A Study of Various Welding Parameters on TIG Welding & Aluminium Alloy-2014

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Abstract— With the development of methods the modern welding technology started just before the end of 19th century for generating high temperature in localized zone. To produce a high temperature zone and to melt raw material welding generally requires a heat source, though without much increase in temperature it is possible to weld two metal pieces. Different standards and methods are adopted, and for new and improved method of welding, there is still a continuous search. The demand for the new welding materials having large thickness components increases, mere gas flame welding, usually are welding engineer known, which is not satisfactory and improved as the development in tungsten insert gas welding, metal insert gas welding, laser and electron beam welding [1].

Key words: TIG Welding Machine, Aluminum Alloy-2014, ER-1100, Hardness, Tensile Strength

I. INTRODUCTION

In 1930 during Second World War, for welding aluminum and magnesium in aircraft industry, the TIG welding was demonstrated first by Russell Meredith. To every branch of manufacturing welding technology has obtained access virtually; to name a few, pipeline, aircraft, automobiles, launch vehicles, nuclear power plants, ships, building construction, rail road equipment's, boilers. With the widespread applications of welding, the welding technology needs constant upgrading [2]. By causing coalescence the welding joins materials, usually metals, or a thermoplastic which is fabrication or sculptural process. To produce the weld, TIG welding uses a non-consumable tungsten electrode which is an arc welding process.

By an inert shielding gas (argon or helium) the weld area is protected from atmosphere, and a filler metal is normally used. From the power source (rectifier), the power is supplied, through a hand-piece or welding torch, the power is supplied from the power source (rectifier) and is delivered to a tungsten electrode which is fitted into the hand piece. Then between the tungsten electrodes an electric arc is created and a constant-current welding power supply is used by work piece that produces the energy and through a column of highly ionized gas and metal vapors it conducted across the arc [1]. From the surrounding air by inert gas the tungsten electrode and the welding zone are protected. Up to 20,000°C temperatures can produced by the electric arc and to melt and join two different part of material this heat can be focused. To join the base metal with or without filler material, the weld pool can be used. In figure 1 and figure 2 the Schematic diagram of TIG welding and mechanism of TIG welding are shown respectively. From 0.5 mm to 6.4 mm diameter and150 - 200 mm length the Tungsten electrodes are commonly available.

Fig. 4.1: TIG Welding Setup– Ever last TIG 250 AC/DC TIG Welding System.

II. PRINCIPLES OF TIG WELDING

With the electrode connected to the negative pole of the power source, DCEN for welding most of materials TIG process conventionally uses direct current. An efficient oxide removal does not given by the welding on this polarity. If in the DCEN (direct current electrode negative) or DCSP (Direct Current Straight Polarity) 2/3rd of the heat then it is concentrated on the weld joint. On the tungsten electrode, the DCEP (direct current electrode positive)or DCRP (Direct Current Reverse Polarity)2/3 rd of the heat is concentrated. For DCEN penetration is deepest, least for DCEP and less for AC.

A. DCSP - Direct Current Straight Polarity

Direct current is used in this type of TIG welding. The negative terminal of power supply is connected with the Tungsten electrode. DC welding process is most commonly and widely used by this type of connection. The negative terminal is being connected with the tungsten; it will only receive 30% of the welding energy (heat). A good penetration and a narrow profile are shows by the resulting weld.

B. DCRP - Direct Current Reverse Polarity

The positive terminal of power supply is connected with the tungsten electrode in this type of TIG welding setting. Because most heat is on the tungsten, this type of connection is used very rarely, so the tungsten can easily burn away and easily overheat. A shallow is produces by the DCRP, at low Amp wide profile and is mainly used on very light material.

C. AC - Alternating Current

For most white metals, it is the preferred welding current, e.g. magnesium and aluminum. From one side of the wave to the other, the heat input to the tungsten is averaged out as

the AC wave passes. The tungsten electrode is positive on the half cycle, from base material to the tungsten, the electrons will flow. On the base material, this will result in the lifting of any oxide skin.

