UNIVERSITY TEKNIKAL MALAYSIA MELAKA

THE EFFECT OF TORCH ANGLE ON PHYSICAL PROPERTIES OF WELDMENT AREA

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process)

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **The Effect of Torch Angle on Physical Properties of Weldment Area.**

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I hereby, declared this report entitled "The Effect of Torch Angle on Physical Properties of Weldment Area" is the results of my own research except as cited in the references.

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APPROVAL

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

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Supervisor

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ABSTRAK

Kimpalan Arka Gas Logam merupakan salah satu peralatan yang paling kerap digunakan dalam industri kimpalan kerana kebaikannya. Antara kebaikannya ialah menghasilkan penyambungan logam yang kukuh dengan kadar deposisi yang tinggi, penghasilan gas yang minima dan fleksibilitinya. Namun, taktik kimpalan yang umum digunakan oleh kebanyakan pengipal iaitu dengan menukar sudut obor berdasarkan keselesaan mereka biarpun pengipal yang berpengalaman. Hal ini menghasilkan sudut awal yang baik tetapi berakhir dengan bentuk yang sangat berbeza berbanding dengan yang asal. Oleh sebab itu, ia menghasilkan kimpalan yang tidak seragam dan sifat fizikal yang berbeza. Sudut obor mempunyai kesan yang besar terhadap penampilan dan stuktur kimpalan. Jadi, kajian ini dijalankan untuk menyiasat kesan sudut obor terhadap sifat fizikal bahan ujikaji. Ujian tarik dan pemeriksaan bahan ujikaji bawah mikroskop telah dijalankan untuk mengkaji tahap kekuatan struktur kimpalan dan menganalisis zon yang terkena panas daripada proses kimpalan. Kajian yang dijalankan menunjukkan bahawa sudut kimpalan berdarjah 30° mempunyai tahap kekuatan tarik yang maksimum iaitu 423 N/mm^2 dan penetrasi yang baik berbanding dengan spesimen kajian yang lain.

ABSTRACT

Gas Metal Arc Welding (GMAW) is a useful tool for joining process because of its high deposition rate, eliminates slug and flux removal, reduction in fumes and smoke, and its versatility with wide and broad application ability. However, a common tactic for many welders are to change the welding torch angle based on their comfortability even those with years of experiences. This results in a relatively good starting angle but ends up with very different form compared to the original set up. Therefore, this situation has form non-uniform welding bead and different physical properties on weldment surface. Torch angle can have large effects on the bead appearance and its structure, thus this study has been carried out to investigate on the parameter to produce high strength weld structure with minimum heat-affected zone. Proper adjustment of the torch angle can produce smooth controlled clean weld and prevent spattery and unstable weld. Tensile test and microscope examination are conducted to study the physical properties of the weldment area. It was found that the 30° welding angle has a maximum stress 423 N/mm^2 and good welding penetration among other angles.

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Finally, I thank my parents and my siblings for continuous supporting me throughout the entire final year project period.

DEDICATION

This study report is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. I would also like to dedicate this to my mother, who taught me that even the largest task can be completed if it is done one step at a time.

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LIST OF ABBREVIATIONS

A	-	Ampere
Ar	-	Argon
ASTM	-	American Society for Testing and Materials
AWS	-	American Welding Society
CO_2	-	Carbon Dioxide
CTWD	-	Contact Tube-to-Work Distance
DC	-	Direct Current
DCEN	-	Direct Current Electrode Positive
DCEP	-	Direct Current Electrode Negative
GMAW	-	Gas Metal Arc Welding
HAZ	-	Heat-Affected Zone
MAG	-	Metal Active Gas
MIG	-	Metal Inert Gas
PSM	-	Projek Sarjana Muda
UTM	-	Ultimate Tensile Machine
UTS	-	Ultimate Tensile Strength
V	-	Voltage
W	-	Watt

CHAPTER 1

INTRODUCTION

This chapter introduces to the background of the study for the final year project (PSM) which explains the problem faced by the industries. Besides that, it contains the planning and work organization to complete the PSM. This chapter also includes the scope and the significance of this study.

