INFLUENCE OF PROCESS PARAMETERS ON ALUMINIUM ALLOY 5083 IN PULSED GAS TUNGSTEN ARC WELDING

[1]B. RAVINDAR, [2]K. GURURAJ

[1]Department of Mechanical Engineering, Vaageswari College of Engineering, Thimmapur, Karimnager, Telangana state, India.
[2]Department of Mechanical Engineering. Kakatiya Institute of Technology & Science, Yerragattu Hillock, Hasanparthy, Warangal,Telangana state, India.
E-mail: [1]bhanothuravindar@gmail.com, [2]yadav_56@yahoo.co.in

Abstract-Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure. During welding the work piece to be joined are melted at Among all the welding processes, the chief advantages in using Gas Tungsten arc welding (GTAW) for surfacing are high reliability, all position capability, ease of use, low cost and high productivity. Due to high strength, good welding properties, increased wear and corrosion resistance and high strength-to weight ratio, Aluminium 5083 is widely used in Ship building, Rail cars, Vehicle bodies, Tip truck bodies, Pressure vessels. In this study, Pulse TIG welding parameter's on weldability of 5083 alloy specifications. The welding parameters such as welding current, Gas flow rate, and different filler diameters are taken into account which influences the properties of material at welded area. Aluminium 5083 sheets were welded by Pulse Tig welding with 5356. The effect of welding process parameters is analyzed by conducting of micro hardness, and Impact tests on weld joint.

Key wards: AA 5083, Pulsed TIG welding, Gas Flow rate, Welding Current, Micro hardness and Impact test properties.

I. INTRODUCTION

Tig welding is an arc welding process that uses a non – consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere by an inert shielding gas (argon or helium) and a filler metal is normally used. The power is supplied from the power source (rectifier), through a hand piece or welding torch and is delivered to a tungsten electrode which is fitted into the hand piece. An electric arc is then created between the tungsten electrode and the work piece using a constant currant welding power supply that produces energy and conducted across the arc through a column of highly ionized gas and metal vapors. The tungsten electrode and the welding zone are protected from the surrounding air by inert gas.. The welding came into existence from "Bronze Age" about 2000 years ago. But Egyptian people learned to weld iron pieces together during Iron Age. TIG Welding is preferred only for aluminium alloys because it starts to spread out from weld pool during the welding operation in other processes.

TIG welding was demonstrated first by Russell Meredith in 1930 during Second World War for welding aluminum and magnesium in aircraft industry.Tig welding with Pulsating current has been known for many years. The welding current weaves periodically between a high (pulse current) and low (basic current) values. In the basic current phase, the low temperature causes a decrease in the volume of the molten pool. The welding has applications in manufacturing field such as ships, boats, cyclic, automotive industry, aircraft industry and pipelines. The weld quality was strongly characterized by weld bead geometry because the weld pool geometry plays an important role in determining mechanical properties of weld. Maximum quality can be achieved with control of welding parameters and material and material used must be cleaned. The heat affected zone influenced with the increment of heat input due to increased welding current. The width of heat affected zone increases due to low heat input. The weld bead geometry of weld repaired aluminium alloy was similar as cast aluminium alloy in appearance but different in micro-structure.

Table1: Chemical Composition AA 5083

Element	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Al
% present	0.4	0.4	0.1	0.4-1.0	4.0-4.9	0.25	0.05-0.25	0.15	Remaining

Table 2: Mechanical Property AA 5083

Property(Mpa)	Value
Tensile Strength(MPa)	330
Shear Strength(MPa)	185
Elongation(%)	17
Hardness Vickers(HV)	95

Table 3: Physical Properties of AA 5083

Property	Value
Density	2650 kg/m^3
Melting Point	570^{o}C
Modulus Resistivity	72 Gpa
Electrical Resistivity	0.058x10^{-6}
Thermal Conductivity	121 W/m.K
Thermal Expansion	25x10^{-6} m/k

