Optimizing Gtaw Process Parameters On Mechanical Properties Of Aluminium Alloy 5052-6061 Weldments

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***Abstract*- GTAW is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The work is based on the mechanical properties of 5052-6061 aluminium alloys in GTAW is rarely found in the literature collection and dissimilar metal shows comparatively better strength than similar metal.In GTAW welding current range, gas flow rate and the filler rod diameter play major role in deciding the joint characteristics. By using response surface methodology (RSM) in minitab software optimal range of values can be found. After finding the optimum range of values welding process is carried out. To find the strength of weldjoints tensile strength, Yield strength (YS) and hardness test were established for each set of optimal values and analyzing the best result.**

***Keyword:* GTAW process, RSM(Response surface method), aluminium alloy.**

I. INTRODUCTION

GTAW is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas. Two series of aluminium alloys can be welded by using GTAW process. The dissimilar metal shows comparatively better strength. By using RSM method we can find the optimum range of values. The aluminium alloy of different series can be welded by using optimum range of values and find the strength of welded joints by using tensile strength, yield strength, and hardness test. Aluminium, magnesium, copper alloys can be welded easily. Inconel, carbon steels, stainless steels can be welded. Thin parts and sheet metals can be welded easily. Can sealing, instrument diaphragms and transistor cases can be welded very efficiently. Expansion bellows and other delicate parts can joined. Atomic energy, aircraft, chemical and instrument industries use this welding process. Rocket motor chamber fabrication welding can be done by this process**.**

II. MATERIALS

GTAW

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as autogenous welds, do not require it. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as a plasma.

GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques. A related process, plasma arc welding, uses a slightly different welding torch to create a more focused welding arc and as a result is often automated.

POWER SUPPLY

Gas tungsten arc welding uses a constant current power source, meaning that the current (and thus the heat) remains relatively constant, even if the arc distance and voltage change. This is important because most applications of GTAW are manual or semiautomatic, requiring that an operator hold the torch. Maintaining a suitably steady arc distance is difficult if a constant voltage power source is used instead, since it can cause dramatic heat variations and make welding more difficult.

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Fig.1. GTAW power supply

The preferred polarity of the GTAW system depends largely on the type of metal being welded. Direct current with a negatively charged electrode (DCEN) is often employed when welding steels, nickel, titanium, and other metals. It can also be used in automatic GTAW of aluminum or magnesium when helium is used as a shielding gas. The negatively charged electrode generates heat by emitting electrons, which travel across the arc, causing thermal ionization of the shielding gas and increasing the temperature of the base material. The ionized shielding gas flows toward the electrode, not the base material, and this can allow oxides to build on the surface of the weld. Direct current with a positively charged electrode (DCEP) is less common, and is used primarily for shallow welds since less heat is generated in the base material. Instead of flowing from the electrode to the base material, as in DCEN, electrons go the other direction, causing the electrode to reach very high temperatures. To help it maintain its shape and prevent softening, a larger electrode is often used. As the electrons flow toward the electrode, ionized shielding gas flows back toward the base material, cleaning the weld by removing oxides and other impurities and thereby improving its quality and appearance.

Alternating current, commonly used when welding aluminum and magnesium manually or semi-automatically, combines the two direct currents by making the electrode and base material alternate between positive and negative charge. This causes the electron flow to switch directions constantly, preventing the tungsten electrode from overheating while maintaining the heat in the base material. Surface oxides are still removed during the electrode-positive portion of the cycle and the base metal is heated more deeply during the electrode-negative portion of the cycle. Some power supplies enable operators to use an unbalanced alternating current wave by modifying the exact percentage of time that the current spends in each state of polarity, giving them more control over the amount of heat and cleaning action supplied by the power source. In addition, operators must be wary of rectification, in which the arc fails to reignite as it passes from straight polarity (negative electrode) to reverse polarity (positive electrode). To remedy the problem, a square wave power supply can be used, as can high-frequency voltage to encourage ignition.