1.1 Background

The effect of welding parameter on physical properties of weldment area is investigated has been discussed by many researchers (Brooks, 2008). According to Kalpakjian and Schmid, (2006) gas metal arc welding (GMAW) was developed in the 1950s and formerly known as metal inert gas (MIG) welding, the welded area is shielded by an effectively inert atmosphere of argon, helium, carbon dioxide or various other gas mixtures. The consumable bare wire is fed automatically into the weld arc through a nozzle by a wire fed drive motor. In addition to use inert shielding gases, deoxidizers usually are present in the electrode metal itself in order to prevent oxidation of the molten weld puddle.

The present trend in manufacturing demands the joining or welding of materials that are capable of withstand ever increasing stresses and temperatures (Brooks, 2008). Unfortunately, weld quality problems arising due to poor joint strength are generally faced by the manufacturers which limit the application of welding. The tensile characteristics of weld joint primarily depends on the weld bead shape and weld microstructure influenced by process parameters in GMAW. The welding current, arc voltage and welding speed are the major parameters in GMAW. The welding torch angle, its position with respect to base plate as well as the direction of welding also influences the weld quality (Kamal and Surjya, 2010).

1.2 Problem Statement

According to Brooks, (2008) a common tactic for many welders are to change the welding torch angle based on their comfortability even those with years of experiences. This usually results in a relatively good starting angle but ends up with very different form compared to the original set up. It causes the welders to make changes to their welding speed or welding method by end of the work. Therefore, this situation has form non-uniform welding bead and different physical properties on weldment surface.

In his study, torch angle which is the angle of the welding torch relative to the direction of travel is one of the most overlooked variables in modern welding. Torch angle can have large effects on the bead appearance and its structure. Proper adjustment of the torch angle can produce smooth controlled clean weld and prevent spattery and unstable weld. Likewise, a poor torch angle can ruin the weldments (Brooks, 2008).

1.3 Objectives

The objectives of this study are:

a) To analyze the effect of torch angles on the physical properties of mild steel weldment area.
b) To analyze the effect of torch angle on heat-affected zone (HAZ) of mild steel weldment area.
c) To analyze the effect of torch angle on the quality of the welding bead.

1.4 Scope of the Study

In this study, the welding robot is selected to perform welding tasks. The manipulated welding parameter is torch angle. Others parameters such as current, welding speed and filler wire diameter are kept constant. Three angles are used to perform the welding task. Mild steel is selected as the work material for this study.

1.5 Significance of the Study

The main significances of this study are:

a) Very little of research work has been done on the effect of torch angle on physical properties of mild steel weldment area. It is hope that this comprehensive study will enrich knowledge and understanding of the influence of torch angle on its physical properties.
b) An understanding of the welding technique and control in welding parameter will give alternative to the manufacturing industries to exploit cost saving while producing good physical properties welding.

1.6 Organization of the Study

This study contains six chapters, which begins with the introduction in Chapter 1, followed by literature review in Chapter 2. Chapter 3 determines the research methodology. Chapter 4 covers the result and discussion of this study. The last Chapter attempts to conclude overall study findings and recommendation for future study. The chapters are written in a paper-like format whereby the related literature was initially reviewed.

CHAPTER 2

LITERATURE REVIEW

This chapter describes the literature review based on the previous studies and journals published. The objective of the literature review is to understand the problem, technique and method used as a guideline to this study.

2.1 Introduction

American Welding Society (AWS) defined a weld as "localized coalescence of metals or non-metals produced either by heating the material to the required welding temperatures with or without the application of pressure, or by application of pressure alone and with or without the use of filler materials (Jeffus, 2004).

