FAILURE ANALYSIS ON TIG WELDMENT

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Report submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Manufacturing Process) with Honours

By

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DECLARATION

I hereby, declare this thesis entitled "Failure Analysis on TIG Weldment" is the result of my own research except as cited in the reference.

Signature	:	…………………………………………
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ABSTRAK

Projek sarjana muda ini mendedahkan dan membincangkan kajian tentang analisa kegagalan dalam kimpalan arca gas tungsten (TIG Welding). Objektif projek kajian menganalisa kegagalan dalam TIG welding ini adalah untuk mengenalpasti jenis kegagalan atau kecacatan yang berlaku dalam proses lekatan atau pengabungan produk. Parameter atau keadaan yang menyebabkan kegagalan atau kecacatan ini akan dikaji dan dianalisa. Projek ini akan dijalankan di makmal mesin syop, di Universiti Teknikal Malaysia, Melaka dan mesin yang akan digunakan ialah kimpalan arca gas tungsten (TIG welding). Bahan yang sama seperti mild steel akan digunakan untuk tujuan proses kimpalan, dan proses ini akan diulangi. Kegagalan atau kecacatan yang berlaku pada proses kimpalan tersebut akan direkodkan. Kegagalan atau kecacatan yang dijangka akan berlaku pada proses kimpalan tersebut adalah seperti “root crack”, “porosity”, “slag inclusion” dan “lack of root fusion”. Method yang digunakan dalam mengkaji dan menganalisa kecacatan yang berlaku ialah “Fault Tree Analysis” (FTA) dan gambarajah tulang ikan atau gambarajah Ishikawa. Method ini digunakan untuk mencari sebab dan penyebab yang menyumbang berlakunya kegagalan atau kecacatan dalam proses kimpalan dan penyelesaian akan diberi untuk teknik penggunaan kimpalan dengan betul dan mesin “setting” dengan betul.

ABSTRACT

This project is discussed about failure analysis on Tungsten Inert Gas (TIG) weldment. The objective of this failure analysis project is to determine and identify the type of failure that most occur in TIG welding. The parameter that contribute to this failure occur also will be study and identify. This failure analysis project will be held in machine syop laboratory at Universiti Teknikal Malaysia, Melaka and the machine that will be used is Tungstent Inert Gas welding. The same material such as mild steel will be used to do the joining process, and this action will be repeated and all the failure or defects that occur during this process will be recorded. The failure that expected to be occurring during this joining process is root crack, porosity, slag inclusion, and lack of root fusion. These all defects or failures will be analyzed using Fault Tree Analysis (FTA) and fishbone or cause and effect diagram. This method is used to determine the causes for this failure occur and recommendation for proper welding technique and proper parameter setting for this machine can be suggested after that.

DEDICATION

For my beloved parents, supervisor, lecturers, and friends who always support me

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

TIG	-	Tungsten Inert Gas Welding
GTAW	-	Gas Tungsten Arc Welding
SMAW	-	Shielded Metal Arc Welding
FTA	-	Fault Tree Analysis
FMEA	-	Failure Mode and Effect Analysis
AC	-	Alternating current
DC	-	Direct Current
AMC	-	Aluminum matrix composite
DCEP	-	Direct current with positive charge electrode
DCEN	-	Direct current with negative charge electrode

CHAPTER 1

INTRODUCTION

1.1 Background Introduction

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld puddle) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them, without melting the workpieces.

There are about 100 different types of welding. Arc welding is the most common type. It uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is sometimes protected by some type of inert or semi-inert gas, known as a shielding gas, or an evaporating filler material. The process of arc welding is widely used because of its low capital and running costs.

Welders use many types of welding equipment set up in a variety of positions, such as flat, vertical, horizontal, and overhead. They may perform manual welding, in which the work is entirely controlled by the welder, or semiautomatic welding, in which the welder uses machinery, such as a wire feeder, to perform welding tasks.

1.1.1 Tungsten Inert Gas welding (TIG)

Tungsten Inert Gas (TIG) Welding is another name for Gas Tungsten Arc Welding. In arc-welding, developed in the mid – 1800s, the heat required is obtained from electrical energy. The process involves is either a consumable or a nonconsumable electrode. An arc is produced between the tip of the electrode and the workpiece to be welded, by using an AC or a DC power supply. The arc temperature is about 30,000 degree Celsius that had much higher temperature than those developed in oxyfuel-gas welding.

Tungsten Inert Gas (TIG) Welding uses a nonconsumable tungsten electrode that creates an arc between the electrode and the weld pool. An inert shielding gas is used in the process at no applied pressure. Argon is most commonly used as the shielding gas, and the process may be employed with or without the addition of filler metal.

The TIG welding process is used for a wide variety of metals and applications, particularly aluminum, magnesium, titanium, and the refractory metals. TIG welding also suitable especially for thin metals. The cost of the inert gas makes this process more expensive than shielded metal arc welding (SMAW) but provides a high quality welds and surface finish. It is used in a variety of critical applications with a wide range of work piece thicknesses and shape and the equipment is portable.

Typical applications for TIG welding include pipes, pressure vessels and heat exchangers. Since TIG welding can be used to weld thin metals and small objects, the method is also used in the electronics industry.

1.1.2 Failure Analysis

Failure analysis can be defined as a method or a series of actions undertaken to find the reasons a particular failure exists and correcting the causes. It is also the process of collecting and analyzing data to determine the cause of a failure and how to prevent it from recurring. It is an important discipline in many branches of manufacturing industry, where it is a vital tool used in the development of new products and for the improvement of existing products. It is vitally important to understand that these two distinct elements are both essential if one is to embark on a study of failure analysis.

