DESIGN AND FABRICATION OF HYBRID TIG/HEATING AND MIG WELDING TORCH HOLDER

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DESIGN AND FABRICATION OF HYBRID TIG/HEATING AND MIG WELDING TORCH HOLDER

MOHAMAD ZULHILMI BIN ROSLI

A report submitted in partial fulfilments of the requirement
for the award of the Diploma in Mechanical Engineering.

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JUNE 2013

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
Name of Supervisor: LUQMAN HAKIM BIN AHMAD SYAH
Position: LECTURER
Date : …….

STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature:

Name: MOHAMAD ZULHILMI BIN ROSLI

ID Number: MB 11003

Date : ……

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ABSTRACT

This study is about designing and fabricating a hybrid heating/TIG and MIG welding torch holder. The objectives of this project are to design and fabricate a hybrid heating/TIG and MIG welding torch holder which can be used on the automatic welding machine. Besides that, the study validates the effectiveness of the torch holder through a welding process on the automatic welding machine which is available in Faculty of Mechanical Engineering. The three-dimensional modeling of the holder was developed by using the SolidWorks™ engineering drawing software. The fabrication process such as material marking, cutting, drilling, tapping, milling and finalizing the holder by painting was conducted. Other than that, the validation process was performed by using automatic welding machine. The results of testing the product were also discussed in this thesis. As a conclusion, the final product achieves the objective of this Final Year project.

ABSTRAK

Kajian ini adalah mengenai merekabentuk dan menghasilkan pemegang penunu TIG/pemanas dan kimpalan MIG. Objektif projek ini adalah berkaitan merekabentuk dan menghasilkan pemegang penunu TIG/pemanas dan kimpalan MIG yang boleh digunakan di mesin kimpalan automatik. Selain itu, kajian ini mengenalpasti keberkesanan pemegang penunu ini melalui proses kimpalan menggunakan mesin kimpalan automatik yang terdapat di Fakulti Kejuruteraan Mekanikal. Model tiga dimensi pemegang penunu tersebut dihasilkan menggunakan perisian lukisan kejuteraan iaitu SolidWorks™. Proses fabrikasi seperti mengukur bahan, memotong, meggerudi, “milling” dan kemaskini juga telah dijalankan. Selain itu, proses ujian juga dijalankan dengan menggunakan mesin kimpalan automatik. Hasil daripada ujian tersebut juga dibincangkan didalam tesis ini. Kesimpulannya, produk akhir ini telah mencapai objektif Projek Tahun Akhir.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

For this chapter, it is about discussion of the project background, problem statement, objective of the project, and lastly scope of the project.

1.2 Project background

Basically, welding is a process of joining the materials by using coalescence. This process are often use in many heavy industry and become one of the most important process in assembly process (http://en.wikipedia.org/wiki/Welding). Therefore, this welding process has been develops into automatic process. Nowadays, there are many machine can perform automatic welding process. One of it is called automatic welding machine which can be found in Universiti Malaysia Pahang (UMP).

Automatic Welding Machine is an important machine for those who are involved in welding research. This device is commonly used by those who want to do the analysis about the welding and to study about it strength. By using this machine, it

will help the user to reduce or to totally eliminate defects that may occur at the welding area because this machine can do a constant welding compare to manual welding that done by hand. Therefore, this becomes advantage for this machine because it produces the continuous constant and perfect welding.

Besides that, in welding there is preheating process. Preheating is a process of heating the material before the welding process (Modern Welding Technology, Scott C. Helzer, 2005). Basically, preheating process will provide the material in a suitable condition for the welding process. This is because, preheat can reduce the shrinkage stress and weld distortion. Next, it will promote the fusion and remove any moisture such as oil that may have on the materials.

1.3 Problem statement

Using high tech machine such as CNC Milling and Lathe machine means it is user friendly and easy to work with. At the same time, it does not require the user to use their energy a lot. It goes same with the automatic welding machine. This machine can perform the linear welding using a MIG welding automatically by itself. But unfortunately the machine arm can only hold the MIG welding torch. Therefore, this machine cannot hold another torch such as TIG torch. Because of that, this machine can only perform automatic welding process and cannot perform automatic preheat process at the same time. This situation will cause the user to face the problem of needing to preheat the work piece manually by hand using TIG or heating torch. By doing the preheat process manually, it will lead to unbalance heat distribution on work piece that will cause defects in welding area.

1.4 Objective

By finishing this project, the problem that is faced by the user can be solved in an effective way. Among it are:

i. Design and fabricate a hybrid heating/TIG and MIG welding torch holder which can be used in the automatic welding machine.
ii. Validate the effectiveness of the torch holder through a welding process.

1.5 Project scopes

The scopes of this project are:

i. Design a hybrid heating/TIG and MIG welding torch holder using the AutoCad programmer which is SolidWorks™.
ii. Fabricate a hybrid heating/TIG and MIG welding torch holder using the suitable materials based on the requirements of the project.
iii. Validate the product using TIG/MIG hybrid technique on butt welding of Aluminum-Alloys.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To design and fabricate a hybrid heating/TIG and MIG welding torch holder, it is important to have knowledge about how it works, function and others. Therefore, executing research is necessary to obtain all the relevant and useful information that are related to this project. With the information and knowledge that is obtained, the project can be accomplished with guidance in achieving the target mark.