According to David *et al.*, (2000) welding is a common fabrication technology used extensively in industries. Defects in welds or poor performance of welds can lead to catastrophic failures. In the last several decades, welding has evolved as an interdisciplinary activities requiring synthesis of knowledge from various disciplines. During welding, as the heat source interacts with the metal, melting, solidification and various solid state transformations occur and these transformations influence the structure and properties of the weldment. In the weld pool, metal undergoes vigorous circulation. In non-autogenous welding where filler metals are used, additional physical processes add to the complexity of the weld pool phenomena. The fluid flow and heat transfer affect the size and shape of the weld pool, the cooling rate and the kinetics and the extent of various solid state transformation reactions (David and Vitek, 1989). The weld pool geometry influences dendrite and grain growth selection processes (David *et al.*, 1990). The distribution of nitrogen, oxygen and hydrogen between the weld pool and its surroundings significantly affects the weld metal composition, microstructure and properties.

2.1.1 Welding Robot

OTC DR 4000 welding robot is one of the welding robots that used in welding industry (Ertmer, 2008). The usage of robot in welding can minimize the cost and increase the safety compared with manual welding. Figure 2.1 shows the DR-4000 series welding robot manufactured by OTC. Table 2.1 shows the specification of the OTC DR-4000 welding robot.

Robots are essentially consisting of position-controlled devices that can receive a trajectory and run it continuously. With welding applications, it is necessary to start from a trajectory. For example, from a CAD model of the working piece and have the means to correct it in real time as a function of the observed results of the welding process (Pires *et al.*, 2003).

Figure 2.1: Welding robot OTC DR-4000.

Table 2.1: OTC DR-4000 robot specification (Ertmer, 2008).

Specification	
Axes	6
Payload	6kg
H-Reach	1336mm
Repeatability	±0.1mm
Robot Mass	130kg
Structure	Vertically articulated
Mounting	Floor, handling, ceiling

2.2 Overview of Gas Metal Arc Welding (GMAW)

Gas metal arc welding (GMAW), formerly called metal inert gas (MIG) welding was developed in the 1950s. GMAW is an arc welding process that uses an arc between a continuous filler metal electrode and the weld pool (Cary and Helzer, 2005). The weld area is shielded by an effectively inert atmosphere of argon, helium, carbon dioxide or various other gas mixtures. Figure 2.2 shows schematic illustration of the gas metal arc welding process. The consumable bare wire is fed automatically through a nozzle into the weld arc by a wire-feed drive motor. Figure 2.3 shows the basic in gas metal arc welding process. In addition to using inert shielding gases, deoxidizers usually are present in the electrode metal itself in order to prevent oxidation of the molten-weld puddle (Kalpakjian and Schmid, 2006).

