UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WELDING AID KIT FOR SHIELDED METAL ARC FLAT WELDING

Thesis submitted in accordance with the requirements of the

Universiti Teknikal Malaysia Melaka for the

Bachelor of Engineering Manufacturing (Manufacturing Process)

By

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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Main Supervisor

(Official Stamp and Date)

DECLARATION

I hereby, declare this thesis entitled “Development of Welding Aid Kit for Shielded Metal Arc Flat Welding” is the results of my own research except as cited in the reference.

Signature :……

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Date : MAY 2007

ABSTRACT

This thesis contains the development of welding aid kit for shielded metal arc flat welding. The purpose of this thesis are mainly about to understand on welding parameters and hence to develop with a product so that problems that may arise from it can be solved. It also explains about the common arc welding process that usually incorporates inside the part that is about to be processed, how to identify, how to tackle the problem and what solutions are available. Common problem that arise when use this welding operation are hard to maintain the arc length, hard to control the electrode angle when the electrode decrease and inconsistently of travel speed when doing this operation. Main objective is to study of all the parameters and to design a product to make sure that all the parameters can be control when doing the operation. A few solutions to welding process were identified throughout the thesis with details on each one. A product which contains the mechanical movement is chosen and designed to be associated with the welding parameter. Based on the current technologies, the welding aid kit was designed to solve two main problems that are to constant the travel speed and the arc length. The design development of the welding aid kit consists of the arm and base of the product. Few features that were necessary to the design are railway, mechanical part, connector and holder for electrode holder. After the design process, all the manufacturing costs and product specification was stated using some method including Design for Manufacturing (DFM), Design for Assembly (DFA), screening method and design selection criteria. Results from this project have solved the process of designing the welding aid kit and some physical calculation for the design. Thus, for the precise movement, the best mechanism used includes the electronic device system.

ABSTRAK

Tesis ini mengandungi penerangan mengenai tajuk projek iaitu pembangunan bagi alat bantuan kimpalan untuk kimpalan jenis arka yang diaplikasi pada proses kimpalan arka bagi bahan kerja yang mempunyai permukaan rata. Tujuan utama adalah untuk mengkaji pembangunan alat bantuan tersebut seiring dengan pemahaman mengenai parameter-parameter bagi proses kimpalan untuk menyelesaikan masalah yang dihadapi. Ini juga dapat menerangkan mengenai proses kimpalan arka dan cara-cara untuk mengatasi masalah yang dihadapi, cara untuk mengenal pasti masalah dan juga cara untuk mengatasi masalah yang dihadapi dengan berkesan. Masalah yang kerap kali berlaku semasa proses ini ialah sukar untuk mengekalkan jarak antara elektrod dan permukaan benda kerja, sukar untuk mengekalkan sudut elektrod apabila elektrod semakin pendek dan kesukaran untuk mengekalkan kelajuan pergerakan tangan semasa operasi dijalankan. Objektif utama tesis ini adalah untuk mengkaji parameter semasa menjalankan operasi kimpalan arka dan juga mereka alat bantuan bagi memudahkan pengguna untuk mengawal semua parameter tersebut semasa menjalankan oerasi tersebut. Beberapa cara mengatasi masalah akan dikenal pasti sepanjang pembangunan produk tersebut. Pilihan produk yang dikaji mengandungi pergerakan secara mekanikal yang berasaskan segala parameter yang sedia ada pada proses kimpalan arka. Berdasarkan kepada teknologi terkini, produk ini direka untuk menyelesaikan dua masalah utama iaitu untuk mengekal kelajuan kimpalan dan juga jarak antara elektrod dan permukaan bahan kerja. Bahagian utama dalam produk ini ialah lengan produk dan juga badan utama produk. Bahagian tambahan untuk menambah lagi baikan produk ialah landasan, bahagian mekanikal, penyambungan dan juga pemegang bagi ‘electrode holder’. Selepas mereka bentuk produk, kesemua kos-kos pembuatan dan juga spesifikasi produk perlu ditentukan menggunakan langkah seperti Rekabentuk

untuk pembuatan (DFM), Rekabentuk untuk penyambungan (DFA), langkah ‘Screening’ dan juga kriteria untuk memilih rekabentuk. Projek ini telah menyelesaikan beberapa masalah contohnya dalam merekabentuk produk dan juga pengiraan berdasarkan bentuk fizikal unutk rekabentuk tersebut. Dalam pada itu, untuk mendapatkan pergerakan mekanikal yang lebih jitu, alat-alat tambahan seperti sistem elektronik perlulah ditambah pada masa hadapan.