Table 4: Fabrication Response of AA 5083

Process	Rating
Workability – Cold	Average
Machinablity	Poor
Weldability – Gas	Average
Weldability – Arc	Excellent
Weldability –Rsistance	Excellent
Brazability	Poor
Solderability	Poor

Table5: Chemical Composition of Filler rod ER 5356

Element	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	O thers	Al
% Present	0.25	0.40	0.10	0.05-0.2	4.5-5.5	0.15	0.06-0.2	0.05-0.02	0.15	Balance

The base metal employed is AA 5083 of chemical composition is shown in Table 1. Filler material used is AA 5356 alloy. The selection of filler material is based on the mechanical properties, resistance offered during welding process and similarity in properties to that of parent metal. The chemical composition of the filler metal AA 5356 is shown in Table 2 the filler wires used to transfer the extra material to fill the gap b/n the joints of same composition of base metal. There are different diameters of 5183, 5356, 5554, 5556, and 5654 available in the market on the base metal compositions. In this analysis the filler wire of 5356 graded is selected for welding the 5083 Al ally because of its good and similar physical, mechanical properties and chemical compositions for obtaining the best weld joint.

II. LITERATURE REVIEW

Aluminum alloy has excellent performance so used in aerospace industry, aviation, marine industry, automobile, defense and others [1-3]. Tungsten Inert Gas (TIG) welding process is used for welding the materials with the coalescence of heat generated by an electric arc established between a non-consumable tungsten electrode and the metal [4]. Most commonly, Argon, helium and their mixture are preferred to use as a shielding gases for better welding because of does not chemically react or combine with each other. The main purposes of shielding gas: i) shield the welding area from air, preventing oxidation, ii) transfer the heat from electrode to metal and iii) helps to start and maintain a stable arc due to low ionization potential [5]. Heat input parameter influences the cooling rate; weld bead size and mechanical properties of the weld [6]. TIG weld quality is strongly characterized by the weld pool geometry because the weld pool geometry plays an important role in determining the mechanical properties of weld [7-8]. The weld quality was strongly characterized by weld bead geometry because the weld pool geometry plays an important role in determining mechanical properties of weld [9-10].

A. Pulsed Current Gas Tungsten Arc Welding (PCGTAW) on Aluminium

T Senthil Kumar *et al.* [5] studied influences of pulsed current TIG welding parameters on the tensile properties of AA 6061 aluminium alloy. Pulsed current TIG welding process utilizes arc energy more efficiently by reducing the wastage of heat energy by conduction into the adjacent parent metal. In PCTIG welding heat required to melt the base metal is supplied only during peak current pulses for brief intervals of time, allows the heat to dissipate leading to a narrower HAZ. The results reveal that the refinement of microstructure is due to pulsed current welding is more compared to conventional continuous current welding. It is also observed that the pulsed current welding also improves mechanical properties like tensile strength & hardness. N Karunakaran and V Balasubramanian [6] studied the effect of pulsed current on temperature distribution, weld bead profiles and characteristics of gas tungsten arc welded aluminium alloy joints. The result reveals that use of pulsed current technique is found to improve the tensile properties of the weld compared with continuous current welding due to grain refinement occurring in fusion zone.

B. FINDINGS FROM THE REVIEW

The literature review reveals that research have been carried out in the field of welding of aluminium alloys. However very few studies have been carried out in pulsed current gas tungsten arc welding on aluminium. Moreover, no systematic study has been reported so far to analyze the mechanical & micrhardness properties of AA 5083 weldment with AA 5356 as filler metal.

AA 5083 was selected as the base metal as it has gathered wide acceptance in the fabrication of light weight structures requiring a high strength-to-weight ratio and excellent weldability, such as transportable bridge girders, military vehicles, road tankers and ship building. The GTA welding was found more beneficial compared to other welding process as the mechanical properties found to increase. Further studies revealed that the pulsed current gas tungsten arc welding (PCGTAW) produces less HAZ and improved mechanical & micro structural properties compared to conventional continuous current gas tungsten arc welding (CCGTAW) process. AA 5356 was selected as the filler material due to its similarities in properties with AA 5083 and ease of availability.

