Quest Journals
Journal of Research in Mechanical Engineering
Volume 7 ~ Issue 11 (2021) pp: 07-14
ISSN(Online) : 2321-8185
www.questjournals.org

Research Paper

ANNM Tungsten Arc Welding On Aa6061

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ABSTRACT
GTAW process is generally preferred because it produces a very high quality weld. Distortion is the major problem in welding of thin sections. This distortion is controlled in pulsed and magnetic arc oscillation GTAW process. The metallurgical advantages of pulsed TIG welding are grain refinement in fusion zone, reduced width of HAZ, less distortion, control of segregation, reduced hot sensitivity and residual stresses. It was observed that Pulsed TIG Welding produces finer grain structure of weld metal than conventional TIG welding (without arc pulsation). The mechanical properties and microstructure characteristic of weld metal depends upon the microstructure of the weld. The microstructure of the weld depends upon pulsed parameters peck current, base current, pulse frequency, pulse duration. Artificial Neural Network Modeling (ANNM).
KEYWORDS: *ANNM, GTAW, HAZ & TIG welding etc..*

Received 08 November, 2021; Revised: 22 November, 2021; Accepted 24 November, 2021 © The author(s) 2021. Published with open access at www.questjournals.org

I. INTRODUCTION

An **alloy** is a mixture or metallic solid solution composed of two or more elements. An alloy will contain one or more of the three: a solid solution of the elements (a single phase); a mixture of metallic phases (two or more solutions); an inter-metallic compound with no distinct boundary between the phases. Solid solution alloys give a single solid phase microstructure. Aluminium and its alloys play crucial and critical role in engineering material field. The predominance of this is attributed to the excellent corrosion properties owing to the tenacious oxide layer, easy fabric ability and high specific strength coupled with best combination of toughness and formability. In the construction of pressure vessels and storage tanks, the weldability play unique role in selection of materials from the various candidate materials.

The maximum temperature exceeds various critical temperatures at which phase transformation occur in the metals involved in the welding. The extent and slop of thermal gradient is determined by the heat supplied by the welding process per unit volume of the metal per unit time and thermal conductivity of the base metal parts. The study of welding metallurgy requires a consideration of the following metallurgical phenomena that play an important role in fusion welding.

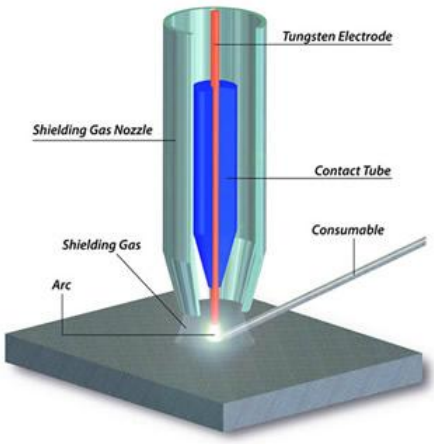


Figure 1: Working principle of TIG.

1.2 Pulsed Current Tungsten Inert Gas Welding

Pulsed current tungsten inert gas (PCTIG) welding, developed in 1950s, is a variation of tungsten inert gas (TIG) welding which involves cycling of the welding current from a high level to a low level at a selected regular frequency. The high level of the peak current is generally selected to give adequate penetration and bead contour, while the low level of the background current is set at a level sufficient to maintain a stable arc.