DEDICATION

For all your advice and encouragement, this thesis is gratefully dedicated to my family, Mr Shahir Bin Kasim, and my friends. Thank you very much for your continuous support and effort towards the publication of this thesis.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

DFM	-	Design for Manufacturing
DFA	-	Design for Assembly
SMAW	-	Shielded Metal Arc Welding
FKP	-	Fakulti Kejuruteraan Pembuatan
UteM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Introduction

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material that cools to become a strong joint, but sometimes pressure is used in conjunction with heat, or by itself, to produce the weld [1]. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

Arc welding processes use a welding power supply to create and maintain an electric arc between an electrode and the base material to melt 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, and filler material is sometimes used as well.

Welding aid kit can be as a guide to make sure that the beginner users can make a good quality of welding. There are some parameters must be concentrate to make sure that a good quality of welding cab be produced. These parameters are involved when doing the arc welding process. Two main parameters must be constantly do are travel speed and arc length.

1.1.1 Current issues

Arc welding is mostly used with the skills of the users to make the good quality of the welding. Many techniques are created to make the easiest way to weld the joining method. As we can see, the experienced users are able to make a good quality of the welding. But, it certain time, when the users in fatigue or not in concentration, they also can make the mistake of the welding. As the result, bad quality of welding is performed by the users. Meanwhile, for the new user, they must learn the basic term of the welding before start the operation. It is hard to get the good quality of welding when it use for the first time. New users must practice frequently to get the right rhythm of the welding.

1.2 Problem statement

Shielded metal arc welding (SMAW), also known as manual metal arc (MMA) welding is one of the oldest, simplest and most versatile joining method. This welding process uses a consumable coated electrode. During process, arc is formed at the small gap between the electrode and the work piece resulting high temperatures causing the work piece and the electrode to melt [2].

Basically, this project will be done based on these problem statements:

1. For the beginner user, the main cause is hard to maintain arc distance where too much distance will cause poor welding.
2. The speed when move the welding holder is exactly influences the quality of the welding.
3. For the flat surface or the straight line, consistency is difficult to obtain and that will cause the bad quality of welding.
4. Beginner must always practice use this type of welding processes to get the best quality of the welding.

As we know, a lot of manual instructions are available to make the easiest way of the welding for the new users. But, it stills a lot of difficulty to study the term of manual

instruction. Position of hand, the speed of the hand and timing of the gap between electrode and work piece must be studied to make sure that less defect can be make after the welding process. As the solution for the problem statement, a development of welding aid kit are made to make sure that user can get the easiest way to use this welding processes.

1.3 Current Technologies

Nowadays, a new technology of robot is manipulated into the welding system. Robots take many forms but are essentially mechanized devices which can repeat a sequence of operations with a high degree of consistency. In the welding shop, a robot is a manipulating tool which moves the welding head along the joint line but at the same time maintains the correct relationship between the welding gun and the work. The robot can do this only if it given instructions, so there must be a facility to program the complete welding sequence, including control of the welding parameters. Ideally, there should be some form of feedback, so that the robot can check that it is welding in the right place.

