TAILORED ORBITAL WELDING OF DISSIMILAR STAINLESS STEELS MATERIAL

MOHD FAIZAL B MOHD PAUZI
B051010127

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

by

MOHD FAIZAL B MOHD PAUZI
B051010127
871009-11-5757

FACULTY OF MANUFACTURING ENGINEERING

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TAJUK: Tailored Orbital Welding Of Dissimilar Material (Austenitic Stainless Steel)

SESI PENGAJIAN: 2012/13 Semester 2

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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) (Hons.). The member of the supervisory is as follow:

……

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ABSTRAK

Kebelakangan ini reka bentuk paip dalam aplikasi seperti industri aeroangkasa, industri nuklear, industri farmaseutikal, industri makanan, dan sebagainya telah dikomersialkan bergantung menggunakan teknologi kimpalan orbit. Dalam projek ini eksperimen untuk menyertai bahan berbeza (keluli tahan karat austenit 304 hingga 316L) dikimpal menggunakan gas kimpalan arka tungsten (GTAW). Sebab projek ini eksperimen dilakukan adalah memeriksa kesan kimpalan GTAW ke arah gabungan logam yang berbeza pada microhardness dan sifat-sifat mekanik. Objektif kajian ini adalah untuk membuktikan bahawa keluli tahan karat boleh menyertai dengan keluli tahan karat lain-lain bergantung kepada keadaan yang diperbuat daripada teori. Matlamat kajian ini adalah untuk mencapai kombinasi sempurna bahan berbeza. Ini kimpalan GTAW akan menggunakan MACHINE FRONIUS dengan bantuan dua bahan yang berbeza. Parameter yang berbeza berubah-ubah sebagai voltan arka, semasa arka dan kelajuan kimpalan akan digunakan untuk menentukan kualiti kekerasan kimpalan pada permukaan kimpalan. Jenis-jenis sendi dikimpal yang telah dipilih sebagai pembolehubah adalah sendi punggung dengan dimensi paip 2 "(50mm) x60mm. Kemudian ujian akan menjalankan selepas kimpalan adalah microhardness menggunakan Vickers ujian kekerasan dan mikrostruktur akan pemerhatian pada mikroskop optik untuk disiasat kimpalan zon patah. Pemeriksaan NDT juga digunakan untuk mengesan struktur kimpalan kecacatan.

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ABSTRACT

Nowadays fabricating pipe shape in commercial application such as aerospace industry, nuclear industry, pharmaceutical industry, food industry, and so on rely using orbital welding technologies. In this experimental project to joining dissimilar material (stainless steel austenitic 304 to 316L) welded using gas tungsten arc welding (GTAW). The reason of this experimental project done is examining the effect of the GTAW weld toward the combination of different metals on microhardness and mechanical properties. The research objective is to prove that stainless steel can be join with other stainless steel depend on the condition made from the theory. The goal of this research is to achieve the perfect combination of dissimilar material. This GTAW welding will be using FRONIUS MACHINE with the help of two different materials. The different variable parameter as arc voltage, arc current and welding speed will be used to determine the weld quality hardness on the welding surface. The types of welded joints that has chosen as variable is a butt joint with a dimension of pipe 2”(50mm) x60mm. Then the test will conduct after the welding are microhardness using Vickers hardness test and microstructure will be observation on optical microscope to investigated weld fracture zone. NDT examination also used to detect of defect welding structure.

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DEDICATION

Especially dedicated to both my mother and father who loved Rohidah binti Amin and Mohd Pauzi bin Mahamud for always giving spirit and encouragement to me. "

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Welding is one of the permanent joining process that produce coalescence of material by heating them to the welding temperature with or without the application of pressure or by the application of pressure alone and with or without the use of filler metal for metal or non metallic. At present, the use of welding is widely used in general engineering. Industrial welding is involved using the automotive manufacturing industry and building structure. Various types of welding processes designed to weld metal. Some of the welding process used in the present industry, is an arc welding, metal inert gas arc welding, tungsten inert gas arc welding and gas welding oxyacetylene. Many differences can be seen in terms of microstructure, which is produced moldings and porosity when using a variety of different welding parameters.