2.2 MIG welding torch

MIG welding which stands for Metal Inert Gas (MIG) is also known as Gas Metal Arc Welding (GMAW). MIG welding is a process which used heat from an electric arc between electrode (metal wire) and the work to melt the base metal in order the coalescence to occur (ASM International, 2003). While the welding process occurred, the shielding gas must be provided to prevent the melt metal react with oxygen and other unwanted reaction and at the same time stabilized the arc. Therefore, in this welding process, the inert gas will be used to provide protective atmosphere. As the

result of using inert gas, the welding will be good in versatility and no slag removal required since no slag is produced. Figure 2.1 shows the MIG welding torch.

Figure 2.1 MIG welding torch

2.3 Heating torch

Heating torch is a tool which is used to preheat any material that need to be heated (Graville, 1975). It has been used in the variety kind of industry such as medical industry and especially in heavy duty industry such as manufacturing industry. It can be used in a lot of process such as solidification, molding, hardening and welding. For an example, in some of the welding process, heating torch is widely used to preheat the steel that needs to be welding using fuel gas or electrical resistance. The main purpose of preheat the steel before the welding process is to slow the cooling rate in the weld area. In order to achieve that purpose, there also some aspects that needs to be consider before preheat process such as the thickness of the steel involve, the material properties and others. By doing this, we can avoid cracking of the weld metal or heat affected zone. Figure 2.2 show the heating torch.

Figure 2.2 Heating torch

2.4 TIG torch

TIG torch is a device that is used to heat the material that needs to be heated. Its function is similar to the heating torch. Besides that, it is made up of a head to protect the tungsten, collet (sleeve to hold the tungsten) collet body (to hold the collet), tungsten and a ceramic cup (Bailey, N. et al). The tungsten carries the current which produces an arc. Orifices in the collet direct shielding gas to flow out of the ceramic cup and surround the weld pool. Figure 2.3 shows the TIG torch.

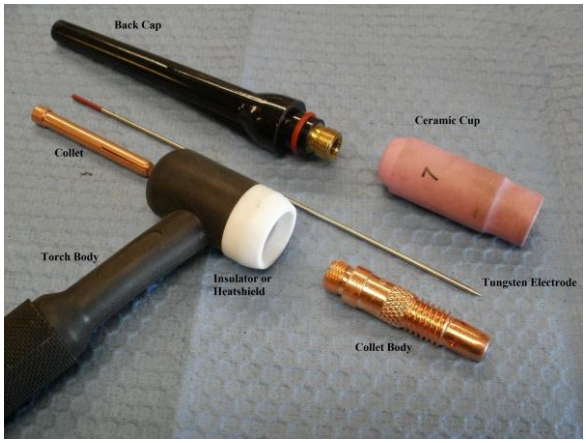


Figure 2.3 TIG torch

2.5 Automatic welding machine

The automatic welding machine is a device that can perform the welding process automatically by itself. This machine is available in faculty of mechanical engineering in Universiti Malaysia Pahang and it is custom made machine. However, this machine is just for the linear welding process. By using this machine, the user can get a constant welding due to the constant velocity of welding. Figure 2.4 shows the automatic welding machine.

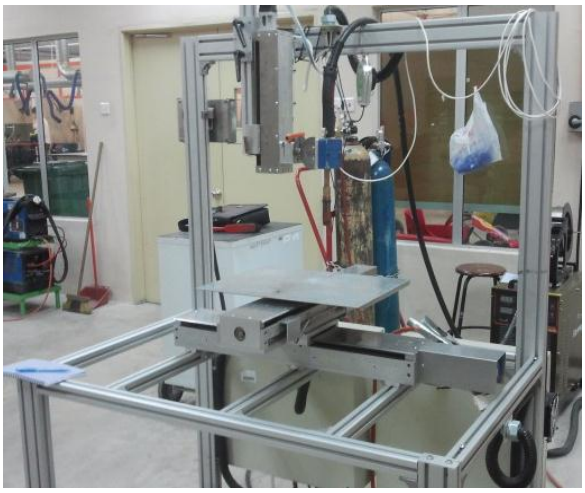


Figure 2.4 Automatic welding machine

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will be explaining the details about the methodology that is involved in this project. There are many processes that need to be accomplished before the fabrication process. This chapter will explain from the beginning of the idea until the fabrication process is done. Besides that, it covers and explains all the process that is involved in the fabrication process such as cutting, assembling and finishing.

3.2 Methodology flowchart

As shown below, Figure 3.1 shows the flow chart of the whole Final Year Project. To make sure this project run smoothly, an appointment was made up weekly with the supervisor.