III. EXPERIMENTAL WORK

In this analysis pulsed current tungsten inert gas welding is used. The studied material is AA 5053 sheets, 4 mm thickness. Firstly material cut by shear machine as required dimensions of 100 x 100 x 4 mm are prepared and weld was made by joining two pieces. The configuration of the joint groove was V-shaped. Root gap is 2mm, Root height is 2 mm and angle is 90^o. The process of welding is Pulsed TIG Welding completed by one pass by using ER 5356 filler metal of different diameters and weld samples of weld at different conditions by changing the Gas flow rate, welding current and filler rods. Total number of samples is 27.

Table6: Pulse TIG welding machine Welding process parameters

Specimen Id	Welding current (Amps)	GasFlow Rate (Lt/min)	Fillerrod dia.(mm)
1	180	8	1.6
2	180	8	2.4
3	180	8	3.2
4	180	10	1.6
5	180	10	2.4
6	180	10	3.2
7	180	12	1.6
8	180	12	2.4
9	180	12	3.2
10	210	8	1.6
11	210	8	2.4
12	210	8	3.2
13	210	10	1.6
14	210	10	2.4
15	210	10	3.2
16	210	12	1.6
17	210	12	2.4
18	210	12	3.2
19	240	8	1.6
20	240	8	2.4
21	240	8	3.2
22	240	10	1.6
23	240	10	2.4
24	240	10	3.2
25	240	12	1.6
26	240	12	2.4
27	240	12	3.2

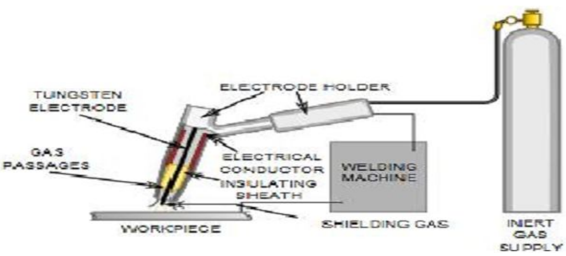

Fig1: Pulse TIG welding Schematic diagram

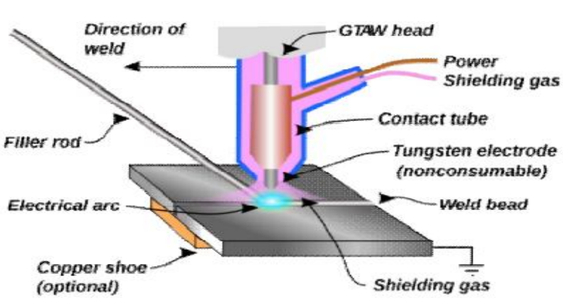

Fig3: Welding Process

Fig4: Before welding Clamping & Alignment

Fig5: Test samples cut by EDM

Fig5: Samples after Test

IV. RESULTS AND DISCUSSION

Table 7: Base Metal impact energy

Sl.No.	Impact Energy (joules)
1	14

Table 8: Hardness values of base metal

Distances (mm)	Hardness(HV1)
0	88.8
0.2	88.6
0.4	87.9
0.6	88.2
0.8	88.5
1.0	88.8
1.2	87.5
1.4	88.0
1.6	88.6
1.8	88.9
2.0	88.5

Table9: Result of Impact energy (joules)

Result of Impact energy (joules)				
Sample Id	I	II	III	Average value
1	6	8	10	8
2	5	8	11	8
3	4	6	7	6
4	3	2	2	2
5	5	4	4	4
6	8	8	7	8
7	3	4	6	4
8	2	2	2	2
9	4	4	5	4
10	15	14	12	14
11	2	4	6	4
12	12	12	12	12
13	16	14	13	14
14	5	8	10	8
15	12	12	13	12
16	15	14	14	14
17	9	10	11	10
18	8	8	9	8
19	9	10	10	10
20	9	10	11	10
21	15	12	10	12
22	12	12	11	12
23	6	8	8	7
24	5	6	8	6
25	11	10	8	10
26	5	4	2	4
27	13	14	16	14