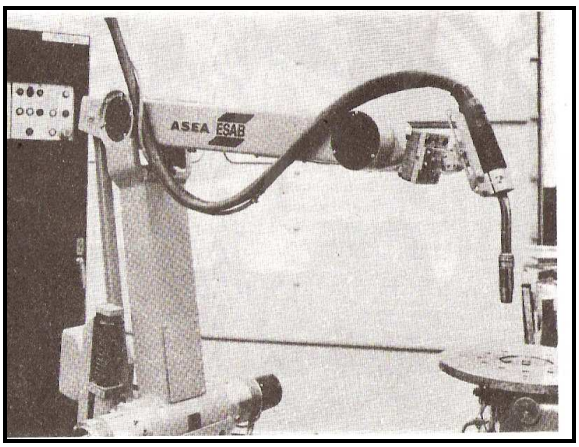


Figure 1.1: Typical jointed-arm robot.

As we mentioned above, this project is related to make a development of welding aid kit for shielded metal arc flat welding. It also can give the opportunity to explore about the welding processes especially for the speed of hand movement and the gap

between electrode and work piece. This all parameters are influence in developing the aid kit for the welding method.

1.4 Objectives

1. To design this welding aid kit for flat surface of work piece.
2. To study about current design of welding aid kit to develop into SMAW welding process.

1.5 Scope of the study

There is much type of skills when using this type of welding processes especially in straight and flat welding. The main cause that influences the process is the skills of the users. Users must maintain the distance from the electrode to the work piece. As the result, we can see the comparison of output between human skills and the device. Study of the selected design must include all the product specification and the manufacturing cost to produce the product. Development of the product must consist the usage of the drawing software; 'Solid Work' and simulation; 'Working Model' to calculate the physical terms of the product.

1.6 Thesis Organization

For the thesis, it consists 6 chapters:

1. Chapter 1 introduce about the welding, Shielded Metal-Arc welding, objectives and scope of the project.
2. Chapter 2 reviews about the literature on the journals, books and internet. The area covered the rate of the electrode, method of basic principle to move the kit and the tolerance between electrode and work piece.

3. Chapter 3 describes methodology to develop this welding aid kit and the requirement to ensure that this welding aid kit work based on the chosen electrode, tolerance between electrode and work piece and time when electrode decrease.
4. Chapter 4 describes the design selected. It includes the product specification; all the costs involve and design criteria.
5. Chapter 5 shows the analysis of the design and the calculation of physical terms; it uses 'Working Model' simulation. For the strength of the material, it uses 'CosmoXpress' simulation and for the gearing system, it uses 'MDesign' software to calculate it.
6. Chapter 6 evaluates about final design. It includes the drawing for all the components and the selected material for each component.
7. Chapter 7 describes about discussion on the design selected.
8. Chapter 8 reviews about conclusion and recommendation of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to shielded metal arc welding

Shielded metal arc welding (SMAW), also known as manual metal arc (MMA) welding or informally as stick welding, is a manual arc welding process that uses a consumable electrode coated in flux to lay the weld [1]. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination.

Because of the versatility of the process and the simplicity of its equipment and operation, shielded metal arc welding is one of the world's most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and though flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of steel structures and in industrial fabrication [3]. The process is used primarily to weld iron and steels (including stainless steel) but aluminum, nickel and copper alloys can also be welded with this method.

The heat generated melts a potion of the trip of the electrode, of its coating, and of the base metal in the immediate area of the arc. A weld forms after the molten metal, a mixture of the base metal (work piece), the electrode metal and substances from the coating on the electrode, solidifies in the weld area. The electrode coating deoxidizes

the weld area and provides a shielding gas to protect it from oxygen in the environment.

The polarity of the DC current that is the direction of current flow can be important; its selection depends on such factors as type of electrode, the metals to be welded and the depth of the heated zone. In straightly polarity, the work piece is positive and the electrode negative; it is preferred for sheet metals, because it produce shallow penetration and for joints with very wide gaps [4]. In reverse polarity, the electrode is positive, and deeper weld penetration is possible. In the AC method, the arc pulsates rapidly; this method is suitable for welding thick sections and for using large-diameter electrodes at maximum currents.

