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Effect of Welding Parameters on TIG Welding of Aluminium Plate

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ABSTRACT:

Aluminum is a material that is now widely used for welding because this material has good mechanical properties, is corrosion resistant, is light in weight and can be recycled. The problem that occurs in aluminum welding is the presence of a passive layer or layer of Al2O3 oxide which has a high affinity for oxygen. This oxide layer is also an insulator which can inhibit the flow of current in welding. The amount of current in the welding process greatly affects the amount of heat input, weld concentration and arc stress. The purpose of this study was to determine changes in the mechanical properties of tensile strength and hardness of welded metal joints with variations in welding current using the TIG welding process. The stages of the research method carried out were to carry out the TIG welding process on aluminum material joints with variations in currents.

1. Introduction

Welding is a everlasting becoming a member of manner used to sign up for one of a kind materials like metals, alloys or plastics, together at their contacting surfaces by means of software of heat and or strain. During welding, the paintings-pieces to be joined are melted at the interface and after solidification a everlasting joint may be achieved. Sometimes a filler material is delivered to shape a weld pool of molten cloth which after solidification gives a strong bond between the substances. Weld capacity of a fabric relies upon on specific elements like the metallurgical adjustments that arise at some stage in welding, modifications in hardness in weld region due to speedy solidification, quantity of oxidation because of reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

1.1 Different form of welding procedures

Based on the heat supply used welding procedures can be categorized as follows:

- **Arc Welding**: In arc welding system an electric power supply is used to produce an arc among electrode and the paintings-piece material to joint, so that work-piece metals soften at the interface and welding can be executed. Power supply for arc welding system may be AC or DC type. The electrode used for arc welding will be consumable or non-consumable. For non-consumable electrode an outside filler fabric might be used.
- **Gas Welding**: In fuel welding procedure a targeted excessive temperature flame produced by using combustion of fuel or gas aggregate is used to soften the paintings pieces to be joined. An outside filler material is used for proper welding. Most common type gasoline welding process is Oxy- acetylene fuel welding where acetylene and oxygen react and producing some warmness.
- **Resistance Welding**: In resistance welding heat is generated because of passing of excessive quantity present day (1000 – 100,000 A) through the resistance caused by the touch between two metal surfaces. Most common kinds resistance welding is Spot-welding, wherein a pointed electrode is used. Continuous type spot resistance welding may be used for seam-welding where a wheel-formed electrode is used.
- **High Energy Beam Welding**: In this kind of welding a targeted electricity beam with excessive intensity such as Laser beam or electron beam is used to melt the work portions and be part of them.
- **Collectively:** These styles of welding particularly used for precision welding or welding of advanced material or from time to time welding of dissimilar substances, which isn't always feasible via conventional welding process.
- **Solid-State Welding**: Solid-state welding approaches do now not involve melting of the paintings piece substances to be joined. Common sorts of strong-state welding are ultrasonic welding, explosion welding, electromagnetic pulse welding, friction welding, friction-stir-welding and many others.

- **Arc Welding:**

Among a lot of these varieties of welding strategies arc welding is widely used for specific styles of substances. Common varieties of arc welding manner are:

A) Shielded Metal Arc Welding (SMAW) or Manual Metal Arc Welding: This is maximum not unusual type arc welding method, wherein a flux coated consumable electrode is used. As the electrode melts, the flux disintegrates and produces shielding fuel that protect the weld location from atmospheric oxygen and other gases and produces slag which covers the molten filler steel because it switch from the electrode to the weld pool. The slag floats to the floor of weld pool and protects the weld from atmosphere as it solidifies.

B) Gas Metal Arc Welding (GMAW) or Metal inert or lively gasoline welding (MIG/MAG): In this kind of welding system a non-stop and consumable wire electrode is used. A protective gasoline commonly argon or now and again aggregate of argon and carbon dioxide are blown through a welding gun to the weld area.

C) Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas (TIG): GTAW or TIG welding process is an arc welding manner uses a non consumable tungsten electrode to provide the weld. The weld area is covered from ecosystem with a shielding fuel typically Argon or Helium or on occasion mixture of Argon and Helium. A filler metallic may additionally additionally feed manually for proper welding. GTAW most generally referred to as TIG welding method become advanced in the course of Second World War. With the improvement of TIG welding manner, welding of difficult to weld materials e.g. Aluminium and Magnesium end up possible. The use of TIG today has unfold to a selection of metals like chrome steel, slight metallic and high tensile steels, Al alloy, Titanium alloy. Like different welding gadget, TIG welding electricity assets have additionally stepped forward from primary transformer types to the surprisingly electronic controlled energy source today.

2. Basic mechanism of TIG welding:

TIG welding is an arc welding procedure that uses a non-consumable tungsten electrode to provide the weld. The weld area is blanketed from atmosphere by means of an inert protective fuel (argon or helium), and a filler metallic is normally used. The power is supplied from the electricity supply (rectifier), through a hand-piece or welding torch and is introduced to a tungsten electrode which is equipped into the hand piece. An electric arc is then created among the tungsten electrode and the work piece the use of a constant-cutting-edge welding power supply that produces strength and carried out across the arc through a column of extraordinarily ionized gasoline and metallic vapours [1]. The tungsten electrode and the welding sector are covered from the surrounding air by way of inert gasoline. The electric arc can produce temperatures of up to 20,000oC and this heat can be centered to soften and be a part of two exceptional part of cloth. The weld pool may be used to enroll in the base steel with or without filler cloth. Schematic diagram of TIG welding and mechanism of TIG welding are shown in fig. 1 & fig. 2 respectively.

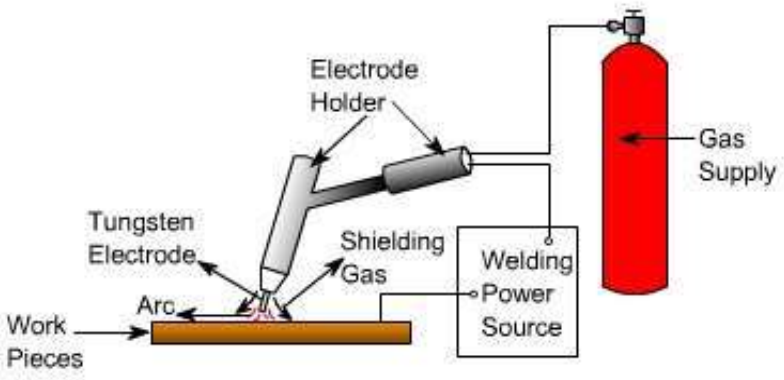

Fig 1: Schematic Diagram of TIG Welding System. [Ref*:* 1]

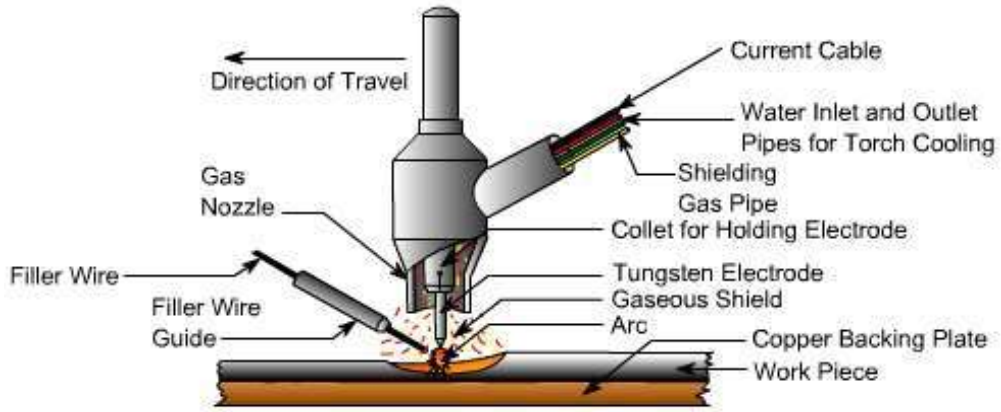

Fig. 2: Principle of TIG Welding. [Ref*:* 1**]**

Tungsten electrodes are commonly available from 0.5 mm to six.4 mm diameter and one hundred fifty - 200 mm duration. The current wearing ability of every length of electrode depends on whether or not it's miles related to bad or high-quality terminal of DC energy supply.