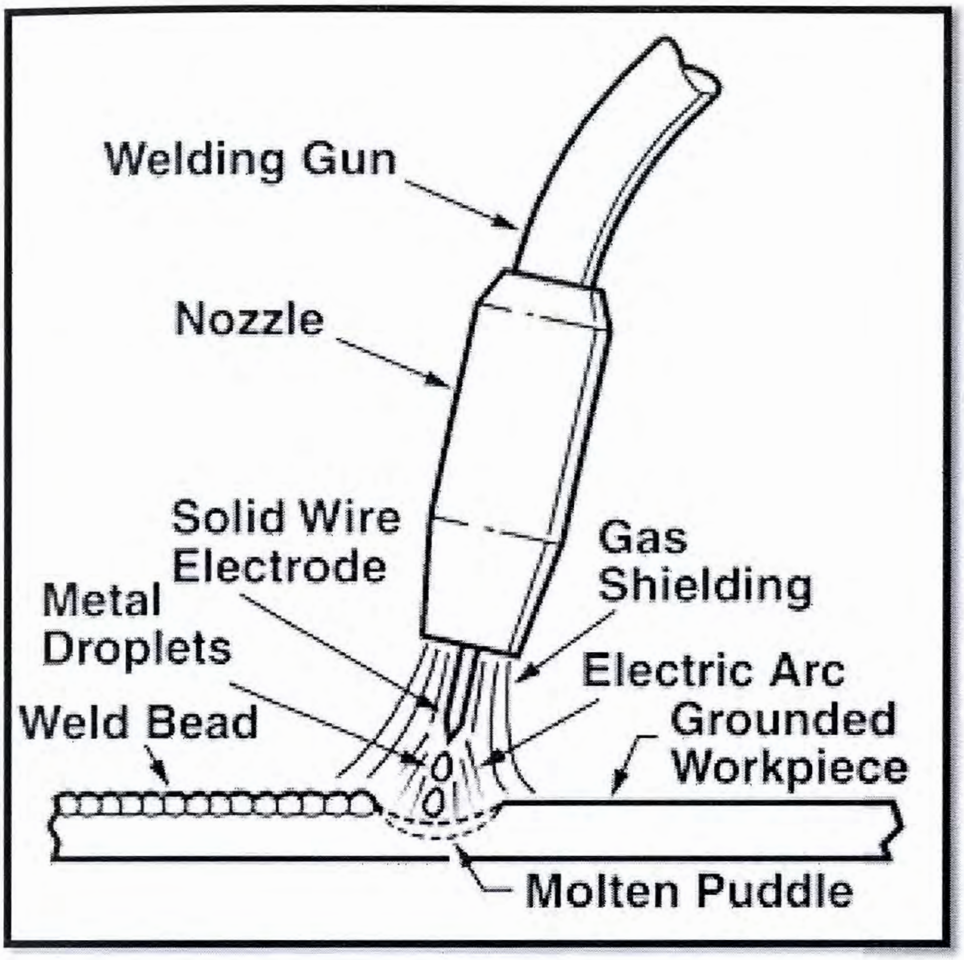

Figure 2.2: Schematic illustration of the gas metal arc welding process (Cary and Helzer, 2005).