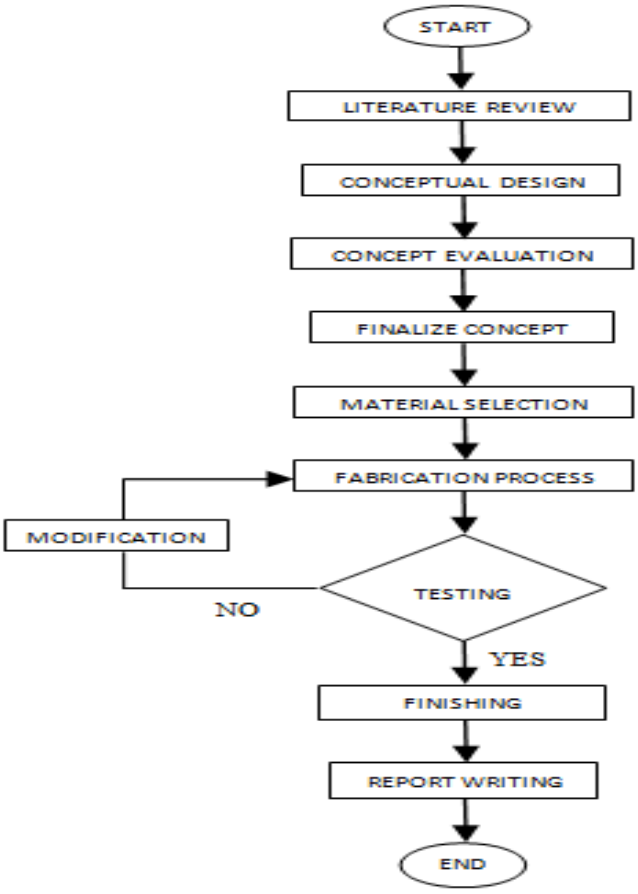


Figure 3.1 Flow chart of the project

First of all, the discussion about the literature review with the supervisor had been discussed specifically. In this literature review, there is some briefing from the supervisor about the tittle given such as objective, problem statement and scopes of this project. After the briefing and detailed explanation from the supervisor, some ideas on how to solve the problem that is faced by the user of the automatic welding machine were discussed.

After going through all the information given, the conceptual design was started. There was a lot of brainstorming before the sketching was started. All the knowledge and ideas have been applied into the sketching in order to achieve the objective. After

the sketching process, concept evaluation was made. In this process, all the sketching details have been evaluated one by one. After the evaluation process, the best concept and sketching that will be used as the product final design can easily be determined. After choosing the best design, the process of finalizing the concept was started. The design that has been choosen was transformed from rough sketching to engineering drawing. This has been done using SolidWorks™ software. Using this software, makes it possible to design in 3D without making any prototyping which costs a lot and use a lot of time. Besides that, in this process all dimension and geometry of the product can be specified.

After done with finalizing the design, the material that will be used is being listed. Next some discussion with the supervisor has been done to discuss about material selection for the product. As the result from the discussion, aluminum plates for the torch holders and aluminum profile as the main part has been choose.

After choosing the right material, the fabrication process of the design according to final design was started. In this process, there are many processes that need to go through. The first thing that needs to be done is to cut the material into the dimensions that is needed. Next, another process such as making a pocket using a milling machine, through hole using drilling machine and others process one by one have been done after all the material are cut according to the design.

Once the fabrication is done, the product will be tested until get a satisfactory result was obtained. In this process, the product was attached to the automatic welding machine. After that, the product performance will be tested by trying to run the Automatic welding machine. By doing this, any problem that may be occur in the product would be able to detect. And if so, there will be some modification on the product until it can perform perfectly.

The last step for the product is finishing process. In this process, there are some finishing on the product such as grinding the burr using hand grinder tool, making sure there is no sharp edge, tightening the screws and other processes.

Finally, the final report writing and presentation slides were prepared. Presentation slides are then reviewed by the supervisor so that errors can be corrected. Everything regarding the project is then presented to the panels and draft report is submitted to the supervisor. Mistakes are corrected and the final product is then submitted to complete the Final Year Project.

3.3 Sketching

Sketching is the most important step for making any modification on existing design and especially for those who are making a new design idea. For this project, the sketching is more to create a new design idea that does not exist in current market. This sketching also important because it doesn't need any detailed information such as dimension of the product, types of material and others. Because of that, it easy to throw out all the ideas while doing the sketching. Next by having a sketch design, it will help a lot in using CAD software such as SolidWorks™ for designing the product. Lastly, for this project there are three sketches that have been made.

3.4 Design concept generation and selection

Among the three design made, one of the best design is chosen based on the design specification. The design specification includes:

i. Functionality
ii. Lightweight
iii. Long lasting

The design is selected based on their 3 concept design specification. For this design specification selection, "+" indicates it is better than, "0" indicates it is same as, and "-" indicates it is worse than. The highest score in the concept scoring matrix will be the final design concept of the product. Table 3.1 shows the design concept matrices.