The power supply required to hold the TIG arc has a drooping or regular present day feature which affords an essentially constant cutting-edge output when the arc period is numerous over several millimeters. Hence, the natural versions within the arc period which occur in guide welding have little impact on welding present day. The capacity to limit the current to the set fee is similarly essential while the electrode is brief circuited to the work piece, in any other case excessively high cutting-edge will waft, unfavorable the electrode. Open circuit voltage of strength source ranges from 60 to 80 V.

3. Types of welding contemporary utilized in TIG welding

a. DCSP (Direct Current Straight Polarity): In this type of TIG welding direct current is used. Tungsten electrode is attached to the poor terminal of electricity deliver. This kind of connection is the maximum common and widely used DC welding procedure. With the tungsten being related to the negative terminal it'll most effective get hold of 30% of the welding energy (warmness). The ensuing weld suggests accurate penetration and a narrow profile.

b. DCRP (Direct Current Reverse Polarity): In this kind of TIG welding putting tungsten electrode is attached to the effective terminal of strength supply. This form of connection is used very rarely because most heat is at the tungsten, therefore the tungsten can easily overheat and burn away. DCRP produces a shallow, extensive profile and is particularly used on very light cloth at low Amp.

c. AC (Alternating Current): It is the favored welding modern for maximum white metals, e.g. Aluminum and magnesium. The heat input to the tungsten is averaged out as the AC wave passes from one aspect of the wave to the other. On the half of cycle, where the tungsten electrode is fantastic, electrons will glide from base fabric to the tungsten. This will bring about the lifting of any oxide skin on the bottom fabric. This facet of the wave shape is called the cleaning half. As the wave moves to the point in which the tungsten electrode will become bad the electrons will glide from the welding tungsten electrode to the bottom material. This facet of the cycle is known as the penetration half of the AC wave paperwork.

d. Alternating Current with Square Wave: With the appearance of current energy AC welding machines can now be produced with a wave shape called Square Wave. The square wave has better control and every aspect of the wave can provide a greater cleaning half of the welding cycle and more penetration [2].

4. Applications of TIG Welding

The TIG welding process is satisfactory appropriate for metal plate of thickness around 5 - 6 mm. Thicker cloth plate can also be welded by means of TIG the use of multi passes which results in excessive warmth inputs, and leading to distortion and discount in mechanical homes of the base steel. In TIG welding high fine welds can be performed due to high degree of manipulate in heat input and filler additions one after the other. TIG welding can be achieved in all positions and the method is useful for tube and pipe joint. The TIG welding is a particularly controllable and easy system desires very little finishing or every now and then no completing. This welding technique can be used for both guide and automated operations. The TIG welding method is notably used in the so-referred to as excessive-tech industry applications such as

I. Nuclear enterprise

II. Aircraft

III. Food processing industry

IV. Maintenance and repair work

V. Precision manufacturing industry

VI. Automobile enterprise

5. Process parameters of TIG welding

The parameters that affect the nice and final results of the TIG welding procedure are given beneath.

A) Welding Current

Higher contemporary in TIG welding can cause splatter and paintings piece emerge as damage. Again decrease contemporary placing in TIG welding cause sticking of the filler cord. Sometimes large heat affected place can be discovered for lower welding cutting-edge, as excessive temperatures need to carried out for longer durations of time to deposit the same quantity of filling materials. Fixed contemporary mode will range the voltage so one can preserve a steady arc modern-day.

B) Welding Voltage

Welding Voltage can be constant or adjustable depending on the TIG welding gadget. A high preliminary voltage lets in for smooth arc initiation and a extra variety of running tip distance. Too high voltage, can result in huge variable in welding exceptional.

