STRENGTH OF GAS TUNGSTEN ARC WELDING JOINT

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ABSTRACT

Welder that involve in small business obviously not using gas tungsten arc welding because of the high cost. This welding is suitable for materials that have a high ability of strength. This welding often use in heavy and middle industry and the strength of the welding joint is proven by the majority of the heavy industry like piping. The advantage of using gas tungsten arc welding are the strength and do not have to use the grinder because the surface of the weld is already smooth. Skill and technique of handle the current and material that used to this welding is very useful because it complex than others. Stainless steel and mild steel is used in this project and the material is weld in tee joint, butt joint and lap joint. To test the joining that been weld, Instron tensile machine is used. The study shows that stainless steel that use lap joint has a maximum strength that is 0.97255 MPa. The study also show that the joint is effect the strength of the welding, and for that the suitable joint that use is lap joint.

ABSTRAK

Kimpalan arka tungsten adalah suatu jenis kimpalan yang jarang digunakan oleh perniagaan mengimpal yang berskala kecil kerana kos yang mahal. Kimpalan ini sesuai digunakan untuk mengimpal besi yang mempunyai ketahanan yang tinggi seperti aluminum dan besi yang tidak berkarat. Penggunaannya lebih kepada industri berat dan sederhana. Kekuatan kimpalan ini terbukti dengan banyak digunakan di industri berat seperti mengimpal paip besi. Ia mempunyai kelebihan kerana tidak perlu dicanai dan struktur pada kimpalan lebih kukuh berbanding menggunakan jenis kimpalan yang lain. Teknik serta skil diperlukan untuk mengendali kimpalan ini, dari segi arus elektrik serta material yang digunakan. Material seperti logam tahan karat serta logam lembut digunakan. Cantuman berbentuk T, hujung ke hujung serta lipatan digunakan untuk menguji kekuatan kimpalan. Eksprimen tegangan dilakukan dengan menggunakan mesin Instron. Keputusan telah menunjukkan bahawa kekuatan yang paling tinggi adalah pada logam yang tidak berkarat yang menggunakan cantuman lipatan iaitu 0.97255 MPa. Kajian telah mendapati bahawa cantuman memberi kesan kepada kekuatan kimpalan itu. Maka jenis cantuman lipatan adalah paling sesuai antara tiga jenis cantuman tadi.

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GTAW	-	Gas Tungsten Arc Welding
El	-	Percent of Elongation
Lf	-	New Elongation
Lo	-	Elongation by Gauge Length
MPa	-	Mega Pascal
KN	-	Kilo Newton
UTS	-	Ultimate Tensile Stress

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Welding is a process critical to our present state of civilization and technical advancement. In this era, the technology of welding more advance and give many advantage to mankind. From the simplest shape like table until the complex like construction of space shuttle, the used of welding is very important. The technology of welding has been used in the sea, land and even at the space. The purpose of welding is to joint and give the strength to the material from being fracture.

1.2 Problem Statement

The design of the joint may not suitable for some condition, the design may not ergonomically and the strength of joining is not very good. These problems arise because of affected by the environment and the outside force. The strength of joining may not same for 3 or 4 years after being weld. The skill for welding is very important to get the good result and minimize delamination.

1.3 Project objective

a) To measure the strength of gas tungsten arc welding joint.

1.4 Project scope

a) To fabricate specimen for testing
b) To test the joining strength
c) To study factors that affecting the strength

1.5 Project background

Gas tungsten arc welding (GTAW) will be used as a welding technique in this project. The experiment was done to understand the factors contribute to the welding weakness. The procedure shall be carried out to get an optimum welding joint strength. The factors that affected the strength of the joint such as an angle of the material to weld, the right power to use and defect like porosity, lamination, delaminations will be analyzed in the project.

CHAPTER 2

LITERATURE REVIEW

2.1 History

The development of the GTAW process was accelerated early in 1940. Initially the process was called ''Heliarc'', because Helium was used for the shielding gas. Later when argon was available the process was renamed tungsten inert gas or ''TIG''.