SHIELDING GAS

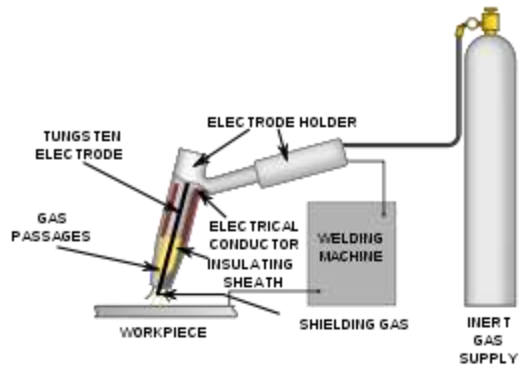

Fig.2. GTAW system setup

As with other welding processes such as gas metal arc welding, shielding gases are necessary in GTAW to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity, and weld metal embrittlement if they come in contact with the electrode, the arc, or the welding metal. The gas also transfers heat from the tungsten electrode to the metal, and it helps start and maintain a stable arc.

The selection of a shielding gas depends on several factors, including the type of material being welded, joint design, and desired final weld appearance. Argon is the most commonly used shielding gas for GTAW, since it helps prevent defects due to a varying arc length. When used with alternating current, argon shielding results in high weld quality and good appearance. Another common shielding gas, helium, is most often used to increase the weld penetration in a joint, to increase the welding speed, and to weld metals with high heat conductivity, such as copper and aluminum. A significant disadvantage is the difficulty of striking an arc with helium gas, and the decreased weld quality associated with a varying arc length.

Argon-helium mixtures are also frequently utilized in GTAW, since they can increase control of the heat input while maintaining the benefits of using argon.

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Normally, the mixtures are made with primarily helium (often about 75% or higher) and a balance of argon. These mixtures increase the speed and quality of the AC welding of aluminum, and also make it easier to strike an arc. Another shielding gas mixture, argon-hydrogen, is used in the mechanized welding of light gauge stainless steel, but because hydrogen can cause porosity, its uses are limited. Similarly, nitrogen can sometimes be added to argon to help stabilize the austenite in austenitic stainless steels and increase penetration when welding copper. Due to porosity problems in ferritic steels and limited benefits, however, it is not a popular shielding gas additive

ELECTRODE

The electrode used in GTAW is made of tungsten or a tungsten alloy, because tungsten has the highest melting temperature among pure metals, at 3,422 °C (6,192 °F). As a result, the electrode is not consumed during welding, though some erosion can occur. Electrodes can have either a clean finish or a ground finish—clean finish electrodes have been chemically cleaned, while ground finish electrodes have been ground to a uniform size and have a polished surface, making them optimal for heat conduction. The diameter of the electrode can vary between 0.5 and 6.4 millimetres (0.02 and 0.25 in), and their length can range from 75 to 610 millimetres (3.0 to 24.0 in).

A number of tungsten alloys have been standardized by the International Organization for Standardization and the American Welding Society in ISO 6848 and AWS A5.12, respectively, for use in GTAW electrodes, and are summarized in the adjacent table.Pure tungsten electrodes (classified as WP or EWP) are general purpose and low cost electrodes. They have poor heat resistance and electron emission. They find limited use in AC welding of e.g. magnesium and aluminum. Cerium oxide (or ceria) as an alloying element improves arc stability and ease of starting while decreasing burn-off. Cerium addition is not as effective as thorium but works well, and cerium is not radioactive. An alloy of lanthanum oxide (or lanthana) has a similar effect as cerium, and is also not radioactive. Thorium oxide (or thoria) alloy electrodes offer excellent arc performance and starting, making them popular general purpose electrodes. However, it is somewhat radioactive, making inhalation of thorium vapors and dust a health risk, and disposal an environmental risk. Electrodes containing zirconium oxide (or zirconia) increase the current capacity while improving arc stability and starting and increasing electrode life.

III. CONCLUSION

RUN ORDER	INPUT PARAMETERS		OUTPUT RESPONSES			
	WC (Amps)	GFR (L/min)	UTS (Mpa)	YS (N/mm^2)	BHN	PE (%)
R1	110	5.5	92.6	35.79	95	5.55
R2	120	5.5	92.81	74.21	73	4.28
R3	110	6.5	75.73	47.79	92	4.00
R4	120	6.5	54.48	36.94	69	5.40
R5	105	6	23.23	30.35	72	5.00
R6	125	6	30.13	49.36	55	5.25
R7	115	5	110.85	66.36	106	4.66
R8	115	7	104.61	55.38	98	4.25
R9	115	6	95.44	67.36	112	4.15
R10	115	6	112.24	67.34	116	4.38
R11	115	6	95.89	67.33	112	4.59
R12	115	6	121.5	72.89	109	4.25
R13	115	6	90.44	61.38	109	4.55

Optimal value of aluminium alloy 5052-6061 can be found successfully.

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