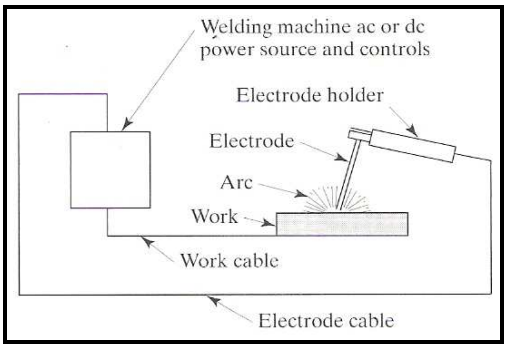


Figure 2. 1: Schematic illustration of the shielded metal-arc welding operation [4].

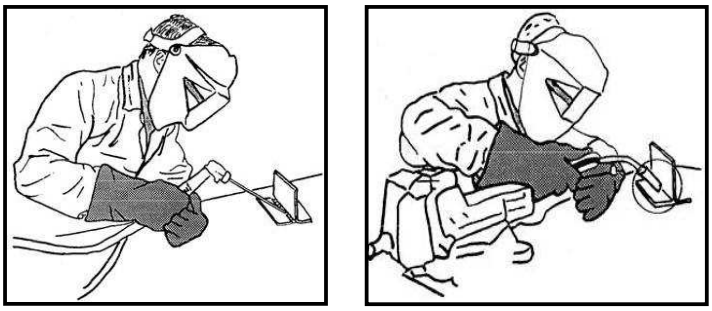
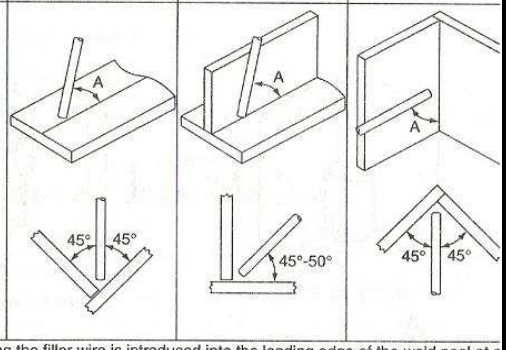


Figure 2. 2: Hand position in the welding processes [4].

2.2 Position of welding

Ideally, the work should be positioned during welding so that the molten weld metal is held in placed by gravity. It also enables high currents to be used, leading to faster welding. This implies that the work can be turned or manoeuvred [6]. Many fabrications do not lend themselves to this treatment, and much of the welding in industry is done 'in position'. The welder controls the weld by lowering the heat input to reduce the fluidity and to give a small pool which solidifies before it has time to run out of the joint. At the same time, the direction of the arc, i.e. the angle between the electrode and the weld surface, can be varied to position the weld pool to the best advantage.

Table 2. 1: Electrode angles for manual arc welding [6].

Welding position	ELECTRODE ANGLE (A)		
	Flat	Horizontal-Vertical	Vertical
MIG/MAG Welding	75° – 80°	70° – 75°	65° – 70°
MMA Welding	70° – 75°	65° – 75°	70° – 80°
TIG* Welding	70° – 80°	70° – 80°	85° – 90°
			

*In TIG Welding the filler wire is introduced into the leading edge of the weld pool at a angle of 15° – 20° to the pool surface.

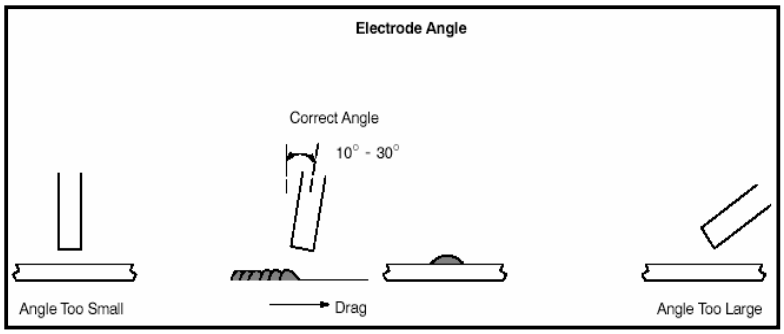


Figure 2. 3: Comparison of the electrode angle [6].