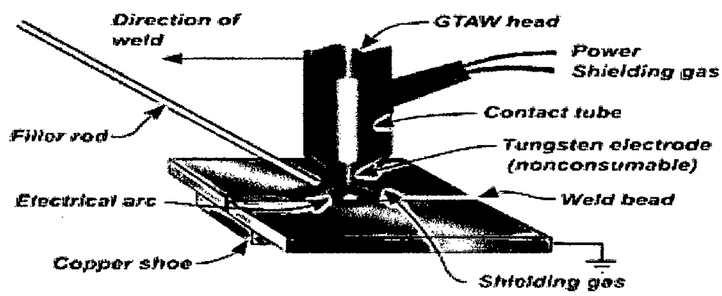

Figure 2.1: Gas Tungsten Arc Welding Operation

Now, it is generally and preferably called gas tungsten arc welding (GTAW), as gases other than argon and helium, which are inert, can be mixed with them. Hydrogen, for example, may be included for its special benefits. The development of aircraft in the World War 2 make the researcher use TIG as intensive for joining such non-ferrous material such as aluminium and magnesium. The process can be used to weld thin or thick materials with or without a filler metal. Development within the GTAW process has continued as well, and today a number of variations exist. Among the most popular are the pulsed-current, manual programmed, hot-wire, dabber, and increased penetration GTAW methods. (Cary, Howard B. and Scott C. Helzer ;2005)

2.2 Types Of Welding

2.2.1 Shielded Metal Arc Welding (SMAW)

Shielded metal arc welding (SMAW), also known as manual metal arc (MMA) welding or informally as stick welding, is a manual arc welding process that uses a consumable electrode coated in flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination. SMAW is often used to weld carbon steel, low and high alloy steel,

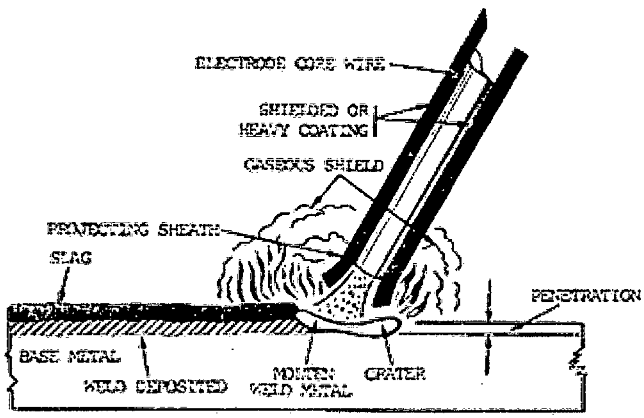

Figure 2.2: Shielded metal arc welding weld area

stainless steel, cast iron, and ductile iron. While less popular for nonferrous materials, it can be used on nickel and copper and their alloys and, in rare cases, on aluminum. The thickness of the material being welded is bounded on the low end primarily by the skill of the welder, but rarely does it drop below 0.05 in (1.5 mm). No upper bound exists: with proper joint preparation and use of multiple passes, materials of virtually unlimited thicknesses can be joined. Furthermore, depending on the electrode used and the skill of the welder, SMAW can be used in any position. (Jeffus, Larry ;1999).

2.2.2 Gas metal arc welding (GMAW)

Gas metal arc welding (GMAW), sometimes referred to by its subtypes, metal inert gas (MIG) welding or metal active gas (MAG) welding, is a semi-automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations.

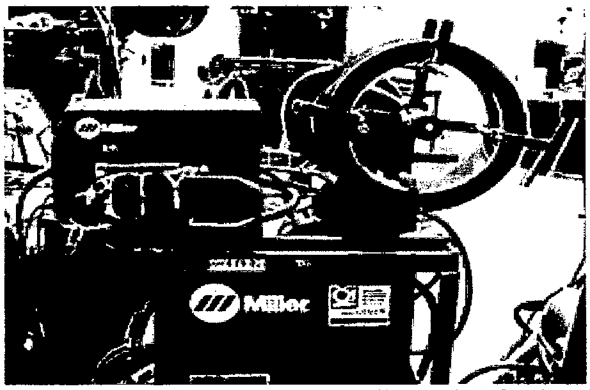

Figure 2.3: Gas metal arc welding wire feed unit

Today, GMAW is one of the most popular welding methods, especially in industrial environments. It is used extensively by the sheet metal industry and, by extension, the automobile industry. There, the method is often used to do arc spot welding, thereby replacing riveting or resistance spot welding. It is also popular in robot welding, in which robots handle the workpieces and the welding gun to quicken the manufacturing process.

2.2.3 Oxyacetylene Welding

Oxyacetylene welding is a gas welding process. A coalescence or bond is produced by heating with a gas flame or flames obtained from the combustion of acetylene with oxygen, with or without the application of pressure, and with or without the use of filler metal. Acetylene is widely used as the combustible gas because of its high flame temperature when mixed with oxygen.

