KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA

Analysis of Different Current Setting in OTC DR 4000 Robot Welding for Mild Steel

Thesis submitted in accordance with the requirements of the Kolej Universiti Teknikal Kebangsaan Malaysia for the Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process)

By

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May 2006

DECLARATION

I hereby, declare this thesis entitled "Analysis of Different Current Setting in OTC DR4000 Robot Welding for Mild Steel" is the results of my own research except as cited in the reference.

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ABSTRACT

OTC DR 4000 robot welding is one of the welding robots which are used in the industrial steel welding. The usage of robot in welding can minimize the cost and increase the safety compared with manual welding. Besides, the manual welding is hard to maintain the consistency of welding travel in producing a high quality beads and continuous bonding between filler metal and parent metal. Therefore, a research about analysis the robot welding current to the mild steel is carried out to identify the best quality of welding strength and hardness. The quality is determined by applying the Ultimate Tensile Test, Rockwell Hardness Test, and Magnetic and Penetrant Test. The results of the research can be implementing in the welding industries in order to increase the weld quality and achieve low cost of production and effective.

ABSTRAK

Robot Kimpalan OTC DR 4000 merupakan salah satu robot kimpalan yang digunakan dalam industri kimpalan besi. Robot ini digunakan kerana boleh mengurangkan kos pembuatan and lebih selamat berbanding dengan kimpalan secara konvensional. Selain daripada itu, kimpalan secara konvensional didapati agak sukar untuk mengekalkan pergerakan kimpalan dengan konsisten dan berterusan antara logam pengisi dan logam asas. Oleh yang demikian, satu kajian mengenai analisis mengenai robot kimpalan ini telah dijalankan untuk menentukan hasil kimpalan yang mempuanyai kekuatan dan kekerasan terbaik. Kualiti hasil kimpalan ditentukan dengan mengaplikasikan ujian Kekuatan Muktamad, Ujian Kekuatan Kekerasan serta Ujian Pemeriksaan Zarah Magnet dan Ujian Penusukan. Hasil keputusan ujian boleh digunakan dalam industri kimpalan besi untuk meningkatkan hasil kualiti kimpalan dan mencapai kos pembuatan yang jauh lebih murah dan effektif.

DEDICATION

For my beloved father,

Mohd Arif Muda

My beloved mum,

Juliha Abdul Razak

My brothers,

Ahmad Rakin Mohd Arif

Ahmad Aiman Mohd Arif

Ahmad Zulkamal Mohd Arif

My sisters,

Amirah Mohd Arif

Adibah Hanun Mohd Arif

Arifah Radhiah Mohd Arif

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

L	-	Longitudinal
T	-	Transverse
MIG	-	Metal Inert Welding
WPS	-	Welding Procedure Specification
AW	-	Arc Welding
CO_2	-	Carbon Dioxide
Ar	-	Argon
in	-	inch
I_p	-	Peak current
I_b	-	Background current
t_p	-	Pulsed width
DC	-	Direct current
B	-	Butt joint
C	-	Corner joint
E	-	Edge joint
L	-	Lap joint
T	-	Tee joint
NDT	-	Non-Destructive Test
DT	-	Destructive Test
MPI	-	Magnetic Particle Inspection
HAZ	-	Heat-Affected Zone
GMAW-P	-	Gas Metal Arc Welding Pulsed
LOP	-	Lack of penetrant
SEM	-	Scanning Electron Microscope
AS	-	Arc Start

CHAPTER 1
INTRODUCTION

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INTRODUCTION

1.1 Background

A GMAW process is an arc welding process that joins metal together by heating them with an electric arc that established between a consumable wire and the workpiece. An external supplied gas or gas mixture acts to shield the arc and molten weld pool. The weld joint will be test using the Non-destructive method (Dye-penetrate test). Salter,1982 said that, the Design of Experiment is used.

Although the basic GMAW concept was introduced in the 1920s, it was not commercially to be fundamentally a high-current-density, small-diameter, bare electrode process using an inert gas for arc shielding. Its primary application was aluminum welding. As a result, it becomes known as metal-inert gas (MIG) welding, which is still common nomenclature. Subsequent process development included operation at low current densities, and pulsed direct current, application to a broader range of materials, and the use of reactive gases are used, les to the formal acceptance of the term gas-metal arc welding (D.B. Holliday, 2000).

The GMAW process can be operated in semiautomatic and automatic modes. All commercially important metals, such as carbon steel, aluminum, copper, and nickel alloy can be welded in all positions by this process if appropriate shielding gases, electrodes, and welding parameters are chosen.

Hundreds of small and medium-size manufacturers and job shops are learning what corporations have realized for many years that robotic welding is not only highly productive, but also very affordable. In fact, for most shops it is cost prohibitive to weld many jobs any other way. In times when companies need to streamline operations and fine-tune manufacturing coats, robotic welding just makes sense. OTC Daihen 4000 has 6 axis and 8000 points memory instructions.