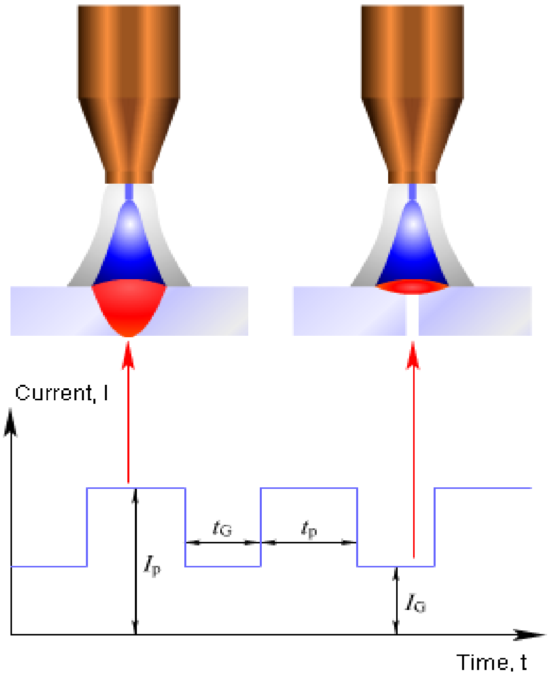


Figure 2: Principle of pulsed current TIG welding

II. LITERATURE REVIEW

Titanium is one of the most important nonferrous metals, Single pass gas tungsten arc (GTA) welding of thin sections of Ti–6Al–4V was accomplished with pulsing current technique and was found to be superior to conventional continuous current process in terms of grain refinement in the fusion zone.

This research investigated the effect of pulsed TIG welding parameters such as pulse duration, peak current, pulse frequency on the microstructure of heat-affected zone, and fusion line and weld metal of Al-0.5%Mg-0.5%Si weld joints.

III. METHODOLOGY

Mechanical properties are governed by the micro structural characteristic and the micro structural properties are governed by the pulse parameter are peck current, base current, pulse frequency and pulse duration. Controlling of all these factors can help in improving the mechanical properties.

The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in union to solve specific problems. Since most manufacturing processes are complex in nature, highly non- linear and there are a large number of input variables, there is no close mathematical model which can describe the behavior of these processes.

Supervised training is the process of providing the network with a series of sample inputs and comparing the output with the expected responses. The training continues until the network is able to provide the expected response. In a neural network, for a sequence of training inputs there may exist output vectors.

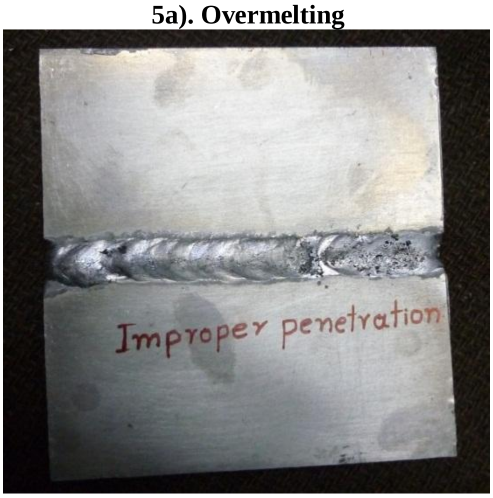
IV. ANALYSIS OF GAS TUNGSTEN ARC WELDING ON AA6061

- Selection of base material.
- Identifying the important Pulsed Current Tungsten Inert Gas welding parameters which are having Influence on grain refinement.
- Finding the upper and lower limits of the identified parameters.
- Design experimental condition and procedure.
- Preparation of material
- Conducting the experiments as per the design.

- Mechanical test
- Microstructure analysis

Figure 3.: TIG Welding Equipment

5a). Overmelting



5b). Improper penetration

Figure 5.: Overmelting due to high temperature & improper penetration due to low temperature

The eight numbers of trial runs have been carried out using 5mm thick rolled plate of AA6061-t6 aluminium alloy to find feasible working limits of pulsed current GTA welding parameters. AA 4043 (Al-5% Si) aluminum alloy of 3 mm diameter has been used as filler metal. Single V butt joint configuration has been used to fabricate the joints

Table 1 : Welding conditions used in the present investigation

S. no	Peak current & without pulse(Amp)	Base current (Amp)	Pulse frequency (Hz)	Pulse duration (ms)
1	160	-	-	-
2	180	-	-	-
3	160	120	25	4
4	160	120	50	4
5	160	120	100	4
6	180	120	25	6
7	180	120	50	6
8	180	120	100	6

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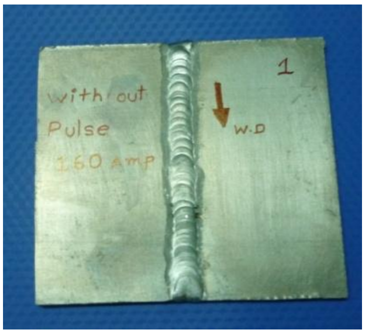
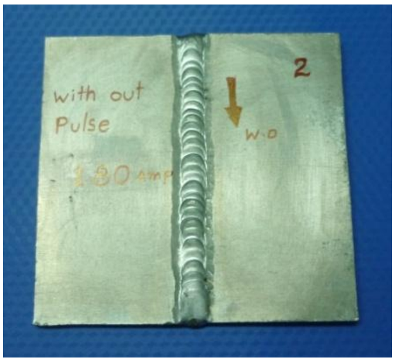


