UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF ARGON GAS RATIO TO QUALITY OF GAS WELDING

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) with honours

by

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TAJUK: **Effect of Argon Gas Ratio to Quality of Gas Welding**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Mechanical Engineering Technology) Hons. The member of the supervisory is as follow:

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ABSTRAK

Tujuan kajian ini dijalankan adalah untuk mengkaji kesan nisbah gas argon terhadap kualiti kimpalan. Kajian ini dilakukan untuk mengenal pasti nisbah gas argon dan karbon dioksida digabungkan bersama. Kedua, untuk menguji sambungan kimpalan dengan menggunakan pelbagai nisbah gas argon digabungkan dengan karbon dioksida. Sambungan kimpalan akan dilaksanakan dengan mengunakan proses GMAW dimana, logam dileburkan dengan menggunakan tenaga elektrik dan elektrod disuap secara berterusan. Ujian ketegangan dan zarah magnet akan dilakukan dan di analisis untuk mendapatkan keputusanya. Di akhir kajian ini, nisbah gas argon digabungkan dengan karbon dioksida yang optima akan dikenal pasti. sambungan kimpalan akan dijalankan dengan mengunakan pelbagai nisbah gas argon dan karbon dioksida.

ABSTRACT

The purpose of this research is to investigate the effect of argon ratio to quality of weld. This study is been done to identified the ratio of argon and carbon dioxide mixed. Secondly, to test the weld joint using variety of argon mixed carbon dioxide (CO2). The joint will be obtained by GMAW process in which melts metal by heat supplying an electric arc established between a continuously fed filler wire electrode. The result will be analyzed by means of tensile strength and magnetic particle test of weld joint. At the end of this study the optimum ratio of argon mixed carbon dioxide is identified and the weld joint is tested using variety of argon and carbon dioxide ratio.

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

The author wishes to take the opportunity to express his utmost gratitude to the individual that have taken the time and effort to assist the author in completing the project. Without the cooperation of these individuals, no doubt the author would have faced some complications throughout the course.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

H	-	Heat input
V	-	Voltage
I	-	Current
S	-	Speed
A	-	Area
W	-	Width
T	-	Thickness
L	-	Load
SMAW	-	Shielded Metal Arc Welding
GTAW	-	Gas tungsten arc welding
OAW	-	Oxy Acetylene welding
GMAW	-	Gas Metal Arc Welding
DCRP	-	Direct Current reverse polarity
Ar	-	Argon
He	-	Helium
CO2	-	Carbon Dioxide
AC	-	Alternating Current
DC	-	Direct Current
HAZ	-	Heat Affected Zone
NDT	-	Non Destructive Test
UTS	-	Ultimate Tensile Strength
$l_{\circ}$	-	Gauge length
$A_{\circ}$	-	Cross sectional Area
E	-	Young’s Modulus
σ	-	Stress
ϵ	-	Strain
p	-	Load

CHAPTER 1

INTRODUCTION

1.1 Introduction to gas metal arc welding

Gas metal arc welding (GMAW) or the other name is metal inert gas (MIG) is an important method in many industrial operation. Gas metal arc welding (GMAW) process is mostly used in heavy industry especially automotive industry for engine part assembly, chassis joint, several joint at automotive body and some type of metal fabrication joint.

Chen (2012) state that, gas metal arc welding is a method that melts and joint metal by heating them with an arc. The arc is between continuously fed filler wire (consumable) electrode and the workpiece. This technique most commonly used carbon dioxide (CO2) and argon (Ar) as an inert gas to protect arc and molten weld pool from outside contaminant. Argon (Ar) gas requires a lower arc voltage for ionization and provides excellent arc welding stability, and good weld profile on the base metal. Carbon dioxide (CO2) is used for welding applications requiring high heat. Carbon dioxide (CO2) produces a wider arc column and good conductor of thermal energy with higher thermal conductivity than argon. CO2 can improve depth of fusion, improve wetting action and travel speeds but can't provide arc welding stability

By using GMAW technique, if the workpiece weld is improperly joining, it is probable that the part of joining may not fuse well, or the weld joint surface may be defect, and the weld joint of the workpiece is not strong and the quality is not completely well. When using gas metal arc welding (gmaw) technique, most fatigue failure occurred at the structure of weld joint. This condition will give bad harm and dangerous to the surrounding. This experiment is to investigate the effect of different argon gas ratio to the quality of weld joint. This experiment also to find out the good quality of weld joint with the optimum percentage of argon gas.

1.2 Problem statement

Nowadays, gas metal arc welding technique is commonly used in many industrial operations. When using welding method, quality of weld joint is the most important to get the strong and safe work piece. In GMAW process argon and carbon dioxide commonly used as a shielding gas.