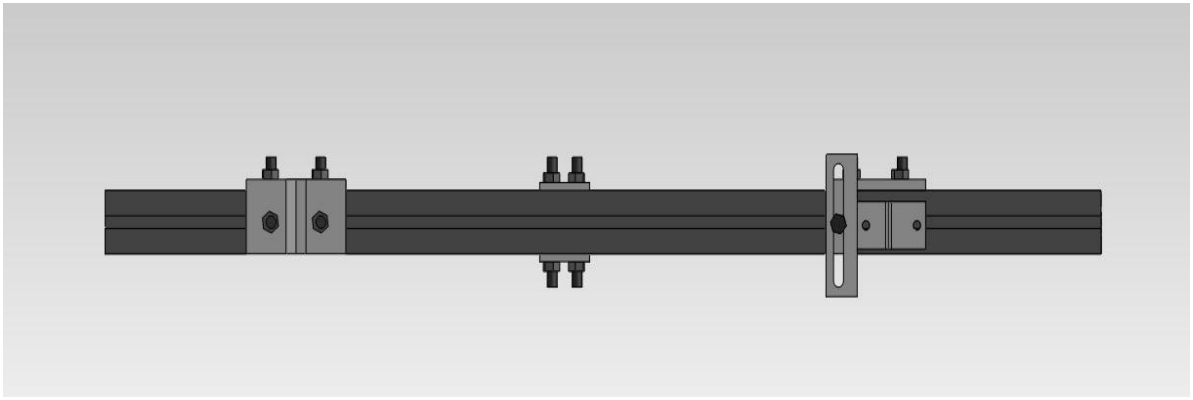
Table 3.1 Design Concept Matrices

Design Specification	**Design Concept**		
	1	2	3
1. Stability	0	0	+
2. space occupied	0	0	+
3. functionality	+	+	+
4. durability	0	+	+
5. weight	0	+	+
6. material saving	-	-	+
Plus (+)	1	3	6
Same (0)	4	2	0
Minus (-)	1	1	0
Net score	0	2	6
Rank	3	2	1

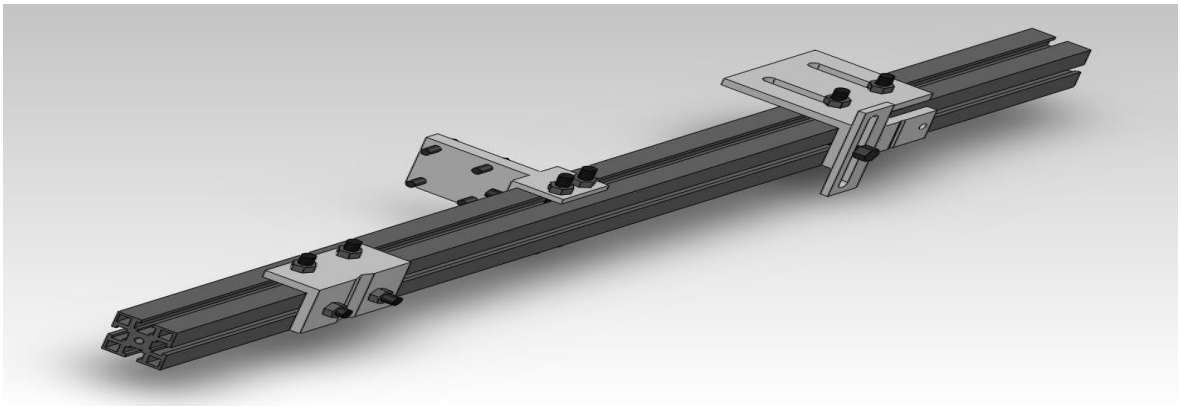
3.5 Finalized the design

For this process, the best design specification which is design number 3 was analyzed and transformed into final design using AutoCad programmer which is SolidWorks™. All the detail of the product has been set up in SolidWorks™ based on the requirements for the fabrication process.

3.6 Product design specification



(i)



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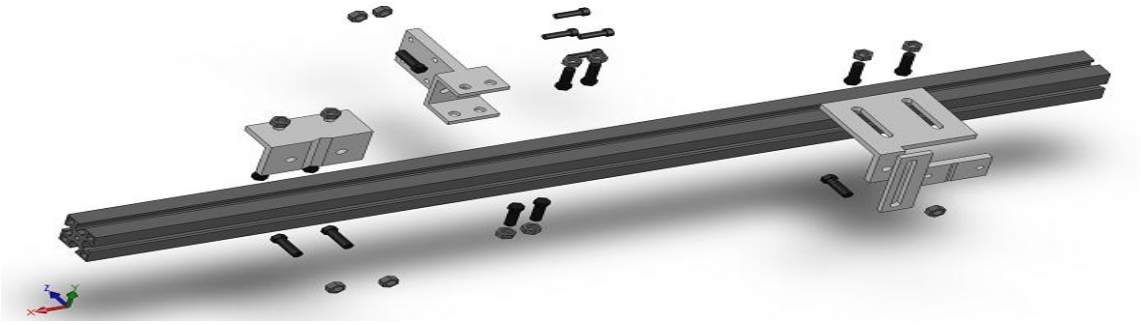


(iii)

Figure 3.2 Design Concept 3(i) Front view (ii) Isometric view (iii) Explode view

Figure 3.2 shows the best design that has been chosen. This design is simple but can function as required by the user. This design uses less material which means it is lightweight. Besides that, it can easily be conducted by the user. This design is combination of four major parts.

3.7 Fabrication process

This process is the most important process for my final year project. Fabrication process is a process of converting raw material into product. It can be described as the transformation of materials into terms of greater value by means of one or more processing and/or assembly operations. For this project, it focused on design and fabricating the hybrid heating/TIG and MIG welding torch holder which can be used on the automatic welding machine available in faculty of Mechanical engineering. This project considers the shape, functionality, portability for people to use it and the manufacturing cost.

3.8 Material selection

Selecting the material for the product is important as the important of the assembly process. The criteria of the material that is going to be used must be based on the usage and the function of the product. Appointments with the supervisor and lab technicians have been made to choose the right material of the product. After choosing the right material, the material form needs to be filled out to get the approval from the store keeper who is in charge in the main storage of material. The materials that have been chosen are shown in table 3.2.

Table 3.2 Sort list of materials

N	**Materials**	**Length**	**Quantity**
1	40mm x 40mm aluminium profile	200mm	1
2	75mm x 10mm aluminium square bar	150mm	1
3	Ø8mm bolt and nut	40mm	20
4	Ø6mm bolt and nut	50mm	2
5	Ø8mm Rhombus nut	-	7

3.9 Fabrication flow

Fabrication flow is prepared based on the priority of the process which needs to done first, second and so on. Figure 3.3 shows the flow of fabrication.