C) Inert Gases

The preference of protecting gasoline is depends on the operating metals and consequences on the welding price, weld temperature, arc balance, weld pace, splatter, electrode existence and many others. It also influences the completed weld penetration intensity and surface profile, porosity, corrosion resistance, power, hardness and brittleness of the weld material. Argon or Helium may be used efficaciously for TIG welding programs. For welding of extraordinarily skinny material natural argon is used. Argon usually affords an arc which operates greater smoothly and quietly.

Penetration of arc is much less when Argon is used than the arc received with the aid of the usage of Helium. For these reasons argon is preferred for maximum of the applications, except in which better heat and penetration is needed for welding metals of excessive heat conductivity in large thicknesses. Aluminum and copper are metals of high warmth conductivity and are examples of the form of cloth for which helium is tremendous in welding especially thick sections. Pure argon can be used for welding of structural steels, low alloyed steels, stainless steels, aluminum, copper, titanium and magnesium. Argon hydrogen aggregate is used for welding of a few grades of stainless steels and nickel alloys. Pure helium may be used for aluminum and copper. Helium argon combinations can be used for low alloy steels, aluminum and copper.

D) Welding speed:

Welding speed is an vital parameter for TIG welding. If the welding pace is accelerated, power or warmth input in step with unit period of weld is decreases, consequently much less weld reinforcement outcomes and penetration of welding decreases. Welding pace or tour speed is mainly control the bead length and penetration of weld. It is interdependent with present day. Excessive welding velocity decreases wetting action, increases tendency of undercut, porosity and choppy bead shapes at the same time as slower welding pace reduces the tendency to porosity.

6. Properties and benefits of Al:

Aluminum is a very light weight metal (unique weight of 2.7 g/cm^3). Use of aluminum in vehicle and aerospace reduces lifeless-weight and power intake. Strength of Aluminium can be advanced as according to the required properties for various packages by using editing the composition of its alloys. Aluminum is a exceedingly corrosion resistant fabric. Different forms of floor treatment can further enhance its corrosion resistance belongings. Aluminum is an great warmth and electricity conductor and in relation to its weight is almost two times as excellent a conductor as copper. This has made aluminum the most generally used material in major strength transmission lines.

Aluminum is ductile and has a low melting factor. In a molten situation it is able to be processed in a number of approaches. Its ductility lets in products of aluminum to be basically formed near the stop of the product's design [3].

7. Welding of Aluminum and Aluminum alloy

Aluminum can be joined in many ways inclusive of bolting, riveting (brief joint) and welding (permanent methods). Aluminum and its alloys are welded in enterprise by an expansion of techniques.

Thermal conductivity of Aluminium is pretty excessive; therefore warmth is without difficulty performed far from the welding region. It is crucial that the heat supply is powerful sufficient to rapidly attain aluminium's melting point of 565 /650ºC. Coefficient of thermal expansion of Aluminium is also high in comparison to metallic, so it's miles at risk of distortion and pressure inducement if the right welding technique isn't accompanied. Aluminium is a reactive metallic that fast paperwork an oxide layer on the floor and power of the weld region become vulnerable. Therefore welding of Aluminium through conventional arc welding procedure is come to be tough.

By information the welding characteristics and utilizing right procedures Aluminum and its alloys will be without difficulty weld. The maximum not unusual industrial aluminum and aluminum alloy welding methods use an electric powered arc with either a continuously fed wire electrode [with DC current, with and without pulsed current] or a everlasting tungsten electrode plus filler twine with AC contemporary.

To make certain an suitable weld quality, there are two basic factors to keep in mind - breaking unfastened and removing the oxide film, and preventing the formation of recent oxide throughout the weld technique. It is important that right arrangements and precautions always be taken earlier than welding commences. The surfaces to be joined and the area around the weld quarter [~50 mm] must be degreased the use of as solvent [acetone or toluene] and a smooth cloth. The vicinity should be smooth and completely dry as grease and moisture can form gases and purpose pores inside the welded joint [4].

Conclusion

From the study of TIG welding of Aluminum plate following conclusion can be made:

- With the automated welding system uniform welding of Aluminum plate can be possible.
- At lower welding speeds strength is more due to more intensity of current.
- For both side welding tensile strength is found almost equivalent to the strength of base material.
- For both sided welding perform

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