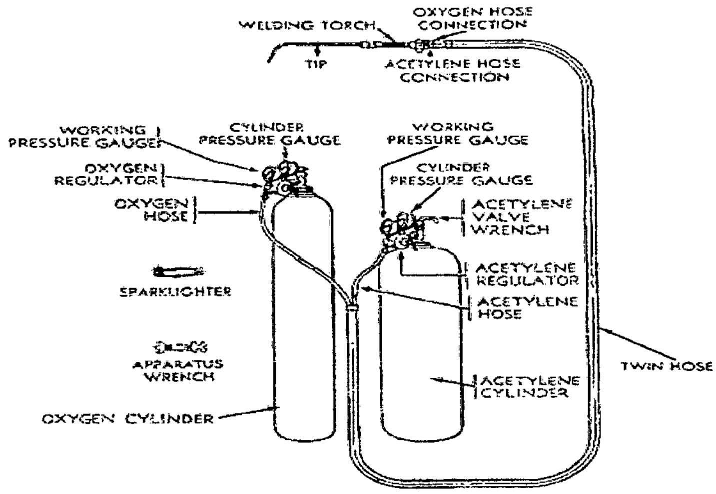

Figure 2.4: Portable oxyacetylene welding and cutting equipment

The temperature, which ranges from approximately 5,700° to 6,300°F, is so far above the melting point of all commercial metals that it provides a means for the rapid, localized melting essential in welding.The oxyacetylene flame is also used in cutting ferrous metals. The oxyacetylene welding and cutting methods are widely used by all types of maintenance activities because the flame is easy to regulate, the gases may be produced inexpensively, and the equipment can be transported easily and safely. (Kalpakjian, and R. Schmid ,2001).

2.2.4 Gas Tungsten Arc Welding (GTAW)

(GTAW) Gas tungsten arc welding provides high-quality welds because of the gas shielding of the molten weld pool. The welding arc is created between a tungsten electrode, which is non-consumable, and the weld pool. The welding can be autogenous (without filler material), or with filler rod/wire. Because of the shielding and high concentration of heat it is used on refractory and reactive metals which oxidize readily without inert gas protection.

Power supplies are the constant or drooping output types and may use either DC or AC current with transformers and rectifiers. Direct current is most often used with the torch electrode being either negative or positive. In welding refractory alloys, aluminum, alternating current is preferred for its oxide removal advantage. For direct current (DC) welding the powers supply can incorporate a pulse forming network. Pulse repetition rates are adjustable as are the pulse profiles. Power supplies may include electronically controlled features such as up slopes and down slopes. The latter are necessary to eliminate craters and crater cracking at the beginning and ends of welds or to accommodate thickness changes. For manual welding much of this power supply sophistication is not used, as the skilled welder modifies his technique as he observes variations in the weld pool during the progress of the weld. For most types of welding

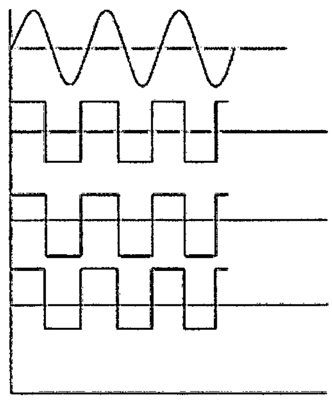

Figure 2.5: Square wave technology alters of sine wave

this high frequency is used only to initiate the arc, but for aluminum GTAW, the high frequency is present continuously and acts like a pilot arc. When selecting a power source, it usually is best to select a newer-technology square wave model, which alters the characteristics of the sine wave to create a more stable arc.

For GTA welding of carbon and stainless steel, the selection of a filler material is important to prevent excessive porosity. Oxides on the filler material and workpieces must be removed before welding to prevent contamination, and immediately prior to welding, alcohol or acetone should be used to clean the surface. Preheating is generally not necessary for mild steels less than one inch thick, but low alloy steels may require preheating to slow the cooling process and prevent the formation of martensite in the heat-affected zone. Tool steels should also be preheated to prevent cracking in the heat-affected zone. Austenitic stainless steels do not require preheating, but martensitic and ferritic chromium stainless steels do. (Minnick, 1996).

2.3 Technical description of Tungsten Inert Gas

Before Welding Starts: Steps 1-4

The following steps and suggestions address the basic areas of GTAW setup. However, they are no substitute for carefully reading the operator's manual, watching instructional videos, and following safety precautions such as wearing protective gloves and glasses.

2.3.1 Determine amperage requirements.

Each 0.001 inch of metal to be melted requires about 1 amp of welding power. For example, welding 1/8-inch aluminum requires about 125 amps.