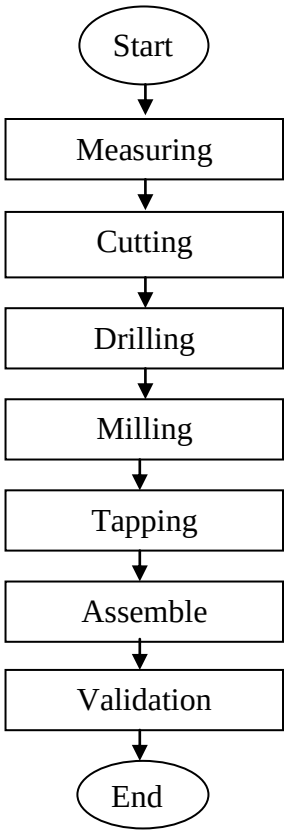


Figure 3.3 Fabrication flow

3.9.1 Measuring

Measuring process is the important process before the cutting process. In this process, measuring tape, Vernier caliper and ruler are use in this process.

3.9.2 Cutting the material

Cutting the material is the process of cutting the material into a specified dimension based on the design using the cutting machine such as Chop saw and others. Besides that, it is the next process after getting the material from the material storage. Material

that has been taken is not in the dimension and geometry of the product. Therefore, it is needed to cut the material into the dimension based on the final design before move on to another process. It also as acts preparation for another the fabrication process such as welding, pocketing and others. Figure 3.4 shows the chop saw used in this project.

Figure 3.4 Chop saw

3.9.3 Drilling process

Drilling is the most common machining process where the operation involves making ground holes in metallic and nonmetallic materials. Besides that, drill process can be divided into two types which are through holes or blind holes. For this project, all the drilling process use the through hole because none of the product mechanism needs blind holes. This process is done at the welding lab. Almost all the drilling process involves 8 millimeter of diameter and the rest is 6 millimeter in diameter hole. Figure 3.5 shows the drilling machine used in this project.

Figure 3.5 Drill machine

3.9.4 Making pocket

Making pocket is one of the most common process for the milling machine. This process can be done using a special drill bit and it is quite similar to ordinary drill bit which can be found at drill machine. For this project, there are 3 pockets that need to do and all of it have 8 millimeter in diameter. This process takes a lot of time because it involving a lot of step when using the milling machine. First of all, the workpiece must be clamped properly at the clamper. Next, reference or zero point at the workpice must be set by using the edge finder. After the zero point was set up and cutting tool at the right coordinates, then the drilling takes place and making the pocket can be start. This process takes a lot of time because of the limitation of the tool to cut just 0.4 millimeter for 1 round. Figure 3.6 shows the milling machine used in this project.

Figure 3.6 Milling machine

3.9.5 Tapping

Tapping process is to make the screw thread either it is internal or external. The hand tap use to make internal tap while the die tap use to make external tap. The process of tapping should be perpendicular to the workpiece surface area. At the same time, oil should be applied to the drilled part frequently to prevent the break of taps. When rotating the hand tap, it is rotated clockwise and anticlockwise repeat so that the hand tap can slowly feed the material. Figure 3.7 shows the tapping process.

Figure 3.7 Tapping process

3.9.6 Assemble process

Assemble process is process of joining or assembling the part of product to become one final product. This process can be divided into two types which is permanent or non-permanents joints. For this project, it is involving non-permanents joint using the screw method. Figure 3.8 shows the assembled of the product.

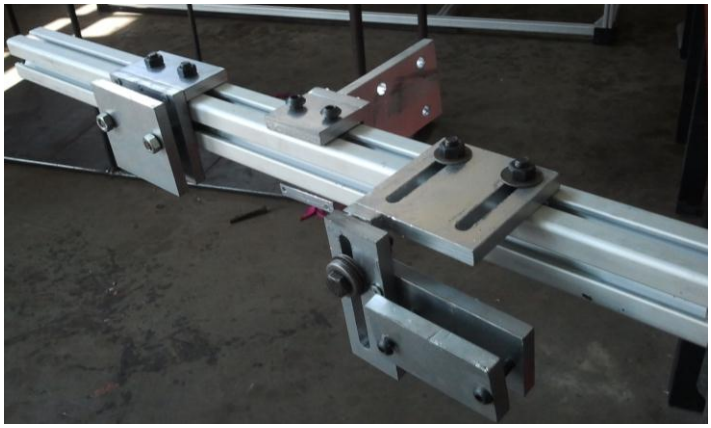


Figure 3.8 Assembled of the product

3.9.7 Validation

Validation in engineering term is the process of confirming that a product or service meets the needs of its users. In this project, the functionality and effectiveness of the TIG/heating and MIG welding torch holder was tested by using TIG/MIG hybrid technique on butt welding of aluminum-alloys. The procedure of testing the final product as listed below in figure 3.9.