6a) Without pulse, 160 amp



6b) Without pulse, 180 amp

Figure 6.: Welding joint produced without pulse

Figure 7: Universal Testing Machine

Figure 8: AA6061- Tensile test specimen

Figure 9: Specimen after tensile test

V. ARTIFICIAL NEURAL NETWORK MODELLING AND ANALYSIS OF GAS TUNGSTEN ARC WELDING OF AA6061

Neural networks are a non linear mapping system that consists of simple processors, which are called neurons linked by weighted connections. Each neuron has inputs and generates an output that can be seen as the reflection of treat information that is stored in connections. The output signal of neuron is fed to the other neurons as input signals via inter connections. Since the capability of single neuron is limited, complex functions are realized by connecting many processing elements network structure, representation of data, normalization of inputs and outputs and appropriate selection of activation function.

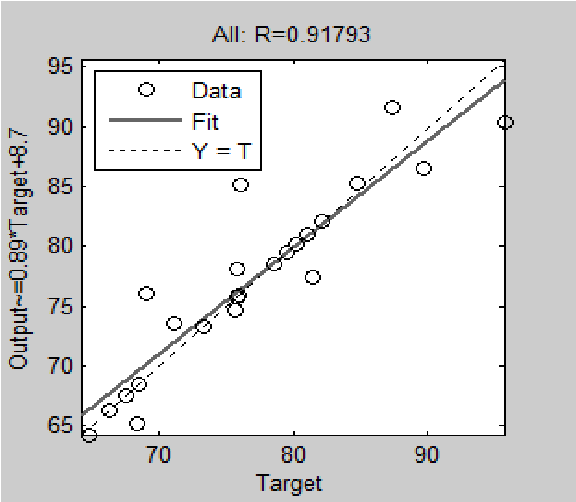


Fig 10 : Regression Graph for microhardness values

VI. RESULTS AND DISCUSSION

Table 2: Mechanical properties of base metal

Joint type	Yield strength (N/mm^2)	Ultimate tensile strength(N/mm^2)	Elongation (%)	Vickers hardness (HV)
Base metal	250	310	10	110

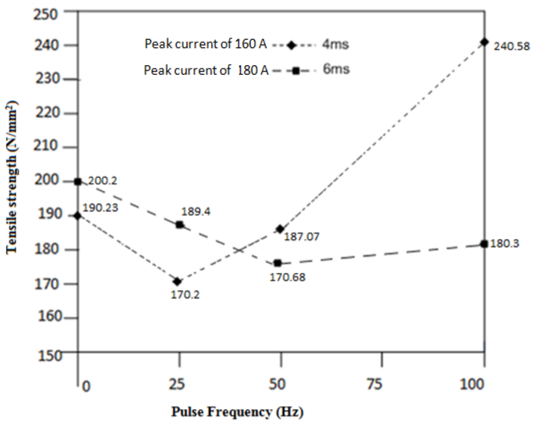


Figure 11: Influence of pulse frequency on tensile strength of weld metal for Peak current of 160 A and 180 A

Table 3: Ultimate tensile strength results

S.No	Peak current & Without pulse in (Amp)	Base current (Amp)	Pulse Frequency (Hz)	Pulse duration (ms)	Ultimate Tensile strength (N/mm^2)
1	160	0	0	0	190.23
2	180	0	0	0	200.2
3	160	120	25	4	170.2
4	160	120	50	4	187.07
5	160	120	100	4	240.58
6	180	120	25	6	189.4
7	180	120	50	6	170.68
8	180	120	100	6	180.3