2.3.2 Select the correct current.

AC should be used for aluminum, magnesium, and zinc die cast. When exposed to air, these metals form an oxide layer that melts at a much higher temperature than the base metal. If not removed, this oxide causes incomplete weld fusion. Fortunately, AC inherently provides a cleaning action. While the EN portion of the AC cycle directs heat into the work and melts the base metal, the EP portion—where current flows from the work to the electrode—blasts off the surface oxides.

2.3.3 Use the right gas.

Usually, pure argon is employed, although thicker weldments may require an argon/helium or other specialty mix. If the wrong gas is used, the tungsten immediately will be consumed or deposited in the weld puddle.

2.3.4 Set the proper gas flow rate.

More is not better, so 15 to 20 cubic feet per hour (CFH) should suffice. Argon is about 1-1/3 heavier than air. When used to weld in a flat position, the gas naturally flows out of the torch and covers the weld pool. For overhead welding, the gas flow rate should begin at 20 CFH, and small increments of 5 CFH can be made, if necessary.
In any position, if the gas flows out at too high a velocity, it can start a swirling motion parallel to the torch cup, called a venturi. A venturi can pull air into the gas flow, bring in contaminating oxygen and nitrogen, and create pinholes in the weld. Unfortunately, some operators automatically increase the gas flow when they see a pinhole, worsening the problem.

Before Welding Starts: Steps 5-12

2.3.5 Select the right type of tungsten.

However, for making critical welds on materials thinner than 0.09 inch, or when using a GTAW power source with an adjustable frequency output, new recommendations call for treating the tungsten almost as if the weld were being made in the DC mode. A 2 percent-type tungsten (thorium, cerium, etc.) should be selected and ground to a point in the long direction, making the point roughly two times as long as the diameter. A 0.010- to 0.030-inch flat should be made on the end to prevent balling and the tungsten from being transferred across the arc.

With a pointed electrode, a skilled operator can place a 1/8-inch bead on a fillet weld made from 1/8-inch aluminum plates. Without this technology, the ball on the end of the electrode would have forced the operator to make a larger weld bead and then grind the bead down to final size.

2.3.6 Select the right diameter of tungsten.

The current-carrying capacity of a tungsten is directly proportional to the area of its cross section.. For example, a 2 percent thoriated, 3/32-inch (0.093-inch) tungsten has a current-carrying capacity of 150 to 250 amps, whereas a 2 percent thoriated, 0.040-inch tungsten has a 15- to 80-amp capacity.

There is no such thing as an all-purpose electrode, despite the reputation of the 3/32-inch electrode. Attempting to weld at 18 amps with a 3/32-inch electrode will create arc starting and stability problems; the current is insufficient to drive through the electrode. Conversely, attempting to use a 3/32-inch tungsten to weld at 300 amps creates tungsten "spitting"—the excess current causes the tungsten to migrate to the workpiece.

2.3.7 Avoid tungsten contamination.

If the tungsten electrode becomes contaminated by accidentally touching the weld pool, welding must be stopped, because a contaminated electrode can produce an unstable arc. To break off the contaminated portion, the tungsten should be removed from the torch, placed on a table with the contaminated end hanging over the edge, and the contaminated portion struck firmly. The tungsten then should be resharpened.

2.3.8 Set the proper tungsten extension.

Electrode extension may vary from flush with the gas cup to a distance equal to the cup diameter. A general rule is to start with one electrode diameter, or about 1/8 inch. Joints that make the root of the weld hard to reach require additional extension, although extensions farther than 1/2 inch may result in poor gas coverage and require a special gas cup.

2.3.9 Select the correct filler metal.

The filler rod needs to be appropriate for the base metal in terms of type and hardness. It should be the same diameter as the tungsten electrode. The welder should refer to charts published by filler metal manufacturers detailing what filler to use for what base metal.

2.3.10 Select a high-frequency (HF) mode.

Inverters require HF for arc starting only because they drive the arc through the zero point so quickly that the arc does not have a chance to go out. For this same reason, inverters produce much less arc flutter. They also offer a lift arc starting method that avoids the use of HF altogether.

2.3.11 Control HF emissions.

High frequency interferes with computers, printed circuit boards, televisions, and other electronic equipment but is a necessary evil. It can be minimized by hooking the work clamp as close to the weldment as possible, keeping the welding torch and clamp cables close together (spreading them apart is like creating a big broadcast dish), and keeping the cables in good condition to prevent current leaks.

2.3.12 Set the balance control

Too much cleaning action (EP duration) causes excess heat buildup on the tungsten, which creates a large ball on the end. Subsequently, the arc loses stability, and the operator loses the ability to control the arc's direction and the weld puddle. Arc starts begin to degrade as well. (Mike Sammons, 19 February 2001)