Review of Welding Parameter Consequences for TIG Welding of Aluminium Alloy

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Abstract— Aluminium composites are compounds in which aluminium is the transcendent metal. The typical alloying elements copper, magnesium, magnese, silicon, tin and zink. Al and aluminium alloys play an important role in engineering and metallurgy field on account of manufacture and formability. TIG welding strategy is one of the exact and speediest procedures utilized as a part of aviation, businesses, dispatch enterprises vehicle ventures, marine ventures, and atomic ventures. TIG welding process is utilized to dissected the information and assess the impact of information parameters on elasticity and hardness of aluminium example- welding current, gas stream rate, and welding speed are the input parameters which affect output responses of aluminium welded joints. To enhance welding nature of aluminium plate pre and post safeguards must be taken during welding process. TIG welding is a brilliant welding process used to weld the aluminium. Welding of AL plate by varying input parameters, the yield parameters get contemplated improved so better nature of welded joints will create. 6061 AL combination are composite are alloyed with zink and have most elevated quality of any simple weldable aluminium alloy. 6061 aluminium combination is generally delicate, effectively machined, sturdy, reuse, light weight, flexible and pliant metal with appearance brilliant. It is non magnetic and does not easily ignite. Al has about one third density and stiffness of steel. From the literature study, it is found that welding of aluminium is a big challenge by conventional arc welding process. Again repeatability of welding relies upon its control on welding speed and other preparing parameters. In this work to perform welding of 5mm thickness 6061 aluminium alloy plate, TIG welding setup will utilize. Welding of the 6061 aluminium composite plate will do by changing the welding parameters on the tensile strength and hardness of weld joint will analyze.

Key words: AA6061, Filler Rod, Welding Speed, Welding Current, Gas Flow Rate, Strength, Hardness

I. INTRODUCTION

In the earth crust, aluminium is the most abundant (8.3% by weight) metallic element and third most abundant of all elements (after oxygen and silicon). Almost all metallic aluminium is produced from ore bauxite occurs as a weathering product of low iron and silica bedrock in tropical climate condition. Large deposits of bauxite and mining areas occurs in Brazil, Australia, Indonesia, Jamaica and china. High strength 6xxxseries weldable aluminium alloys such as 6061 are used extensively in bicycles industry. 6061 Al alloys often used in high performance application such as automation industries, automobile industries, aerospace industries etc.

II. TIG WELDING

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.

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-pieces to be joined are melted at the interface and after solidification a permanent join can be accomplished. Now and again a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occurs during welding, changes on hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

TIG welding was, like MIG/MAG developed during 1940 at the start of the world war. TIG development came about to help in the welding of difficult types of material, eg aluminium and magnesium. The use of TIG today has spread to a variety of metals like stainless mild and high tensile steels. GTAW is most commonly called TIG (Tungsten Inert Gas). The development of TIG welding has added a lot in the ability to make products that before the 1940's were only thought of like other forms of welding. TIG power sources have, over the years, gone from basic transformer types to the highly electronic power source of the world today.

The properties of aluminium alloys are as follow

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr	Al
6061	0.4-0.8	0.5	0.15-0.40	Max. 0.15	0.8-1.2	0.04-035	Max.0.25	Max. 0.15	0.05	Balance

Table 1: chemical properties of 6061 AA

Alloy	Phase	Atomic Number	Standard atomic weight of Al	Appearance	Melting point	Boiling point	Density	Specific mass
6061	solid	13	26.9815	silvery	532°C to 580°C	2470°C	2.7 gm/cm3	960 J/Kg-K

Table 2: physical properties of 6061 AA

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
5356	0.25	0.40	0.10	0.050-0.20	4.50-5.50	0.050-0.20	0.10	0.060-0.20	Balance

Table 3: chemical properties of filler material

The mechanical properties of 6061 aluminium alloys are as follow:

A. Lightness

6061 aluminium alloy is the lightest of every single ordinary metals , about three times as light as steel removing weight from items is an effective response to environmental concerns (energy efficiency, smaller carbon footprint) and economics (profitability of production and use). Softness benefits the applications as well as task on the shop floor and working conditions, and means lower expenditures on material handling equipment.

B. Ease of use

aluminium alloys are used in all the customary process of bending, forming, vessel-making, stamping and machining where other metals are used.

C. Suitability for surface treatment

aluminium and its alloys lend themselves to a huge variety of surface treatment, which enhances its intrinsic qualities. For example an anodization of a few micrometers is enough to preserve the optical or decorative properties of the materials, while improving resistance especially to corrosion and stress.