The important variables of the GMAW process that affect weld penetration, bead geometry, and overall weld quality are welding current (electrode feed speed), polarity, arc voltage (arc length), travel speed, electrode extension, electrode orientation (gun angle) and electrode diameter (wire in this case). Knowledge and control of these variables are essential to consistency produce welds of satisfactory quality. Because they are not completely independent of one another, changing one variable on deposit attributes are shown in the table below:

Table 1.1: Effects of changes in process variables on weld attributes (ASM Handbook,2000)

Welding variables to change	Desired changes							
	Penetration		Deposition rate		Bead size		Bead width	
	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
Current and wire feed speed	Increase	Decrease	Increase	Decrease	Increase	Decrease	Little effect	Little effect
Voltage	No effect	No effect	Little effect	Little effect	Little effect	Little effect	Increase	Decrease
Travel speed	No effect	No effect	Little effect	Little effect	Decrease	Increase	Decrease	Increase
Electrode extension	Decrease	Increase	Increase (a)	Decrease (a)	Increase	Decrease	Decrease	Increase
Wire diameter	Decrease	Increase	Decreas e	Increase	Little effect	Little effect	Little effect	Little effect
Shield gas %	Increase	Decrease	Little effect	Little effect	Little effect	Little effect	Increase	Decrease
Gun angle	Drag	Push	Little effect	Little effect	Little effect	Little effect	Push	Drag

1.3 Scope Of The Project

This project is being going to analysis the robot welding parameter decided, specified for OTC DR4000 robot welding model. The material which going used to be weld is low-carbon steel or also known as mild steel which has less than 0.30% carbon (Kalpakjian, S and Schmid, S.R, 2000). Joint types which will be performed are the butt joint weld. Once a joint has been weld properly using the OTC robot welding, the quality characteristic to be measure is, the weld joint is going to be test using NDT technique, focus in magnetic particle inspection and dye-penetrant test. Standard test that will be referred is Standard Test Method for Liquid Penetrant Examination in ASTM Designation E165-02. The weld quality tested by NDT then will analyze for any defects occur. Visual inspection by using Scanning Electron Microscope will be also do to inspect the weld joint penetration, which this standard is referred to Annual Book of ASTM Standard,2004, Designation E 766. The welding bead hardness is also measured by refer to Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Metarials, Annual Book of ASTM Standard, 2004, Designation E18-03, to be relate with tensile strength of welding.For destructive test, it will cover the tensile test using Universal Tensile Strength Machine to measure the tensile strength of the welding joint, referred to Annual Book of ASTM Standard,2003, Designation E 21.

1.4 Objectives of the Research

a) To analysis the effect of welding current to mild steel plate 3mm, 4mm and 5mm by using filler alloy diameter 1.2 mm and 1.0 mm.
b) Understand the principle of visual inspection, Non-Destructive, Destructive test and its application.
c) To select the best parameter with least defect and high tensile strength.

CHAPTER 2
LITERATURE REVIEW

CHAPTER 2
LITERATURE REVIEW

This literature review is discussing about research which had been made previously. It also discussed the points which related to this project. The objective of the literature review is to appreciate and explain in detail about journal read as the guideline for this project research.

2.1 Introduction

In the last 20 years, the growth of modern welding science and technology has been phenomenal. Worldwide, welding is a multibillion-dollar fabrication technology used extensively in the construction of building and bridges and in the automotive, aircraft, aerospace, energy, shipbuilding, and electronic industries. Perhaps because welding is a construction technique, it is viewed by many as primitive science. (Ranjeet Agarwala, 2000).

The importance of welding process in modern technology can be properly assessed by considering the numerous applications involving metal joining using heat treatment. All welding procedure must be referred to the WPS. Welding Procedure Specification (WPS). A WPS is a written qualified welding procedure prepared to provide direction for making production welds to Code requirements. The WPS or other documents may be used to provide direction to the welder or welding operator to assure compliance with the Code requirements. (ASME SEC IX QW article II). All those standard in WPS are required to achieve high standard generated the need for automation of the welding process, since this provides repeatable and controllable welding conditions and so ensures products of high and constant quality. Automation has also helped towards an optimal balance between the quality of manufactured products and the high production rates required by modern industry.

Ranjeet Agarwala,1999, said that arc welding is considered to be one of the most promising applications of intelligent robots. This situation first stems from a low manual productivity due to the severe environmental conditions resulting from the intense heat and fumes generates the welding process. Second, arc welding is the third largest job category behind assemble and machining in the metal fabrication industry.

Automation of the welding process opens a very challenging area of research in such fields as robotics sensor technology, control systems and artificial intelligence. Automation or industrial automation is the use of computers to control industrial machinery and processes, replacing human operators. It is a step beyond mechanization, where human operators are provided with machinery to help them in their jobs. The most visible part of automation can be said to be industrial robotics. Some advantages are repeatability, tighter quality control, waste reduction, integration with business system, increase productivity and reduction of labor. Automation may be fixed with a single assemble or flexible with the automation equipment or sequence of steps flexible enough for adaptation to different jobs. (Shariman Abdullah,2005).