Each engineer will examine the whole of the material being welded to test longevity, strong and stable when the metal used. Undeniably, environmental factors, material selection and welding methods can affect the level of the welded metal for quite some time.

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1.2 Research Background

The technologies of orbital welding are emerging as useful new techniques for fabricating the product nowadays. Orbital welding is a mechanism technique of welding which is using the concept of rotates 360° whether the arc or material rotate around the weld joint between stationary metal pieces, such as pipes or tube in a continuous weld process by machine to the replacement of traditional welding by hand because of the precision necessary to the welding process. The arc equipment welding automated control system to give the surface result was a more precision and reliable than the manual welding method

Referring from Mannion(1999), the first orbital welding is used in the 1960 when the aerospace industry needed for a superior joining technique for aircraft hydraulic lines. Usually the welding concept of orbital welding used a mechanism which rotates a welding arc from a tungsten electrode around to tube weld joint. Weld current is regulated by a control system automated the entire process. In addition , orbital welding is used in the production of equipment and materials for industries such as aerospace, shipbuilding, automobiles, biotechnology, chemical engineering, pharmaceuticals and food processing.

The combination between dissimilar material have been commercialized because not found any specific source during the research. This study is about the implementation of orbital welding in a pipe or tube welding application. In producing the orbital welding tube or pipe, there are conditions whereby dissimilar materials are required to be joined together. Based on the standard practice, Gas Tungsten Arc Welding (GTAW) is recommended as a heat source for the joining process.

The purpose of this combination of dissimilar materials is to examine how far one the strength of joining materials and quality of two different metals. Can it weld with each other or not based on choosing of the type of metal itself without filler metal as adhesive agents and also to take on the types of welding that is suitable for the welding to joint the both of the metals.

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1.3 Problem Statement

In producing the joining process tube or pipe which welding dissimilar material, orbital welding technique is required to implement of joining between different material. The study of materials by a use steels approach to explore the join of dissimilar materials with other materials which is one stainless steel may be joined to another steel even different alloy content but similar microstructure may be joined. At the end of the topic will be found the defect and problem occurred on the specimen especially on the joining metal which affected the microstructure of welding zone and determine the resistance of metal to penetration.

1.4 Objective

The objectives of this experiment are:

i. To study the effect of welding parameters on microstructure and mechanical properties of dissimilar material
ii. To investigate the quality of welding by non destructive test (NDT) test.
iii. To suggest optimization parameter welding for orbital welding of dissimilar material

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1.5 Scope

To fulfil the objective goals, the welding of dissimilar stainless steel will be done by using GTAW machine welding without filler and then by setting certain parameter such as arc current, arc voltage and speed travel are used to the speed of orbital welding jig that produced effects on the fusion zone and heat affected zone.

A few of lab test will do to the samples that have been welded, the quality of weldabilty will be determined by using the non destructive test which is penetrant test, then the joining of material also is an analysis of microstructure using optical microscope. This is carried out by using a microscope to measure the depth and width of the fusion zone (FZ) and heat-affected zone (HAZ) of the material. After that followed by testing analysis using Vickers micro hardness in determining the hardness variation depth of fusion zone and heat-affected zone

1.6 Project Outline

Based on the Projek Sarjana Muda (FYP) , an organization has been constructed for the process flow of completion in order to fulfil course of Degree in Universiti Teknikal Malaysia Melaka (UTeM). Below shows the format of organization:

(a) Chapter I: Chapter 1 represents the introduction of the project that is conducted. The contents included are background, problem statement, objectives, scope and project outlines. It will explain clearly regarding the subtopics influence in this research.

(b) Chapter II: Chapter 2 represents the literature review on the background ,basic information about heat source for welding current use in orbital technique and basic knowledge about material related on parameter

(c) Chapter III: Chapter 3 represents the methodology. This chapter includes the planning of the research, and flow chart.

