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Influence of peak current and frequency on tensile strength of Aluminum alloy 1100 during TIG welding

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Abstract- These paper aims to identify the effect of peak current and frequency on the tensile strength during the TIG welding of Aluminum alloy AA1100 sheet. For the tensile testing of welded specimens ASTM E8 standard has been followed. After the tensile testing, the regression analysis is done by MINITAB software and a regression equation has been developed.

Index Terms- TIG welding, peak current, frequency, Aluminum alloy 1100, tensile strength, regression equation.

1. BACKGROUND

Aluminum is the world's most existing metal and is the third most common element, comprising 8% of the earth's layer. Aluminum is versatile so that it is most widely used after steel. In any structural application of Aluminum alloys consideration of its weldability has very much importance as welding is largely used for joining of structural components. Tungsten Inert Gas welding process of aluminium alloy is most preferred because it is easy to be applicable and better economy. There are much TIG welding process and different for different materials; therefore for efficient use of the process it is required to identify the effect of these parameters.

Vijay Gautam (2014) conducted optimization of process parameters for gas tungsten arc welding (GTAW) of sheet samples of Aluminum alloy AA1100 using current, gas flow rate and weld speed as the process parameters with Argon as an inert gas. Tensile properties of parent and welded specimens were determined as per ASTM-E8M standard. Taguchi approach was implemented to determine most effective control parameters which will yield better tensile strength of the joints of GTAW welded Aluminum alloy AA1100.

Senthil Kumar *et al* (2007) studied influences of pulsed current tungsten inert gas welding parameters on the tensile properties of AA 6061 aluminum alloy. The use of pulsed current as a parameter was found to enhance the mechanical properties of the welds in comparison to those of continuous current welds of this alloy due to grain refinement occurring in the fusion zone.

Kumar and Sunderrajan (2009) conducted experiments on optimization of pulsed GTAW welding process parameters and studied the effects on mechanical properties of AA 5456 aluminum alloy weldments using Taguchi technique.

Indira Rani et. al (2012) investigated the mechanical properties of the weldments of AA6351 during the TIG welding with non-pulsed and pulsed current at different frequencies. From the experimental results it was concluded that the tensile strength and yield strength of the weldments is closer to base metal. Failure location of weldments occurred at Heat affected zones and from this we can say that weldments have better weld joint strength.

In the present work peak current and frequency has been set as the process parameters during TIG welding of aluminium alloy AA1100 sheet and weld specimens are prepared. After the tensile testing of the weld specimens as per ASTM E8 standard regression equation has been established using MINITAB software.

2. EXPERIMENTAL PROCEDURE

The base material employed was 5 mm thick aluminium alloy 1100 sheet. The base metal was tested for elemental composition using spectroscopy OES method. Table 1 indicates the results of spectroscopy test.

Table 1. Chemical composition of base material

Element	Si	Fe	Cu	Mg	Zn	Al
%	0.084	0.195	0.051	0.018	0.011	99.27

The filler material used for welding was of 4043 grade having 3 mm diameter. The electrode used for welding was of tungsten and the inert gas used was Argon. Single V butt joint was prepared through welding.

2.1. *Selection of process parameters*

The welding was performed on the "TOSHON TIG 315 P AC/DC" machine. As we had focused on the peak current and its frequency as the process parameters, the values of these parameters were set on the basis of trial and error method. For the trial the rough specimen was welded at different values of peak current i.e. 140A, 160A, 180A, 190A and 200A.

Fig. 1 The rough specimen used for estimating the required welding current.

From the above result, it was visually noted that the proper welded joint can be achieved when the welding current is 180A or above. So selected three current values for the welding were 180A, 190A and 200A and on the other hand the pulse frequency was changed simultaneously for each value of current i.e. 62 Hz, 125 Hz, 185 Hz.

The different combinations of process parameters are as per the table 2 given below.

Table 2. Different combinations of peak current and frequency

Sr. no.	Peak current (Ampere)	Frequency (Hertz)
1	180	62
2	180	125
3	180	185
4	190	62
5	190	125
6	190	185
7	200	62
8	200	125
9	200	185

2.2 *Preparation of weldments*

By using the combinations given in table 2 weld specimens were prepared as per given in following figures.

Fig. 2 Weld specimens prepared for different combinations of peak current and frequency as per table 2.

3. TENSILE TESTING

After preparations of weldments, specimens for tensile testing were prepared as per the ASTM E8 standard by using vertical milling machine.

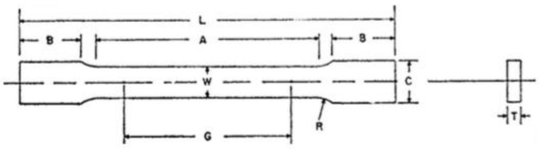

Fig. 3 Dumbbell shaped sheet according to ASTM E8 standard.