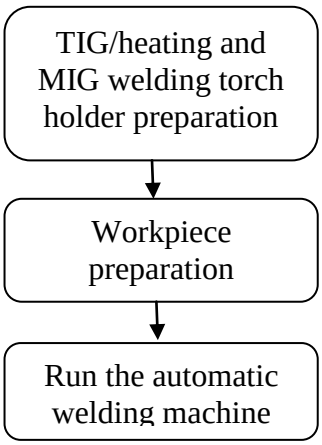


Figure 3.9 The flow of validation process

First of all, the TIG/heating and MIG welding torch holder was set up to the automatic welding machine as shown in the figure 3.10. The holder was attached to the machine perfectly to avoid any vibration or unbalance of the holder when undergoes welding process. The position between TIG/heating and MIG welding torch holder was adjusted to the suitable distance for aluminum-alloys welding process.

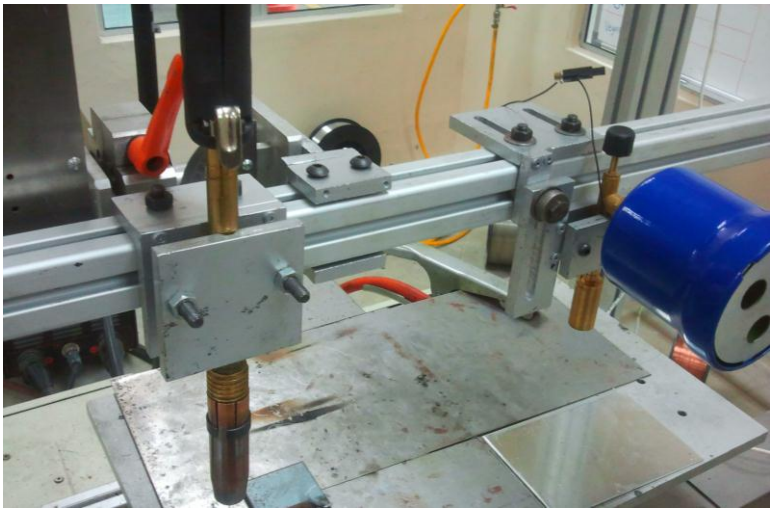


Figure 3.10 TIG/heating and MIG welding torch preparation

After the preparation of the holder was set up, the workpiece had been prepared on the table of automatic welding machine. The position of the workpiece was adjusted to make sure it is in linear position with the MIG welding torch.

Finally, after the holder and the workpiece had been set up, the machine was start up. The data such as velocity of the table was been put into the programmer of the automatic welding machine. After all the preparation, the butt welding of aluminum-alloys was start up.

CHAPTER 4

RESULT AND DISCUSSION

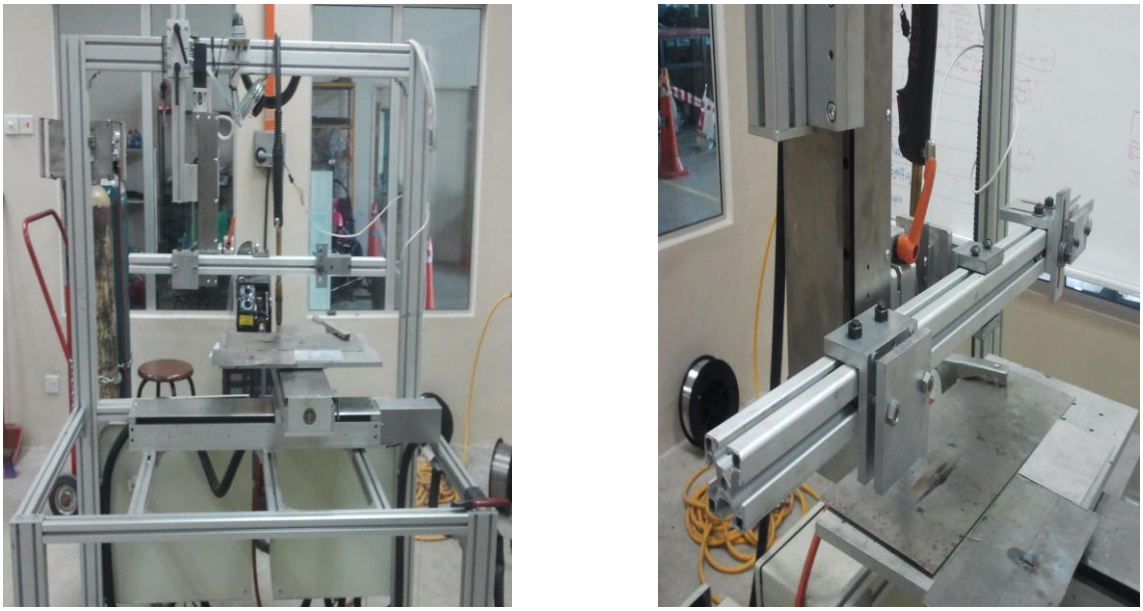
4.1 Introduction

In this chapter, it will show the final product as an achievement of this final year project. Even though the objectives have been achieve, but there were some problem encountered during the process which will be discussed in this chapter. Besides that, this chapter also will discuss the parts of the product.

4.2 Final product

4.2.1 Overview of product

Figure 4.1 shows the product being attached to the automatic welding machine.



(i) (ii)

Figure 4.1The product being attached to the automatic welding machine (i) Front view (ii) Isometric

Basically there are four parts of the hybrid heating/TIG and MIG welding torch holder. First, aluminum profile holder is use to attached the hybrid heating/TIG and MIG welding torch holder to the automatic welding machine. Next, the TIG/heating torch holder is use to clamp the TIG/heating torch. While, the MIG holder will be used to clamp the MIG welding torch. Lastly, aluminum profile which use as the track for the TIG/heating and MIG welding torch to be adjusted.