This side of the wave form is called the cleaning half. The wave moved to the point where negative will be the Tungsten and the electron flow will be from the welding tungsten electrode to the base material. The cycle's side is known as the penetration AC wave forms half and also known as Anodic cleaning.

D. Alternating Current with Square Wave

With a wave form and with the advent of modern electricity AC welding machines can now be produced called Square Wave. The each side of the square wave can give a more penetration and cleaner half of the welding cycle and it has a better control [3].

III. TIG WELDING ADVANTAGES

Over other arc welding process, the TIG welding processes have specific advantages as follows:-

- Concentrated Narrow arc
- Ferrous and non-ferrous metals are able to weld by TIG welding
- Flux is not used by TIG welding and does not leave any slag (to protect the weld-pool and tungsten electrode shielding gas is used)
- During TIG welding, there is no spatter and fumes

IV. TIG WELDING APPLICATIONS

For metal plate of thickness around 5- 6 mm the TIG welding process is best suited. Using multi passes, the TIG can also weld the thicker material plate which results in high heat inputs, and in mechanical properties of the base metal leading to the distortion and reduction. Due to high degree of control in heat input and filler additions separately in TIG welding high quality welds can be achieved. In all positions and the process TIG welding can be performed that is useful for the pipe and tube joint.

The TIG welding needs very little finishing or sometimes no finishing because it is a highly controllable and clean process. For both manual and automatic operations, this welding process can be used. In the so-called high-tech industry applications such as-

- Aircraft
- Nuclear industry
- Maintenance and repair work
- Food processing industry
- Precision manufacturing industry
- Automobile industry

V. TIG WELDING PROCESS PARAMETERS

The quality and outcome of the TIG welding process affected parameters are given below:

A. Welding Current

To splatter and work piece become damaged and the higher current in TIG welding can lead. Lead to sticking of the filler wire again lower current setting in TIG welding. For lower welding current sometimes larger heat affected area can be found and to deposit the same amount of filling materials as high temperatures need to applied for longer periods of time. In order to maintain a constant arc current, the fixed current mode will vary the voltage.

To perform welding a welding power supply is a source that provides an electric current. High current is required by the welding and in welding; it can need above 12,000 amperes. With gas tungsten arc welding, the low current can also be used welding two razor blades together at 5 amps. As the pulse current, the higher current state is known, while the lower current level is called the background current. The weld area is heated and fusion occurs during the period of pulse current.

The weld area is allowed to cool and solidify as the background current is dropped. There are a number of advantages of Pulsed-current GTAW, including warp age in thin work pieces and lower heat input and consequently a reduction in distortion.In addition, the weld pool greater control is allowed by this, and weld penetration can increase quality and welding speed. A similar method GTAW manual is programmed to program a specific rate and magnitude of current variations; it allows the operator for specialized applications making it useful [4].

B. Welding Voltage

Voltage defining as the two points having potential difference or the electric potential energy difference between two points per unit charge, known as electric tension or electrical potential difference. [4]Depending on the TIG welding equipment, the welding Voltage can be fixed or adjustable. A greater range of working tip distance and easy arc initiation, the high initial voltage is allowed. In welding quality high voltage can lead to the large variable.

C. Inert Gases

The working metals dependent is the shielding gas choice and effects on the welding cost, splatter, electrode life, arc stability, weld temperature, weld speed etc. The finished weld penetration depth and hardness and brittleness, surface profile, corrosion, strength, resistance, porosity, of the weld material is also affected by this. For TIG welding applications, the Argon or Helium may be used successfully. Pure argon is used for welding of extremely thin material. An arc is provided by the Argon which operates more smoothly and quietly. By the use of Helium, penetration of arc is less when Argon is used than the arc is obtained.

For most of the applications, the argon is preferred by these reasons, except in larger thickness where higher heat and penetration is required for welding metals of high heat conductivity. The Copper and aluminum are high heat conductivity metal and are examples of the type of material for which helium is advantageous in welding relatively thick sections. For welding of some grades of nickel alloys and stainless steels, the Argon hydrogen mixture is used. For aluminum and copper, the pure helium mixture is used. For low alloy steels, copper and aluminum, the Helium argon mixtures may be used.

