ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 6, February 2018

EXPERIMENTAL INVESTIGATION AND OPTIMIZATION OF TUNGSTEN INERT GAS WELDING PARAMETERS ON ALUMINIUM ALLOY 6063

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ABSTRACT

Tungsten Inert Gas welding is a process that joins pieces of metal by heating them with an electric arc. The quality of the weld joint is directly influenced by the welding input parameters during the welding process. Aluminum alloys for aerospace, marine automotive and many other applications are of commercial importance. Methyl ethyl ketone (MEK) is an excellent solvent which is used in many industrial welding applications. When it is applied before welding, the quality of weldment will be improved. The objective of this work is to establish a relationship between various parameters such as base current, pulse current and pulse frequency for Tungsten Inert Gas welding and to compare the variation in tensile strength of welded joints when applying MEK paste before welding. Taguchi technique which provides straight evaluation of the influence of the investigated parameters was used here to optimize the tensile strength of Aluminium alloy 6063 welded joints. From the study, it has been observed that the weld strength is increased by 43% when applying MEK paste before welding.

INTRODUCTION

Welding is a fabrication process that is used to join two metals by melting the work pieces. When the two metals cool they are permanently bonded. In most welding procedures metal is melted to bridge the parts to be joined so that on solidification of the weld metal the parts become united. The common processes of this type are grouped as fusion welding. Heat must be supplied to cause the melting of the filler metal and the way in which this is achieved is the major point of distinction between the different processes.

A. *Tungsten Inert Gas Welding*

Tungsten inert gas shielded welding is usually called TIG welding. It uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool and the

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non-consumable electrode. The process may be operated autogenously (without filler), or filler may be added by feeding a consumable wire or rod into the established weld pool.

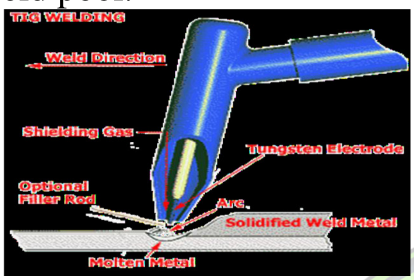

Fig1. TIG Welding process

I. SELECTION OF MATERIAL

Aluminum alloys are a mixture of aluminum and a variety of other metals. Different metals when added to base aluminum impart enhanced properties to the aluminum such as enhanced corrosion resistance, better formability, high electrical and thermal conductivity, recyclable and other beneficial properties in a wide range of permutations and combinations. Aluminum alloys find their application mostly in the transportation industry. They are mainly known for their high strength to weight ratio which makes them indispensable in transportation industries. Combination of two different aluminum alloys has even better advantages. There are various series of aluminum alloys available.

A. *AA 6063 AND AA 4043*

In our work we have chosen Base metal AA-6063 from the 6xxx series and Filler rod AA-4043 from the 4xxx series. They both have a wide variety of applications in the transport industry, aerospace industry and marine industry.

The following two tables illustrate the composition and properties of the chosen alloys.

TABLE I
COMPOSITION OF AA6063 AND AA4043

Composition (%)	Base material Al-6063	Filler material Al-4043
Manganese (Mn)	0.047	0.24
Iron (Fe)	0.43	-
Copper (Cu)	0.067	0.17
Magnesium (Mg)	0.038	0.005
Silicon (Si)	0.48	4.8
Zinc (Zn)	0.17	0.005
Chromium (Cr)	0.025	0.005
Titanium (Ti)	0.018	0.005
Aluminium (Al)	Balance	Balance

EXPERIMETAL PROCEDURE

A.Design Of Experiments

DOE can be defined as the manipulation of controllable factors at different levels to see their effect on some response. There are various methods of experimentation. They are as follows:

- Trial and error method
- One-Factor-at-a-Time method
- Full factorial method
- Fractional factorial method

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- Taguchi method

B. *Taughi Design*

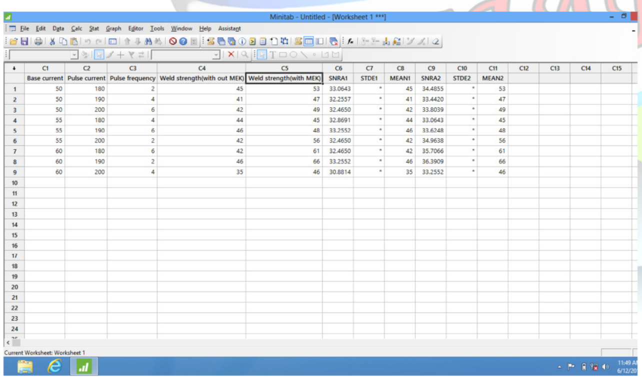
Step 1: Defining the Project scope: This has been dealt with in the previous chapters.

Step 2: Identifying responses: The responses chosen in our work are impact strength and tensile strength.