(d) Chapter IV: Chapter 4 will be discussed on the result obtain and discussion of the experiment and presentation of the data that have been collected in the

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production processes. The progression, experimental data and analysis stated in this chapter.

(e) Chapter V: Chapter 5 will represent the conclusion of the whole study and recommendation for future research.

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CHAPTER 2
LITERATURE REVIEW

This chapter about literature review where literature review is classified about the process of reading, analyzing, evaluating and summarizing a specific topic. In this chapter 2, literature review has revealed the study of matter related to research where will be discussed about the theory of welding process, heat sources for orbital welding, GTAW concept for orbital welding and material metallurgy. Research has been performed in order to develop by reference whether the current issues or previous research through journals, book, several articles relevant and also the website. All information in this chapter is used to ensure the conducted experiment is well guided in theory and practical

2.1 Introduction

In engineering context welding is a joining process where in coalescence of materials by heating them to the welding temperature with or without the application of pressure and with or without the use of filler material. According to Kalpakjian (2010), welding process also involves when the partial melting and fusion between the two pieces to be joined where fusion welding occurred melting together and coalescing materials by means of heats. Filler metals that used in adding to weld area during welding and also may without used known as autogenous welds.

The three major types of fusion welding processes are gas welding, arc welding and high energy beam welding(Kou,2002).

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In the gas welding has known welding process of oxyacetylene welding (OAW). Oxyacetylene is the most commonly used fuel gas mixture. It is widely used for oxyfuel gas welding (OFW), oxyfuel gas cutting (OF) and oxyfuel brazing (TB). In welding arc welding on the other hand there was some type welding process used in manufacturing application. Arc welding can be classified into several types which is shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW), plasma arc welding (PAW), gas metal arc welding (GMAW), flux cored arc welding (FCAW), submerged arc welding (SAW) and eletroslag welding (ESW). There are two types of High-energy beam welding Electron beam welding (EBW) and Laser beam welding (LBW)

Table 2.1 summarize the fusion welding process recommended for carbon steels, low alloy steels, stainless steels, cast irons, nickel base alloys and aluminium alloys where by marked in the table *a* Process code and *b* Abbreviations: S, sheet, up to 3mm (1/8 in.); I, intermediate, 3–6mm (1/8–1/4 in.); M, medium, 6–19mm (1/4–3/4 in.); T, thick, 19mm (3/4 in.) and up; X, recommended.

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TABLE 2.1 Overview of Welding Processes a [Kou, 2002]

Material	Thickness[b]	SMAW	SAW	GMAW	FCAW	GTAW	PAW	ESW	OFW	EBW	LBW
Carbon	S	×	×	×		×			×	×	×
Steels	I	×	×	×	×	×			×	×	×
	M	×	×	×	×				×	×	×
	T	×	×	×	×			×	×	×	
Low-alloy	S	×	×	×		×			×	×	×
steels	I	×	×	×	×	×				×	×
	M	×	×	×	×	×	×				
	T	×	×	×	×					×	×
Stainless	S	×	×	×		×	×		×	×	×
Steels	I	×	×	×	×	×	×			×	×
	M	×	×	×	×		×			×	×
	T	×	×	×	×			×		×	
Cast iron	I	×							×		
	M	×	×	×	×				×		
	T	×	×	×	×				×		
Nickel	S	×		×		×	×		×	×	×
and alloys	I	×	×	×		×	×			×	×
	M	×	×	×			×			×	×
	T	×		×				×		×	
Aluminum	S			×		×	×		×	×	×
and alloys	I			×		×				×	×
	M			×		×				×	
	T			×						×	

[a] Process code: SMAW, shielded metal arc welding; SAW, submerged arc welding; GMAW, gas–metal arc welding; FCAW, flux-cored arc welding; GTAW, gas–tungsten arc welding; PAW, plasma arc welding; ESW, electroslag welding; OFW, oxyfuel gas welding; EBW, electron beam welding; LBW, laser beam

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