D. Corrosion resistance

aluminium and its alloys give incredible protection from air consumption in marine, urban, and mechanical settings. This high resistance expands the life of equipment, significantly reduces maintenance costs and preserves outward appearances. These properties are particularly wanted in mechanical vehicle, steel furniture, traffic signals.

E. Recycling

aluminium can be recycled indefinitely without losing any of its intrinsic qualities. This is a considerable advantage in modern metallurgical industry. For the past 20 years the proportion of metal consumed that is recycled has grown steadily and today stand at something like 30% of primary metal production.

III. LITERATURE REVIEWS

DIN [1] performed pulsed TIG welding of 304L stainless steel and compare the weld bead profiles for constant current and pulsed current settings. Experiment carried out with plate dimension 150mm X 30mm X 1.6mm, welding was performed with gas flow rate 10lit/min. Effect of welding current on tensile strength , hardness profiles, microstructure, and residual stress distribution of welding zone of steel samples were reported. For the experimentation welding current of 75-125A, welding speed 125-375mm/min, pulse frequency 3Hz have been considered. From the experimental result it was concluded that most important parameters affecting the responses have been identified as speed and current. Also found that there is good improvement in tensile strength after optimizing while comparing with parent metal and bend test result is no opening or crack formation. Hence a good quality weld is obtained from face to root, the optimized process parameters would definitely solve the problems of corrosion and fatigue faced by the material, by improving the weld quality at the same time, it increases the strength of the weld with minimum heat affected zone.

LAKS[2] performed TIG welding process to analyze the data and evaluate the influence of input parameters on tensile strength of 5083 AL-alloy specimens with dimensions of 100 mm long x 15mm wide x5mm thick. Welding current (I), gas flow rate (G) and welding speed (S) are the input parameters which effects tensile strength of 5083 Al-alloy welded joints. As welding speed increased, tensile strength increases first till optimum value and after that both decreases by increasing welding speed further. Results of the study show that maximum tensile strength of 129 MPa of weld joint are obtained at welding current of 240 Amps, gas flow rate of 7 lit/min and welding speed of 98 mm/min. These values are the optimum values of input parameters which help to produce efficient weld joint that have good mechanical properties as a tensile strength.

G VEN[3] Analysed the micro structural characterization and corrosion behaviour of top surface of tungsten inert gas (TIG) welded 2219-T87 aluminium alloy (AA2219-T87) in 0.6 M NaCl solution was studied by optical microscopy, scanning electron microscopy (SEM), potentio dynamic polarization, and electrochemical impedance spectroscopy (EIS). The optical microscopy and SEM analyses revealed that the welding of base metal (BM) with ER2319 filler alloy caused the formation of micro pores and micro cracks on the surface of weld zone (WZ) while the welding heat caused the dissolution and segregation of cuA12 intermetallic particles along the grain boundaries in the heat affected zone (HAZ). The decrease of charge transfer resistance of HAZ when compared to WZ and BM obtained by electrochemical impedance spectroscopy (EIS) further confirmed its higher corrosion rate in 0.6 M NaCl solution.

SANJ[4] Did TIG welding of 6 mm thick Al plate. They perform experiment in two phases in first case they used AC power supply of current (100A, 150A, 200A), gas flow rate of (7 lit/min, 15 lit/min) and pulsed frequency of 4 HZ. In second case DC power supply of current (48A, 64A, 80A,96A,112A), gas flow rate (7lit/min). Photomicrographs of welded specimens were taken and analyzed from the experiment it has been observed that shear strength varies with change of pulse current. This change in shear strength is due to lack of refined grain structure of weldments, responsible for poor strength. Maximum value of shear strength has been observed at pulse current of 250A, gas flow rate of 15 lit/min and base current 200Amp. The microstructure, has been found to be very refined grain structure at pulse current 250A and gas flow rate of 15 lit/min. At base current of 200A.

PARM[5] An experimental investigation has been carried out on microstructure, hardness distribution and tensile properties of weld butt joints of 6063 T6 aluminium alloy. Experiment carried out with plate dimension 150mm X 75mm X 6mm, welding was performed with gas flow rate 20 lit/min, welding speed 120mm/min and welding current 90A. Two different welding processes have been considered: A conventional tungsten inert gas (TIG) process and an innovative solid state welding process known as friction stir welding (FSW) process. In this study it has been

found that heat affected zone of FSW is narrower than TIG welding and mechanical properties like tensile strength etc. Are within comfort zone of and are better than TIG welding method. Microstructure result also favour FSW. Result showed a general decay of mechanical properties of TIG joints, mainly due to high temperature experienced by the material. Instead, in FSW joint, lower temperatures are involved in the process due to severe plastic deformation induced by the tool motion and lower decay of mechanical properties. Hence from industrial perspectives, FSW process is very competitive as it saves energy, has higher tensile strength, lower residual stress values and prevents the joints from fusion related defects.