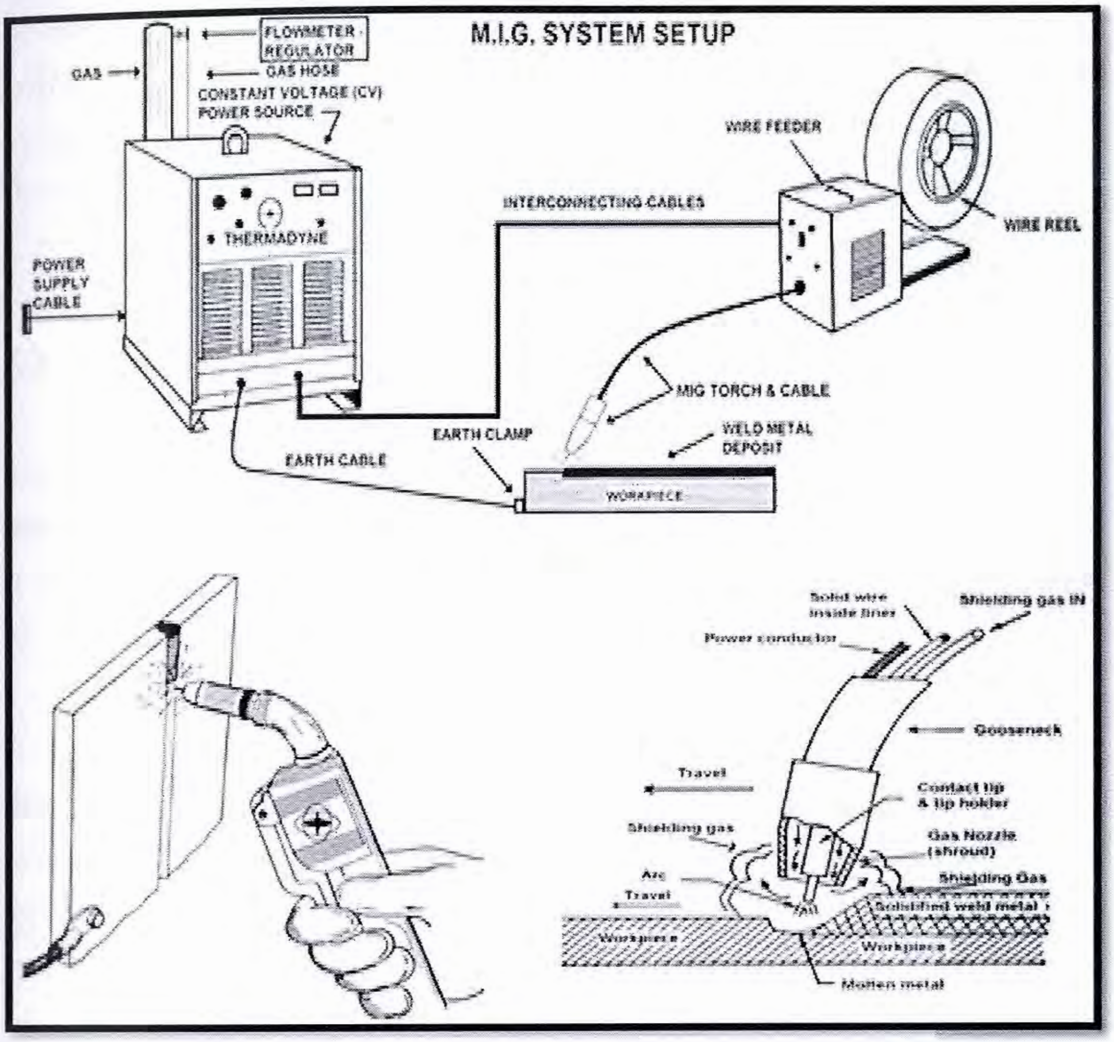

Figure 2.3: Basic system in gas metal arc welding process (Cary and Helzer, 2005).

According to Jeffus, (2004), to performe a satisfactory GMAW it requires more than just manipulative skill. The setup, voltage, amperage, electrode extension and welding angle as well as other factors can dramatically affect the weld product. The very best conditions are those that will allow a welder to produce the largest quantity of successful welds in the shortest period of time with the highest productivity. Increased in productivity may require only that the welder increase the travel speed and current because these are semiautomatic or automatic processes. Campbell, (1999) stated that welding can be weld by using two preferred methods, both methods employ inert gases, pure argon or a mix of argon with helium. Any contamination of these gases causes oxidation of the weld.

Nowadays, GMAW has become one of the most flexible all-round welding tools in the fabricating industry. A great number of types and sizes of wires have been developed and simplified wire-feeding systems and guns are available. A significant step in power source improvement was the invention of the constant voltage welding machine. Thus, the door was opened to a short-circuiting arc with its greater flexibility (Sacks and Bohnart, 2005).

2.3 Gas Metal Arc Welding (GMAW) Principles

The gas metal arc welding (GMAW) is widely employed for fabrication in many industries. The process is versatile because it can be applied for all position welding. It also can easily be integrated into the robotized production canters. (Wêglowski *et al.*, 2008).

Gas metal arc welding is generally used because of its high productivity. GMAW is done using solid wide electrodes (Althouse *et al.*, 2004). The gas metal arc welding process uses the heat of an arc between a continuously fed consumable electrode and the work to be welded. The heat of the arc melts the surface of the base metal and the end of the electrode. The metal melted off the electrode is transferred across the arc to the molten pool. The molten weld metal, also known as weld puddle must be properly controlled to provide a high-quality weld. The depth of penetration is controlled by many factors but the primary one is the welding current. If the depth of penetration is too great, the arc will burn through thinner material and reduce the quality of a weld (Cary and Helzer, 2005). Figure 2.4 shows the process diagram for gas metal arc welding.