4.2.2 Overview of aluminum profile

Figure 4.2 shows the aluminum profile used in this project

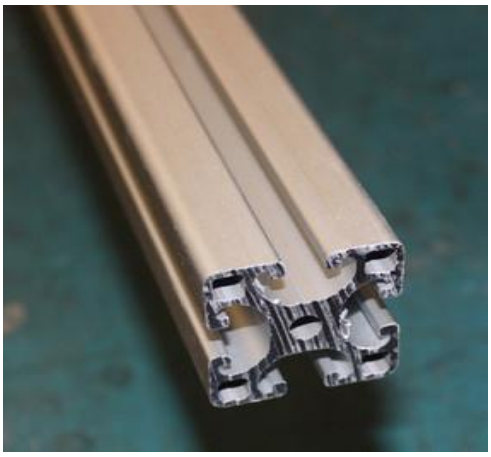


Figure 4.2 Aluminum profile 40x40mm

Aluminum profile is the main part of the holder. All the others part are being attached to it. The design of this aluminum profile allowed the part attached to it to be adjusted. Therefore, the distance between TIG/Heating and MIG welding torch can be adjusted in a single axis according to the user. All the parts attached to it using the bolt and the rhombus nut.

4.2.3 Overview of aluminum profile holder

Figure 4.3 shows the aluminum profile holder

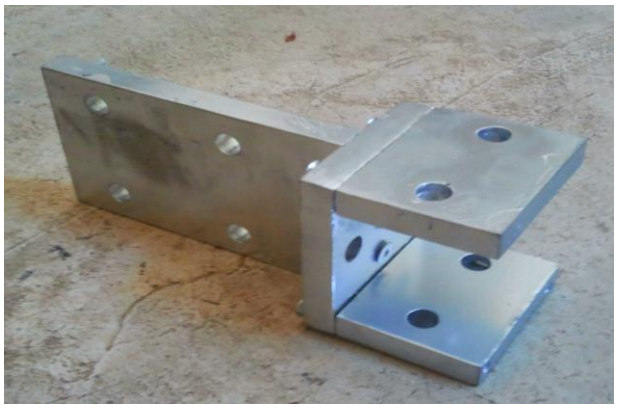


Figure 4.3 Aluminum Profile holder

This aluminum holder is made up from the combination of the aluminum square bar. All the aluminum square bar is assemble using the nut which is easier than using the Aluminum welding. This part will hold the aluminum profile while it is being attached to the automatic welding machine.

4.2.4 Overview of MIG welding holder

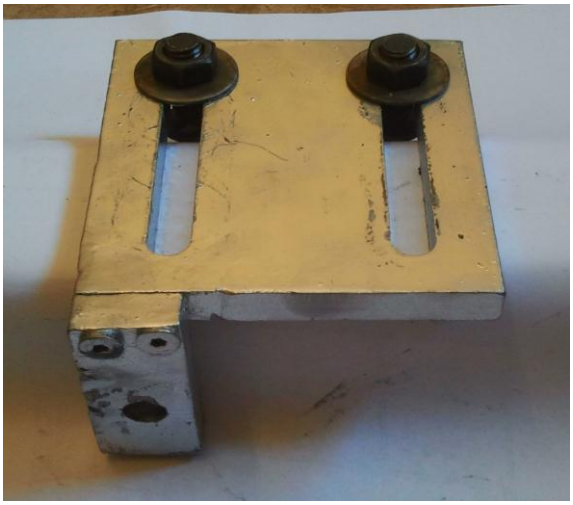
Figure 4.4 shows the MIG welding torch holder

Figure 4.4 MIG welding torch holder

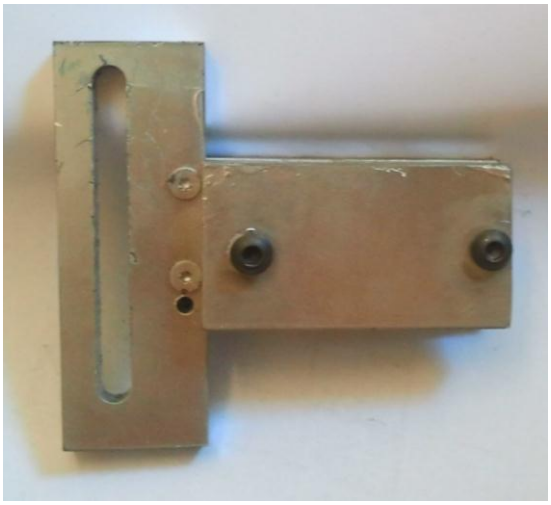
This MIG welding holder is made up using the same method as aluminum profile holder. This holder will clamp the MIG welding torch and it position on the aluminum profile can be adjusted by loosen the nut.

4.2.5 Overview of TIG/heating torch holder

Figure 4.5 shows the parts of TIG/heating torch holder.



(i)



(ii)

Figure 4.5 Parts of TIG/heating torch holder (i) Y-axis adjuster (ii) Z-axis adjuster

TIG/heating torch holder is use to clamp the TIG/heating torch which can be adjusted in X, Y and Z-axis. This part consist of two different parts, the first one, in Figure 4.5(i) is design to be adjusted Y-axis While the second part, in figure 4.5(ii) is design to be adjusted Z-axis. The method of adjusting this holder is by loosening and tightening the nut of this holder.