- G- Gauge length (mm) - 50±0.1
- W-Width (mm)-12.5±0.2
- R-Radius of fillet (mm)-12.5
- L-Overall Length (mm)-200
- B-Length of Grip Section (mm)-50
- C-Width of Grip Section (mm)-20
- T-Thickness of the section(mm)-5

The prepared specimens for tensile testing are given below in fig. 4

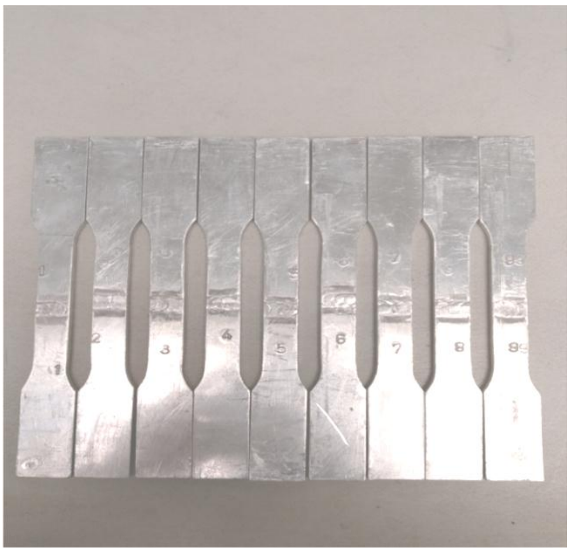

Fig. 4 Tensile test specimens as per ASTM E8 standard

After preparing the tensile test specimen these specimens were tested under TINUS OLSEN /L SERIES H50KL, tensile testing machine situated in mechanical engineering department, Chandubhai. S. Patel institute of technology, CHARUSAT, Changa.

Fig. 5 Tensile testing machine TINUS OLSEN /L SERIES H50KL at CHARUSAT

Fig. 6 Weldment during tensile testing

After the tensile test of all 9 specimen values of tensile strength were achieved for all the combinations of peak current and frequency as per the table 3.

Figure 7 indicates the weldments after tensile test. All the weldments were broken from the weld joint itself.

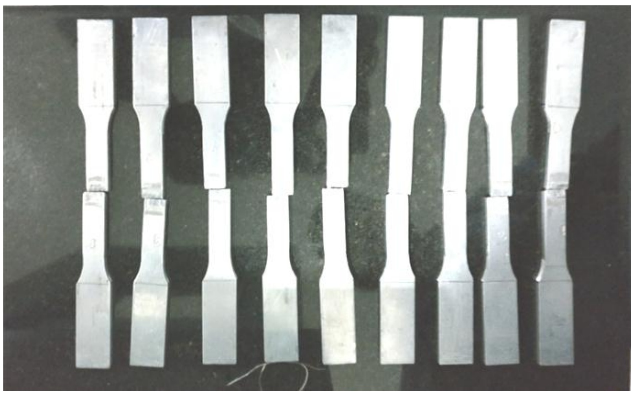

Fig. 7 weldments after tensile testing

Table 3. Tensile strength for all specimens

Sr. no.	Peak current (Ampere)	Frequency (Hertz)	Tensile strength (MPa)
1	180	62	44
2	180	125	44.3
3	180	185	45
4	190	62	50.3
5	190	125	47.9
6	190	185	38.1
7	200	62	40.3
8	200	125	49.1
9	200	185	47.4

4. RESULTS AND DISCUSSION

During these work different values of peak current and frequency were set and TIG welding was performed on sheet of 5 mm thickness of aluminum alloy 1100. After welding tensile testing was carried out of all the weldments as per the ASTM E8 standard. The results in the form of tensile strength have been gathered in table 3. From table 3 we can say that the maximum tensile strength is achieved for 190A current and 62 hertz frequency.

After obtaining the values of the tensile strengths of all the nine specimens, the "Design of Experiment (DOE)" on the MINITAB software was performed and the regression analysis formula Eq. (1) has been obtained which can be used for prediction of tensile strength of the specimen for the constraints of the peak and the frequency.

$$T_s = 84.8294 - 0.297324*f - 0.253551*c - 0.000776014*f*f + 0.0025152*f*c \quad \textbf{Eq. (1)}$$

where, T_s= Tensile strength (MPa),
f = frequency (Hz), c = current (Ampere)

5. CONCLUSION

By comparing the literature review and current work it can be noticed that the frequency has not much more influence on the tensile strength. It also can be noted that within the smaller range of peak current (between 180A & 200 A) there is not much more difference in the value of tensile strength. The tensile strength of weldments remains closer to the tensile strength of base material.

There could be error in the measurements of the chosen parameters which could be beyond our control.

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