D. Welding Speed

For TIG welding the welding speed is important parameters. The heat or power input per unit length of weld is decreases if the welding speed increases, therefore less weld reinforcement results and penetration of welding decreases. The bead size and penetration of weld is controlled by the

welding speed or travel speed. With current, it is interdependent. Decreases wetting action, increases tendency of undercut when there is excessive high welding speed.

E. Gas Flow

For welding running through an outlet flow gauge before travelling to the welder through the gas hoses and regulator, the shielding gas is used. The outlet flow gauge is replaced by a flow meter. With gas flow increments marked around the tube, a flow meter is an enclosed tapered glass or plastic cylinder. A ball float rests by inside the tube. Through the flow meter when the gas flows, through the flow meter the float rises to the amount of gas flowing and to the welding machine

VI. ALUMINUM ALLOY AL-2014

In the aerospace industry, 2014 aluminum alloy or an aluminum-based alloy is often used. However, it is difficult to weld, as it is subject to cracking[5]. After 2024-aluminum alloy, the 2014-aluminum alloy is the second most popular of the 2000-series aluminum alloys. It is commonly forged and extruded. This alloy corrosion resistance is particularly poor. With pure aluminum, it is often clad to combat this. It should be painted as a corrosion protection measure, if unclad 2014 aluminum is to be exposed to the elements. The Al-2014 aluminum alloy is one of the 2xxx-series heat-treatable aluminum alloys. In order to find out the weakest locations of the joints and determine the optimum TIG welding parameters, this paper aims to demonstrate its TIG weldability and the emphasis is placed on the relations of the tensile properties and hardness to the welding parameters.

A. Aluminum Properties & Advantages

The specific weight of aluminum is 2.7 g/cm^3 and very light weight metal. In automobile and aerospace, the use of aluminum is to reduce dead-weight and energy consumption. For various applications by modifying the composition of its alloys as the strength of Aluminum can be improved as per the required properties. Aluminum is a highly corrosion resistant material. Its corrosion resistance property can further improve by the different types of surface treatment. In major power transmission lines, this has made aluminum the most commonly used material. Aluminum has a low melting point and it is ductile. In a number of ways and in a molten condition, it can be processed. To the end of the product's design, its ductility allows products of aluminum to be basically formed close.

B. Applications AA-2014

- Fuselage and pressure cabins
- Wings
- Empennage (horizontal and vertical stabilizers)
- Fuel Tanks of the Space Shuttle are 2xxx alloys
- Heavy dump and tank trucks and trailer trucks employ 2xxx extrusions for their structural members.

Numerous Multi Attribute Decision Taking models have been proposed in the literature to decidethe optimal criteria[6,7,8].

VII. CONCLUSION

In many ways such as riveting (temporary joint) bolting and welding (permanent methods), the Aluminum can be joined. By a variety of methods, Aluminum and its alloys are welded in industry. Aluminum thermal conductivity is quite high; therefore from the welding area heat is easily conducted away. To rapidly reach aluminum's melting point of 565 /650ºC, it is essential that the heat source is powerful enough. As compared to steel, the coefficient of thermal expansion of Aluminum is also high, so if the proper welding procedure is not followed, it is prone to distortion and stress inducement. On the surface and strength of the weld area become weak because Aluminum is a reactive metal that quickly forms an oxide layer. Therefore by conventional arc welding process, the welding of Aluminum is become difficult.

Aluminum and its alloys could be easily welded by understanding the welding characteristics and utilizing proper procedures. An electric arc with a permanent tungsten electrode plus filler wire with AC current or with a continuously fed wire electrode [with DC current, with and without pulsed current] is used by the most common commercial aluminum and aluminum alloy welding methods. The weld quality is acceptable to ensure, to consider breaking loose and removing the oxide film there two basic factors, and during the weld process preventing the formation of new oxide. Before welding commences, it is essential that proper preparations and precautions always be taken. In the welded joint the area must be clean and completely dry as grease and moisture can form gases and cause pores.

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