The primary function of shielding gas is to protect the arc from atmosphere gas such as nitrogen, water vapor, carbon dioxide and oxygen. By using argon gas it required a lower arc voltage for ionization, which provide better arc starting and arc stability (Z.H Rao, 2010).

Carbon dioxide is widely used for welding of mild steel. CO2 provide higher welding speed, better joint penetration and sound deposit with good mechanical properties. Using pure Carbon dioxide as a shielding gas will produce more spatters during welding process. For welding steels, the addition of oxygen or carbon dioxide to argon stabilizes the arc and reduces the spatter (Srinivasan, 2008). Based on previous study, by mixing argon and CO2, it will produce good quality compare to 100% pure gas. However, due to high price of argon gas, industry player tends not to use it during welding process to save the cost.

Nevertheless, the optimum argon gas percentage needed in each weld joint has yet been defined. Thus, this experiment will clarify the minimum argon gas usage in GMAW process enough to get the optimum quality of weld joint.

1.3 Objective

I. To identify the optimum ratio of argon gas and carbon dioxide mixed.
II. To test the weld joint using variety of argon mixed carbon dioxide.

1.4 Scope

I. To identify argon and carbon dioxide ratio by using GMAW technique
II. GMAW is conducted upon low carbon steel on lap joint.
III. Testing of welding joint conducted using tensile strength and magnetic particle test.
IV. Optimization of GMAW welding using different ratio of argon and Carbon dioxide.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction to welding process

Welding process has become increasingly important in almost all manufacturing industries and for structural fabrication. The major industrial employing welding process extensive is automotive industry, ship building, oil pipeline construction and aerospace industrial. Welding process can be classified in two categories such fusion welding and non fusion welding or solid state. In fusion welding, actual melting of the metal is involve in forming bond. For example, arc welding process and gas welding process. While in non fusion welding, pressure and heat energy are applied to the specimen to be joint and bonding occur primarily due to diffusion of atoms and intimate contact of clean surface. In non fusion welding, no melting process is involved, for example, cold welding and solid state welding. (Srinivasan, 2008)

2.2 Research type of welding

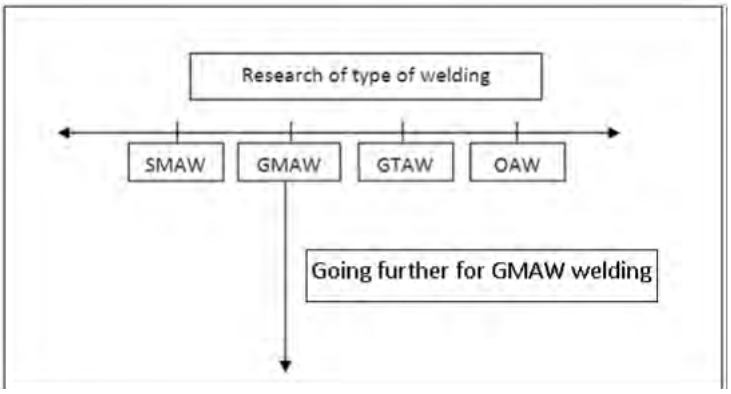

Figure 2.1: Type of welding (Fronius, 1980)

2.2.1 Shielded Metal Arc Welding

Shielded Metal Arc Welding (SMAW) is a welding type that cover welding electrodes consists of an alloy core wire and a flux coating. The core wire is usually similar to the base metal in composition. However, various alloy additions are made in the coating, so that the weld bead chemistry will not be the same as the chemistry of the core wire itself. The additional carbon, manganese and chromium required in the weld deposit are added to the flux coating (Fronius, 1980). Type of welding can be seen as depicted in figure 2.1. During welding, these additions melt in and adjust the chemistry of the weld bead to the specified composition. The electrode coating does four basic jobs:

i. Provides a gas that shields the metal crossing the arc from oxidation
ii. Produces a molten slag which further protects the molten weld bead from oxidation, affects out-of-position weld ability, and controls the bead shape
iii. Adds more alloying elements, such as manganese, carbon or chromium
iv. Promotes electrical conductivity across the arc and helps to stabilize the arc, important when alternating current (AC) is used.

In GTAW welding, the arc is struck between the work piece and a tungsten electrode, which remains unmelted. The argon shielding gas, which protects both the hot tungsten electrode and the molten weld puddle, is brought in through a nozzle or gas cup which surrounds the electrode. This process used to be called TIG (Tungsten Inert Gas). For both stainless and nickel alloys the current used is DCSP, direct current straight polarity (Durgutlu, 2004). The work is electrically positive and the tungsten electrode is the negative electrical pole. The electrode is usually thoriated tungsten, that is, tungsten metal added to improve the emissivity of electrons.