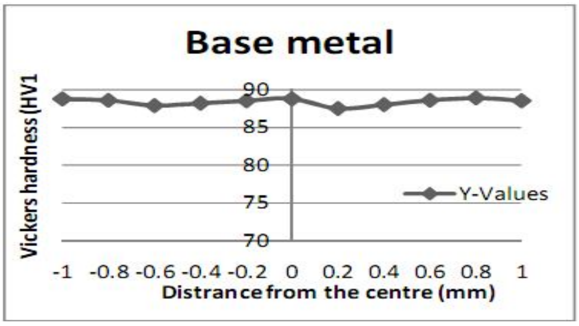

Fig6: Microhardness curve for sample of base metal

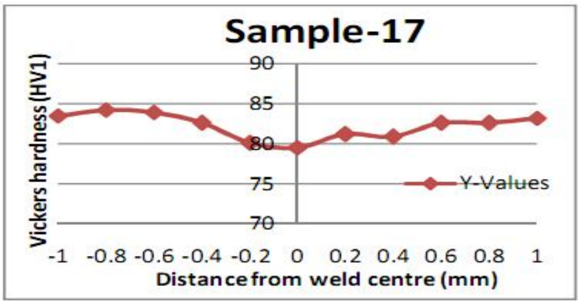

Fig7: Microharndness curve for sample-17

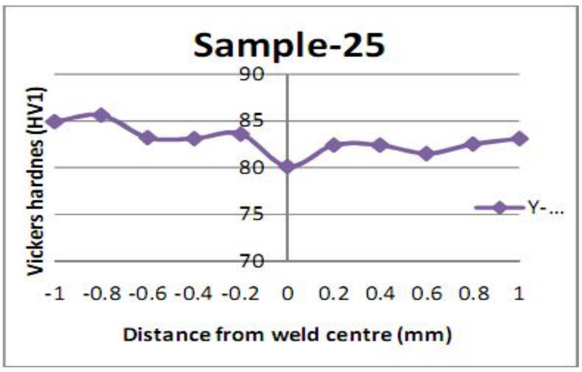

Fig8: Microhardness curve for sample- 25

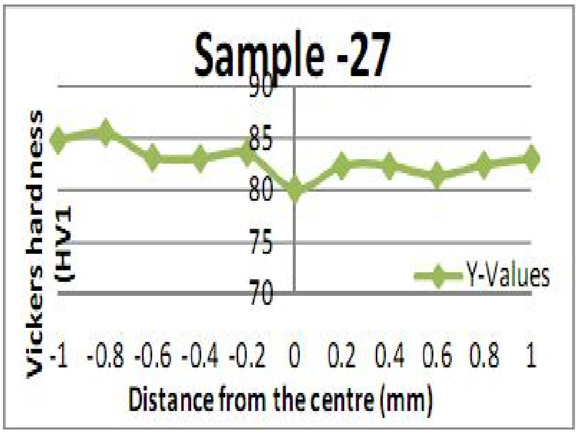

Fig9: Microhardness curve for sample-27

From the above average values of Impact test the vickers hardness (HV) value is very low at welding current (WC) 180 amps, gas flow rate(G) 10 Lit/min and fillerrod (F) dia is 1.6mm. But the HV value is very good at the WC is 240 amps, G is 12 Lit/min and F dia. Is 3.2 mm. Figure 1 show that the micoharness curve of base metal. Microhardness value of the welded zoe was measured for all the welded specimens at the cross section to understand the change in mechanical property of the welded zone Figure 2 ,3 and 4 shows the micro hardness value at the welded zone taken from the centre of the welding zone towords the base metal for different samples performed with different welding current, gas flow rate and filler rod diameters. From the graph it is found that for almost all the sample microhardness value increased in the welding zone than the base material and these values are in the range of 70 to 90 HV in the weld zone. After certain distance these value reduces to the hardness of the base material for the sample processed with welding current of 180 A, gas flow rate 10 Lit/min. and filler rod 1.6 mm diameter. From figure 4 shows that welding done with welding current 240 A, gas flow rate is 12 Lit/min, and Filler rod diameter is 3.2 mm of micro hardness value reaches to the micro hardness value of base material.