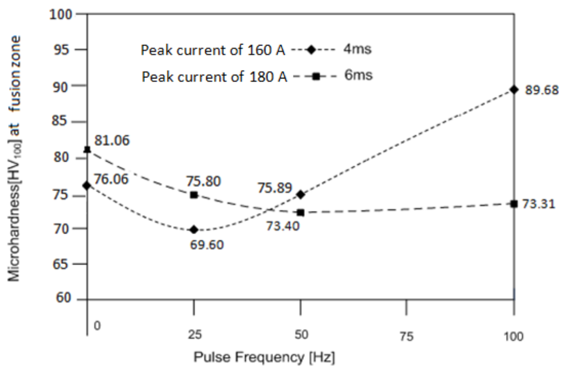
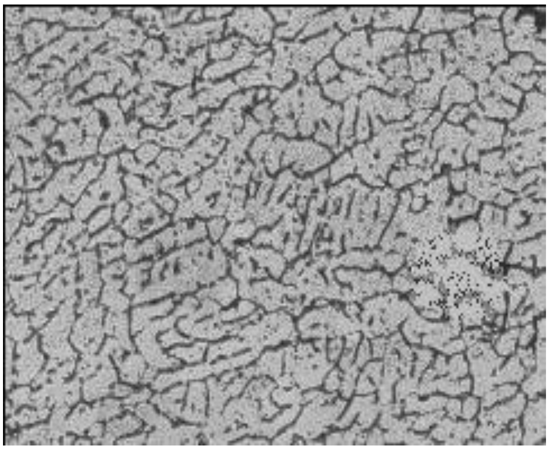
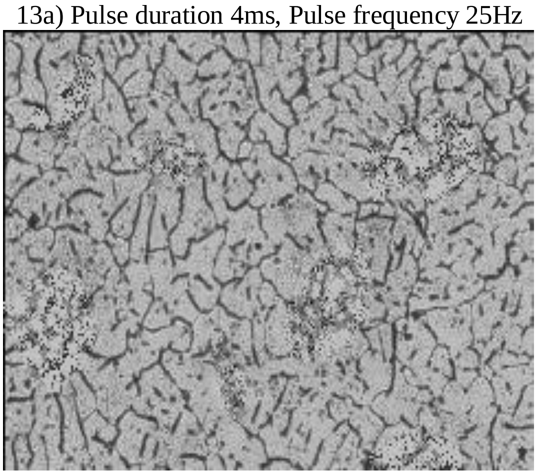


Figure 12: Graph on Influence of pulse frequency on microhardness of fusion zone metal for Peak current of 160 A and 180



13a) Pulse duration 4ms, Pulse frequency 25Hz



13b) Pulse duration 6ms, Pulse frequency 25Hz

Figure 13: Optical micrographs showing the influence of pulse duration on microstructure at different pulse frequencies

Table 4 : Anova Testing of Ultimate Tensile Strength Results

	a1	a2	a3	a4	Result(R_i)	R_i^2
y1	160	0	0	0	190.23	36187.453
y2	160	120	25	4	170.20	28968.040
y3	160	120	50	4	187.07	34995.185
y4	160	120	100	4	240.58	57878.736
y5	180	0	0	0	200.20	40080.040
y6	180	120	25	6	189.40	35872.360
y7	180	120	50	6	170.68	29131.662
y8	180	120	100	6	180.30	32508.090

VII. CONCLUSIONS

- An increase in the pulse frequency up to 100 Hz refines the grain structure of weld metal especially when welding is done using short pulse duration of 4 ms. Increase in pulse frequency decreases the size of aluminum grains in the weld metal.
- For a given pulse frequency 0-25-50-100 HZ with lower peak 160 Amp current by short pulse duration 4 ms produces fine grain structure.
- For a given pulse frequency 0-25-50-100 HZ with higher peak 180 Amp current by long pulse duration 6 ms produced coarser grain structure than short pulse duration 4ms. Longer pulse duration with higher peak 180 Amp current produces coarse grains.
- The microhardness (HV100) of the weld joint produced using 160 A peak current for 4 ms pulse duration showed that increase in pulse frequency from 0 to 25 Hz decreases the microhardness up to at 64.8 HV, 69.60 HV, 75.68 HV at weld zone, fusion zone, and atHAZ zone respectively. A continuous increase in the hardness 84.68 HV, 69.60 HV, 95.67 HV at weld zone, at fusion zone, and at HAZ .up to 100 Hz pulse frequency is observed.

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