Step 3: Develop Noise strategy: No noises in our work.

Step 4: Establish control factors and levels are recommended by PSG DDB (11.16)

There are three control factors. i.e. Pulse current, Base current, Pulse frequency varied over three levels.



	C1 Base current	C2 Pulse current	C3 Pulse frequency	C4 Weld strength(with out MEK)	C5 Weld strength(with MEK)	C6 SNRA1	C7 STDE1	C8 MEAN1	C9 SNRA2	C10 STDE2	C11 MEAN2
1	50	180	2	45	53	33.0643	*	45	34.4855	*	53
2	50	190	4	41	47	32.2557	*	41	33.4420	*	47
3	50	200	6	42	49	32.4650	*	42	33.8039	*	49
4	55	180	4	44	45	32.8691	*	44	33.0643	*	45
5	55	190	6	46	48	33.2552	*	46	33.6248	*	48
6	55	200	2	42	56	32.4650	*	42	34.9638	*	56
7	60	180	6	42	61	32.4650	*	42	35.7066	*	61
8	60	190	2	46	66	33.2552	*	46	36.3909	*	66
9	60	200	4	35	46	30.8814	*	35	33.2552	*	46

Fig2. L9 Orthogonal array developed BY MINITAB Software

C. *Welding Procedure*

The work pieces, Al-6063 were set in the position as shown in the following figure in the fixture of the End milling machine.

Aluminum alloy 6063 material is cut by using power hacksaw (dimension are 80×40×6mm).

- Materials are welded after 10 min of with and without applying the MEK paste.
- The selected parameter levels such as Base current, Pulse current and Pulse frequency.
- Aluminum alloy plate is tightly clamped during welding. The root gap of 2 mm is provided between the two plates while performed for the welding.
- To change a parameter level at 9 experiments by using L9 orthogonal array and it's shown in above table.

D. *Tensile Testing*

The welded plates are machining as per ASTM standard. Then the plates are marked to hold in the universal testing machine. After that the loading were

Applied on the plates by adjusting the oil flow control valve with press the

Downward button. So the plates are elongated then it will comes to critical stage,

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Finally the welded plates are broken. At this time reading were taken as a tensile strength. And also we would like to take the yield point, ductility, modulus of elasticity. Then finally note down the tensile strength value in the table.

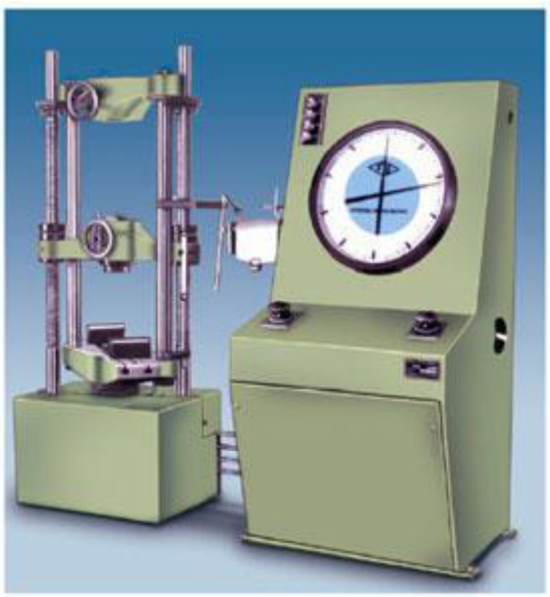

Fig3. Universal testing machine

current				
Pulse Frequency	1.423	2	0.7115	9.7
Error	0.4391	6	0.0731	
Total	4.239	8		

E. Minitab Outputs

CTORS	Base Current	Pulse Current	Pulse Frequency
LEVEL 1	9558.97	9678.62	9755.51
LEVEL 2	9716.04	9751.56	9214.08
LEVEL 3	9329.62	9177.64	9637.34

Source Of Variation	Sum Of Squares	Degree Of Freedom	Mean of Square	Fisher's Ratio	**% of Contribution**
Base Current	0.6566	2	0.3283	4.49	15.4
Pulse	1.72	2	0.86	11.76	40.5

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Fig4. Plates after TIG Welding

Fig5. Plates After Tensile Testing

CONCLUSION

The Taguchi approach is used in this study to optimize the welding parameters of Tungsten Inert Gas welding on Aluminium alloy 6063. The weld strength depends on the number of factors like Base current, Pulse current and Pulse frequency. So, these factors have to be controlled efficiently for a better weld strength. Based on the experimental results the conclusion can be drawn as follows,

- The most important factors affecting weld strength have been identified as pulse current and pulse frequency.
- The following factor settings have been identified as to yield the best combination of process variables.

Parameter/ Condition	Base current (A)	Pulse current (A)	Pulse Frequency (Hz)
Without	55	190	6

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MEK paste				
With MEK paste	60	190	2	66

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