4.3 Procedure to adjust the position of heating/TIG and MIG welding torch holder

There are some steps for the user to adjust the position of the holder along the aluminum profile:

For MIG welding torch holder:

i. Loosen the nut at the upper part of the holder
ii. Drag the holder along the aluminum profile to the wanted position (X-axis).
iii. Tighten back the nut at the upper part properly to make the holder at fixed position.

For TIG/Heating torch holder:

i. Loosen the nut at the upper part of the holder to adjust it forward and backward (Y-axis).
ii. Loosen the nut at the front of the holder to adjust it upward and downward (Z-axis) to change intensity of heat from TIG/heating torch.
iii. Drag the holder to the wanted position.
iv. Tighten back the properly to make the holder at fixed position.

4.4 Validation results

As the result of the validation, overall the product performance is acceptable. The TIG/heating holder was performed as it designed to perform. In validation process, the TIG/heating holder was adjusted in Y and Z-axis to change the intensity of the heat produce by it. Besides that, the aluminum profile allowed the user to adjust the position between the TIG/heating and MIG welding torch holder. In validation process, the distance between the holders is adjusted to the suitable position for the butt welding of aluminum-alloys welding.

The MIG holder performance is acceptable due to its performance in the validation process. In welding process, the MIG welding torch holder are not vibrating and can withstand the heat from the MIG welding torch. Besides that, it also does not moving and very stable in the welding process.

As the conclusion, the heating/TIG and MIG welding torch holder performance is acceptable. It is also easy to conduct in variety kind of welding. The validation process proved that this product is ready to be use on the automatic welding machine. The result of the butt welding of aluminum-alloys is shown in figure 4.6.

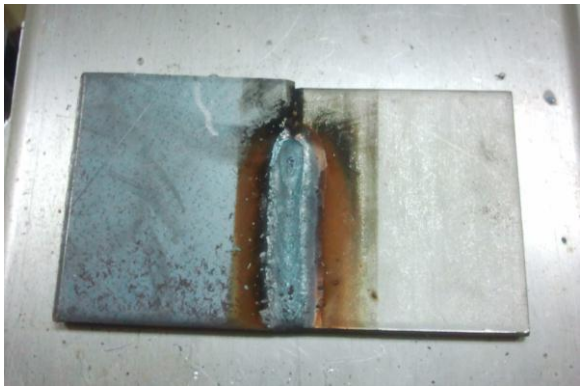


Figure 4.6 The result of validation process

4.5 Problems faced and solutions

In completing this final year project, there are several problems that were faced. The problems could be solved with the help from the supervisor and lab technician.

The first problem that was face is lack of material in material storage. This project, basically use the different thickness of the aluminum square bars but unfortunately material storage does not have some of the thickness that was needed. As an alternative, the same thickness of aluminum square bars was used and did some modification on my product design.

The second is the lack of drilling facilities at the welding lab. For example, the lack of drill bit. The size or dimension of the drill bit in the mechanical lab is limited and some of the drill bits were already broken and blunt. To solve this problem, the drill bit was bought from outside market and the blunt drill bit is repaired by the lab assistance so that it can be reused.

The last one is the problem of assembling the product using the TIG welding. Basically, the TIG welding is use for welding the aluminum and need a lot of skill to handle it. Even though guides were given by the supervisor the TIG welding still could not be used properly. As the solution, nuts were used to assemble the product and the assembling process can be done perfectly in an easier manner.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter will summarized overall the final year project. Recommendation on the final year project also will be given in this chapter.

5.2 Conclusion

As the conclusion of the final year project, the objective was achieved. A hybrid heating/TIG and MIG welding torch holder has been fabricated according to the design that has been drawn using SolidWorks™. The fabrication process took 13 week to complete. A hybrid heating/TIG and MIG welding torch holder can be attached to the automatic welding machine without giving any side effect to the original machine due to its lightweight. The user of automatic welding machine can perform different types of

welding by using this holder. This is because of the functionality of the holder which can be adjusted in 3-axis. Besides that, the holder can be conducted easily and it is user friendly.

The fabrication process required many skills that have been learnt in pervious mechanical laboratory such as material measuring, marking, cutting, drilling, grinding, turning and milling. The fabrication process can let student gain more experience and develop the skill and the ways to operate the machine to complete the project. Besides that, this project teachs the student how to face and work in the real situation as the preparation for the student to become successful workers in their field.

5.3 Recommendation

There are some recommendations related to the facility in the mechanical lab. The machine and the tools in the lab must have maintainer every semester. So that, the student can use the machine to fabricate some product or project without much trouble. Besides that, the facility in the lab also must be improved due to the increase of the project and the amount of student using it. Next, all the students should take their responsibilities when using any tools to avoid troubles to others student. For example, the student should return back all the tools that they use to the lab technician. By doing this, the others student will not face the problem of lack of tool such as drill bit in the future.

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APPENDIX

GANTT CHART

Project activities		Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Literature review	Plan														
	Actual														
Sketch the design	Plan														
	Actual														
Final design in SolidWorks™	Plan														
	Actual														
Find material for design	Plan														
	Actual														
Fabricate the design	Plan														
	Actual														
Evaluate the product	Plan														
	Actual														
Report writing	Plan														
	Actual														
Final presentation	Plan														
	Actual														