2.2.2 Oxy acetylene welding

OAW is a welding process that melts and joins metals by heating them with a flame caused by the reaction between a fuel gas and oxygen. OAW is the most commonly used gas welding process because of its high flame temperature. A flux may be used to deoxidize and cleanse the weld metal. The flux melts, solidifies, and forms a slag skin on the resultant weld metal. There are three different types of flames in oxy acetylene welding that are neutral, reducing, and oxidizing (Fronius, 1980).

2.2.3 Gas metal arc welding (GMAW)

Gas metal arc welding (GMAW) is a welding process which electricity is passed through a continuous wire electrode and is surrounded by a shielding gas. The welding rod is consumed in the heat generated by the arc. The shielding of the arc and the molten pool are obtained by using inert gases such as argon and helium. This type of welding is often used in aluminum and aluminum alloy (Miller, 2012).

Gas metal arc welding (GMAW) started where wire is fed continuously through a hollow cable to the welding gun, where it makes electrical contact. The arc between weld wire and work piece melts the metal. Molten weld filler transfers as either a spray of fine drops, or as larger globs. The metal is protected from oxidation by a continuous flow of shielding gas, usually argon, through the weld torch and around the wire (Miller, 2012). Current is always Electrode Positive (DCRP, direct current reverse polarity)

The process of GMAW welding starts where the arc is protected by argon gas (or argon-helium gas mix) to shield the welding spot and the electrode from being exposed to surrounding. The arc functions as a heat source to provide high temperature and provides high heat input, thus a stable arc, smooth metal transfer with low spatter loss and good weld penetration can be obtained. Figure 2.2 below show the process of gas metal arc welding (GMAW)

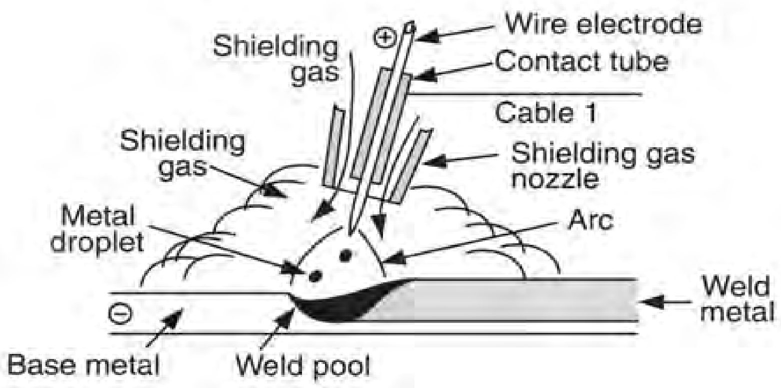

Figure 2.2: Schematic Diagram GMAW welding process (Miller, 2012)

2.3 Gas metal arc welding parameters

(Karadeniz, 2007) found that, when using gas metal arc welding technique, welding parameter are the most factor that affecting the quality of weld joint. In order to achieve optimum result, parameter that affecting the arc welding during process should be known before process started. When all parameter are setup in conformity, the perfect arc can be formed during the welding process. Welding parameter including the welding current, type of shielding gas, wire electrode diameter, welding speed, arc voltage, welding angle, nozzle distance, direction of welding and flow rate of gas. However type of shielding gas and diameter of wire electrode are determine before the welding process is carried out and cannot changed during the process.

2.3.1 Welding voltage

Arc voltage is the voltage between the electrode and the job during welding process. The voltage is determine by arc length for any given electrode, on the other side, the voltage generate by power source. Open circuit voltage generally varies between 50v to 100v, where arc voltage are between 17v to 40v. When arc is struck, the open circuit voltage drop to the arc voltage and the welding load come on power source (N.R.Mandal, 2009).

2.3.2 Welding speed

Mandal (2009) state that, in welding process, welding speed is the most important parameter that can affect the quality of weld joint. Speed of welding is the linear rate and move along weld joint (N.R.Mandal, 2009). Welding speed is particular important because it controls the actual welding time and hence has a direct effect on the cost. Therefore the speed generally is fixed in mechanized welding while the other parameters like current or arc voltage are variable to control the weld deposit and weld quality. The effect of welding speed for any given combination of welding current and arc voltage generally has complied with the general pattern. In welding process when speed is increase.

- Residual stress and distortion will increase
- Heat affected zone will increase in size as the cooling rate decrease
- Heat input rate increase
- Filler metal deposition rate increase
- Reduction in distortion and residual stress.