C. Effect of Weld current on Tenslie strength

Fig: Tensile Strength Vs Welding current

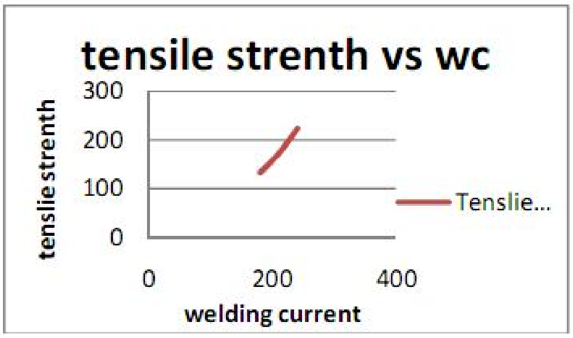

Fig10: Tensile strength Vs weld current

By above curve we can conclude that Weld current increases the tensile strength

D. Effect of Gas flow rate on Tenslie strength

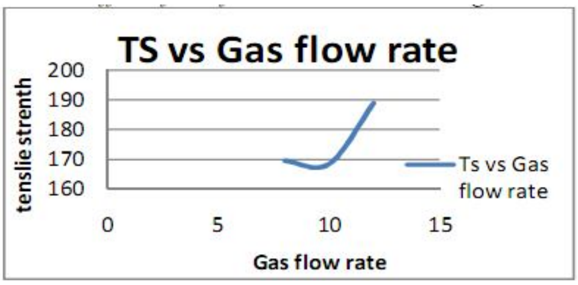

Fig11: Tensile strength Vs weld Gas flow rate

By above curve we can conclude that Gas flow rate increases the tensile strength

E. Effect of Filler rod on Tenslie strength

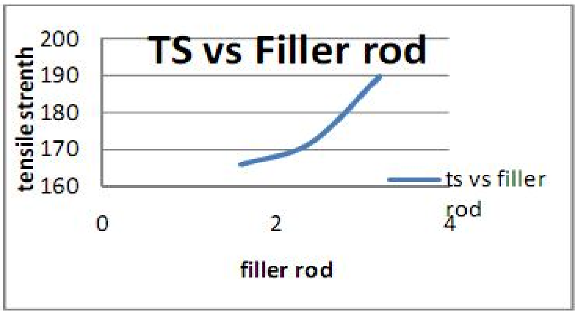

Fig12: Tensile strength Vs filler rod diameter

By above curve we can conclude filler rod diameter gradually increases the tensile strength

F. Effect of Filler rod on Impact energy

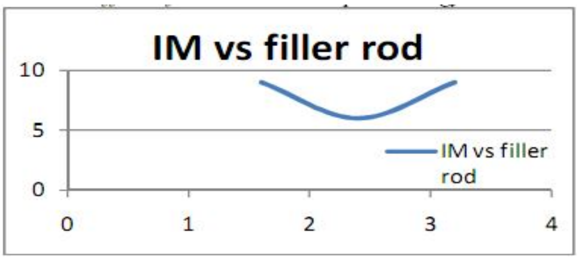

Fig13: Impact energy Vs filler rod diameter

By above curve we can conclude filler rod diameter gradually decreases and increases the impact energy

CONCLUSION

- In this paper the effect of micro hardness and vickers hardness test with changes of welding current, gas flow rate and filler rod diameters by using pulsed tungston inert gas welding technique is investigated.
- The welding current weaves periodically between a high (pulse current) and low (basic current) values. In the basic current phase, the low temperature causes a decrease in the volume of the molten pool.
- Hardness value of the weld zone changes with the distance from weld centre due to change of microtructure.
- At low welding current vickers hardness value is very low due to lack of fusion.
- With increase in current hardness values are almost near to the base values.
- The basic reason for the improvement in vickers hardness and microhardness properties is the refinement produced in fusion zone grain size by pulsed current welding.

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