There is no particular relevance to knowing the cause or causes of a certain failure are if the problem cannot be resolved. In this definition, failure analysis can obviously apply to numerous fields of study. In this project, I was studying failure analysis as it applies to the TIG welding techniques.

The purpose of this project is to analyze, collecting and determine the cause of a failure in Tungsten Inert Gas Welding (TIG) and how to prevent it from occurring. The various technique of TIG welding also will be discuss to ensure the best technique will be apply in various condition of welding. The welding technique will be analyzed with the result that it produces.

In this failure analysis of TIG weldment, The Fault Tree Analysis (FTA), and Fish bone method will be use to analyze the failure that occur in various condition of TIG welding techniques.

1.2 Problem Statements

The failure analysis will be carried on at welding laboratory in Universiti Teknikal Malaysia, Melaka (UTEM) at Ayer Keroh, Malacca. Before that, this failure analysis on TIG welding were be study and the method to be used was recognize to ensure all the probably or actual failure on TIG welding were identified. The TIG welding was very hard to handle and because of that, it may produce a various type of failure in product or component to be joint. The main problem of this welding is it needs a proper technique that must be used according to the situation such as a DC power and current setting must be matching and the use of filler metal in welding.

1.3 Objective

1) To identify the type of failure that occurs in TIG welding.
2) To analyze the failures occur in TIG welding using FTA.
3) To identify parameter that contribute to failure occur in TIG welding.

1.4 Scopes of the Research

This project focuses on failures that occur during Tungsten Inert Gas (TIG) welding. The failures than will be analyze using Failure Tree analysis (FTA) and before that, a statistic such as histogram must be created to identify the type of failure that occur. A proper welding technique must be applied to decrease the probability of failure in TIG welding. In this project, the TIG welding instruments will be used at Manufacturing Laboratory in UTem to complete the analysis of failure that will be produced.

CHAPTER 2

LITERATURE REVIEW

2.1 IINTRODUCTION (JURNAL)

Pantazopoulos, G. and Sampani, A. (2006) doing a case study on weld failure of a rolled Zn- alloy strip that mainly used in construction industry. They found that significant welding defects, such as linear discontinuities, edge micro cracks and fusion zone gas porosity are detected during the investigation procedure. The size and distribution of pores in the fusion zone affect directly the mechanical behaviors and the workability of the welded tube. They also found that Welding defects due to the application of improper welding procedure is a significant contributor of limited weld workability and premature failure. [1]

Jha, A. K. et al. (2003) doing a Metallurgical analysis of cracking in weldment of propellant tank for satellite launch vehicles that use a Medium strength Al–Zn–Mg aluminum alloy. They found that various type of crack occur in TIG welding area at propellant tank and cracking initiated from the root of pit, followed the path of solute enriched dendrite caused intergranular mode of fracture. This confirmed the cracking was due to stress corrosion. The stress introduced during welding as contractional strain in accommodating the nozzle facilitated the cracking phenomena. [2]

Meola, C. et al. (2004) have conduct a testing and analysis of stainless steel welded joints between destructive and non-destructive techniques. They have found three techniques for weld joints analysis that use micrographs, Vickers micro-hardness measurements, and Lockin thermography. These three techniques are synergic and helpful for a complete characterization welded joints and for improvement of the welding method. [3]

Tarng, Y. S., Tsai, H.L. and Yeh, S.S. (1999) have done an experiment in Modeling, optimization and classification of weld quality in tungsten inert gas welding. In the project, they describe an intelligent modeling, optimization and classification of weld quality in TIG welding process. A back-propagation network is used to construct the relationships between the process parameters and the features on the weld pool geometry. A gobal optimization algorithm called simulated annealing is then applied to the network for solving the process parameters with optimal weld pool geometry based on an objective function. Furthermore, the fuzzy *c*-means algorithm is adopted here to classify and verify the weld quality using the features on the weld pool geometry. Through this study, highly non-linear, strongly coupled, multivariable TIG welding processes can be further understood, analyzed and controlled. [4]

Liming, L. and Shengxi, W. (2006) have doing a study on the dissimilar magnesium alloy and copper lap joint by TIG welding. During his study, they have found that in the TIG welding of dissimilar magnesium alloy and copper, intermetallic compounds were produced in the interfacial region. Intermetallic compounds were the main cause of embrittleness of the joints.By using iron plate as interlayer between magnesium alloy and copper, the embrittleness of joint was obviously decreased and the tensile strength of the joint is higher compared with that, without iron plate. They also noticed that Metallic oxides in the interfacial region between iron plate and magnesium alloy were the main reasons influenced the strength. [5]

UrenÄ, A. et al. (2000) has describes about the influence of interface reactions on fracture mechanisms in TIG arc-welded aluminum matrix composites. They conclude that: [6]

- TIG arc welding of aluminum matrix composites (AMC) reinforced with SiC particles produced severe degradation of the materials because of the formation of Al4C3 in the matrix/reinforcement interface.

- The failure mechanisms in the studied AMCs were mainly: particle fracture for particles larger than 10 mm; and ductile matrix failure in the proximity of the SiC/Al interface for particles smaller than 10 mm.

- Fracture of the welded composites was mainly controlled by interface debonding through the continuous interface reaction layer, although the formation of discontinuous tabular Al4C3 aggregates with preferential dissolution of some SiC planes also favoured damage to particles smaller then 10 mm.

- Interfacial reactions between SiC particles and molten aluminium during welding also produced degradation of fracture behavior of the aluminum matrix which was associated with the Si enrichment.

- Arc welding of the studied composites presented an additional problem of porosity in the weld, which was enhanced by the increase of the reinforcement grade and welding power. It has been mainly characterised as interdendritic porosity associated to the low wettability of the SiC particles by molten aluminum.