the results found after tensile testing at different parameters that welding with 4043 filler material giving good result as compared to 4047. As the current level increases, one can observe that there is improvement in tensile strength. It may be due to increased heat input thus increasing welding depth which may leads to increase in tensile strength. With changing flow rate of shielding gas from 8 to 10 Lpm, difference in tensile strength can be observed. It may be due to the better protection of weld pool from the atmospheric gases thus lesser defects which resulted improvement in tensile strength.

CONCLUSION

From the experiment of TIG welding of Aluminium plate 6082 following conclusion can be made:

[1] Welding strength or tensile strength of the weld joint depends on the welding parameters like shielding gas flow rate, welding current and filler material.
[2] With the increase in current, tensile strength of the weld joint increases.
[3] By the use of different filler materials, tensile strength also differs. Here out of two filler materials 4043 and 4047, the weld joint made from 4043 have more tensile strength than weld joint made from 4047.
[4] On increases the gas flow rate tensile strength of weld joint also increases.

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