DONG[6] Analyzed the A double-shielded TIG method to improve weld penetration and has been compared with the traditional TIG welding method under different welding parameters (i.e., speed, arc length, and current). Experiment carried out an martensite stainless steel with plate dimension 100mm X 50mm X 10mm, welding was performed with welding speed 1.5 mm/sec.-5 mm/sec. , welding current 100A – 240A and arc length 1 mm -7 mm. The strength of the marangoni convection was calculated to estimate the influence of the welding parameters on the variation in weld pool shapes. The result show that the changes in the welding parameters directly impact the oxygen concentration in the weld pool and the temperature distribution on the pool surface.

WANG[7] Investigated the dynamic progress and residual distortion of out-of-plane of aluminium alloy 5A12, under different welding condition of TIG welding. Experiment carried out with plate dimension 200mm X 160mm X (2.5mm, 4mm, 5mm, 6mm) welding was performed with gas flow rate 9.5 lit/min, welding speed 8 cm/min, welding current 60A-100A and welding voltage 14V. Out-of-plane distortion mechanism and the effecting parameters on distortion process were analyzed, and the effect of plate thickness and welding heat input on distortion was discussed. The result show that the plate thickness and welding heat input have great effect on the dynamic process and residual distortion of out-of-plane.

LIU[8] Analyzed microstructure, element distribution, phase constituents and micro hardness for welding joint of Mg-Li composite plates of carried out by TIG welding process with Cr-Ni fillet wires. Experiment carried out with plate dimension 110mm X 10mm X 2mm, welding has done with speed (30)mm/min, gas flow rate-13 l/min, and welding current 80A. The result indicate that austenite and ferrite phases were obtained in the weld metal. The micro hardness near the fusion zone at Mg-Li composite side increased from weld metal to fusion zone, and the peak value appeared near the boundary between fusion zone and Mg-Li composite.

WANG[9] Did the experiment using He- Ar mixed gas as shielding gas, the tungsten inert gas (TIG) welding of SiCp/6061 Al composite was investigated without and with Al-Si filler. Experiment carried out with plate dimension 60mm X 30mm X 3mm, welding was performed with gas flow rate 115 ml/s, welding speed 18 cm/min and arc length 4mm. Welded joint with filler were submitted to tensile tests. The microstructure and fracture morphology of the joint were examined. The result show that adding 50 vol.% helium in shielding gas improve the arc stability, and seams with high quality appearance are obtained when the Al-Si filler is added. The microstructure of the welded joint display non-uniformly with many Sic particles distributing in the weld center. The average tensile strength of weld joint with Al-Si filler is 70% above that of the matrix composites under annealed condition.

Indira rani[10] Investigated the mechanical properties of the weldments of AA6351 during the GTAW/ TIG welding with non-pulsed and pulsed current at different frequencies. Experiment carried out with plate dimension 300mm X 150mm X 6mm, welding was performed with current 70-74 A, arc travel speed 700-760mm/min, and pulse frequency 3 and 7 Hz. From the experimental result it was concluded that the tensile strength and YS of the weldments is closer to base metal. Failure location of weldments occurred at HAZ and from this we said that weldments have better weld joints strength.

MAYUR[11] Analyzed structural and mechanical properties evaluation of AA-5083 alloy after single pass tungsten inert gas (TIG). Experiment carried out with plate dimension 125mm X 60mm X 3mm, and welding current 70A, 75A, 80A. Welding was investigated to reveal the weld strength, hardness of welded joints by using weld current as varying parameters. The tensile strength has been increased by an amount 34% and 37% at weld current 75A in comparison with weld carried out at 70A and 80A respectively.

IV. CONCLUSION

- By using TIG welding process uniform welding of aluminium alloy possible.
- The important parameters affecting the output responses have been identified as speed and current.
- Selection and preparation of welding joints greatly affect the welding strength, microstructure etc.
- To improve welding quality of aluminium pre and post welding precaution must be taken during welding process.
- By optimizing and controlling welding parameters (like welding current, gas flow rate, welding speed) welding defect get totally avoided.

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