Automatic welding in simplest terms means that welding operation is performed without human (welder or welding operator) intervention. However, in most of the automatic control operations, a welder is required to make initial preparations and then oversee the operation but not required to continuously monitor the welding operation.
Automatic welding requires a detailed plan of sequential motions and operations. It requires coordination of various parts of the welding equipment such as power supply, wire feeders and torch motion. Robots play an important part in the automation of the welding processes in particular the arc welding such as GMAW. They are extensively used in such industries as automobile manufacturing. Some automatic welding equipment such as electro-mechanical seam following and video-monitoring equipment.

2.2 Gas Metal Arc Welding

This arc welding (AW) is a group of welding processes that produce coalescence of workpieces by heating them with an arc. The processes are used with or without the application of pressure and with or without filler metal. Arc welding is common and consists of at least nine basic processes, some with several variations. There are two basic types of welding arcs. One uses a consumable electrode that is melted in the arc, and the molten metal is carried across the arc gap. The other uses a nonconsumable electrode that does not melt in the arc, and filler metal is added separately to the welding pool. (Howard. B.C, 1999).

The GMAW use 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, sometimes called the weld puddle, must be properly controlled to provide a high-quality weld. The depth of penetration in controlled by many factors, but the primary one is the welding current (Helzer S.C., 1999)

Helzer S.C.,1999, also said that the width of the molten pool is also based on many factors, but the primary one is the travel speed. If the molten pool is too large, particularly when the welding other than in the flat position, the molten metal will run out and create a welding problem. Many factors, including electrode size and the mode of metal transfer, relate to the weld pool size.

An envelope of gas fed through the nozzle provides shielding of the molten pool, the arc, and the surrounding area. This shielding gas, which may be an inert gas, an active gas or mixture, surrounds the arc area to protect it from contamination from the atmosphere. The electrode is fed into the arc automatically, usually from coil of wire. The arc is maintained automatically and travel and guidance can be handled manually or by machine. The metal being welded dictated the composition of the electrode and the shielding gas. The shielding gas and the type and the size of the electrode affect the mode of metal transfer. The metal transfer mode is one way of identifying the variation of the process. The schematic of GMAW is shown below.

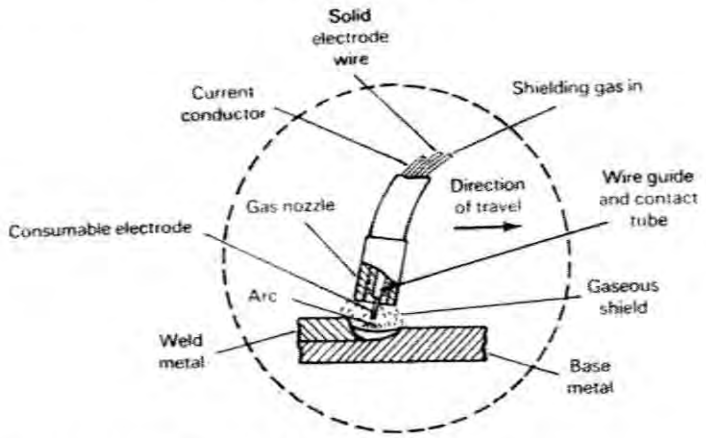

Figure 2.1 Schematic of GMAW (Howard B. Cary,2005)

2.3 Advantage of GMAW

The major advantages of gas metal arc welding are; it can eliminate the slang and flux removal, and reduce the smoke and fumes. Lower skill level in semiautomatic method of application than that require for manual shielded metal arc welding is applicable and automation welding is possible. (Helzer S.C., 1999)

The metal arc welding process can be used to weld most metals. Carbon dioxide welding is restricted to steel. Electrodes are matched to the base metals. The process can also be used for surfacing and for buildup using special metals for bearing surfaces and corrosion-resistance surfaces. Metal thickness from 0.13 inch upward can be welded. The short-cutting variation and the pulsed arc variation are used for welding the thinner material in all positions.

2.4 Parameters involve and the relationship with manual MIG welding

There are 4 types of GMAW process, which is globular, short-circuiting, spray and pulsed-spray. The variation of the GMAW process is shown in the table below:

Table 2.1 : Variation of the GMAW process (Helzer S. C. ,2002)

Metal transfer	Globular	Short-Circuiting	Spray	Pulsed-Spray
Shielding gas	CO_2	CO_2 or CO_2+argon	Ar+O_2 and others	Ar+O_2 and others
Metals to be welded	Low-carbon and medium carbon steel, low alloy high-strength steels	Low-carbon and medium-carbon steels, low-alloy high-strength steels, some stainless steel	Low-carbon and medium-carbon, low alloy high-strength steels	All steels, aluminum and many alloys
Metal thickness	10 gauge(0.140 in.); up to ½ in without bevel preparation	20 gauge (0.038-in), up to ¼ in, economical in heavier metals for vertical and overhead welding	¼ to ½ in with no preparation; maximum thickness practically unlimited.	Thin to unlimited thickness
Welding positions	Flat and horizontal	All positions (also pipe welding)	Flat and horizontal with small electrode	All positions