DESIGN AND MANUFACTURE THE INNER SHELL OF DIESEL FURNACE

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DESIGN AND MANUFACTURE THE INNER SHELL OF DIESEL FURNACE

MUHAMMAD MUIZZUDDIN BIN YUSOF

A report submitted in partial fulfillment of the requirements for the award of the
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SUPERVISOR DECLARATION

I hereby declare that I had read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the purpose of the granting of Diploma of Mechanical Engineering.

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I declare that this thesis entitled "DESIGN AND MANUFACTURE THE INNER SHELL OF DIESEL FURNACE" is the result of my own research except as cited in references. The thesis has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

Signature :

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DEDICATION

To my beloved father and mother

YUSOF BIN MUDA

ZAUYAH BINTI HAMZAH

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First of all I am grateful to ALLAH S.W.T for blessing me in finishing my final year project (FYP) with success in achieving my objectives to complete this project.

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ABSTRACT

This report is about the design and manufactures the inner shell of diesel furnace. This project encourages the study of melting furnace. Melting furnace is a device used to melt the metal for casting metal application. The project is start with the study and research. From the information gathered from literature study, four designs had been created. One of the designs is chosen using screening concept and final design is decided. The fabrication process consists of cutting process and construction of the wall inside the furnace. By putting the buffers will keep the heat inside the furnace and make the crucible melt the metal faster. Furthermore, the furnace is heat up by the burning of diesel fuel to blow the fire into the combustion chamber. When the product is finished, it is tested to determine the time of metal to melt completely and to prove the product is working and success. All of the problems faced during and after making the product are discussed. Some recommendation base on the problems also discussed in the last chapter of this report to improve the product in the future.

ABSTRAK

Ini adalah laporan mengenai rekaan dan pembuatan bahagian dalam kulit pada relau disel. Projek ini menggalakkan pembelajaran tentang relau lebur. Relau lebur ialah alat yang digunakan supaya dapat melebur logam untuk aplikasi tuangan logam. Projek ini bermula dengan pembelajaran dan kajian. Berdasarkan informasi yang diperoleh daripada kajian literature, empat rekaan telah dihasilkan. Salah satu daripada rekaan tersebut telah dipilih dengan menggunakan konsep penapisan dan rekaan terakhir telah diputuskan. Proses fabrikasi terdiri daripada proses memotong dan pembinaan dinding di dalam relau. Dengan meletakkan beberapa penghadang akan memerangkap haba di dalam relau dan membuatkan mangkuk pijar meleburkan logam dengan cepat. Lebih-lebih lagi, relau tersebut telah dipanaskan oleh pembakaran minyak disel yang menghembuskan api ke dalam kebuk pembakaran. Apabila produk telah siap,ianya diuji untuk menentukan masa yang diambil untuk logam melebur secara keseluruhan dan membuktikan yang produk dapat berfungsi dan berjaya. Semua permasalahan yang dihadapi semasa dan selepas membuat produk tersebut telah dibincangkan. Beberapa cadangan berdasarkan semua permasalahan juga dibincangkan dalam bab terakhir laporan ini untuk meningkatkan mutu produk ini pada masa akan datang.

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LIST OF SYMBOLS

Kg	Kilogram
Mm	Milimeter
s	Second
ºC	Degree Celcius
C	Carbon
Cr	Chromium
Fe	Ferum / iron
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
P	Phosphorus
S	Sulfur
Si	Silicon

LIST OF ABBREVIATIONS

BC	Before Century

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter is explaining about the project background, problem statement, project objective and scope of the project.

1.2 PROJECT BACKGROUND

This project is about designing and manufacturing the inner shell of diesel furnace. The furnace is use to heat and melt the solid metal and transform it to the liquid state. The furnace use combustion of diesel as a fire source to heat the crucible and melt the solid metal inside that for a certain time. The firebrick coated with refractory inside the furnace will keep the heat around crucible to make sure heat not loss and save the time while melting the metal. After the metal totally melt, the liquid will flow out and use for casting.

1.3 PROBLEM STATEMENT

Although there are firebrick and refractory inside the furnace, the heat still flow unregulately. This will make the melting process take about two until 3 hours for melt completely. A alternative way must be adapt to solve this problem.

1.4 PROJECT OBJECTIVE

The main objective of this project is to design and manufacture the heat flow system of the inner part furnace.

1.5 PROJECT SCOPE

The scopes of this project are :

(i) Design the buffer plate to keep the heat on the crucible
(ii) This project focused on melting non-ferrus metal only.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The oldest extant blast furnaces were built during the Han Dynasty of China in the century BC. However, cast iron farm tools and weapons were widespread in China by the 5th century BC, while third century BC iron smelters employed an averange workforce of over two hundred men. These early furnaces had clay walls and used phosphorus that containing mineral as a flux. The effectiveness of the Chinese blast furnace was enhanced during this period by the engineer, Du Shi who applied the power of waterwheels to piston bellow in forging cast iron.

2.2 FURNACE ONE

This furnace are custom homemade. It used propane tank as shell that will be cutted to fix the refractory castable. As the propane under pressure can penetrate the steel of the tank, the hot water was fill to moisture the content inside the tank. The crucible only use a small diameter with depth tube that welded to a chunk of one over four inch plate. The bolts welded to the top side for lifting and the nut on the bottom is used to aid in pouring.

Figure 2.1: Tube crucible

As the refractory rated to 1650ºC, this requires no additional sand. It just mix with water with a suitable amount.

Figure 2.2: Furnace after finishing

The refractory was left to set-up over night before the forms were removed and left to cure for a week. Both forms have a slight taper and were removed without damage to the refractory. The fire up procedure on the bag states to raise the temp in 75ºC increments every 30 minutes per inch of refractory thickness. This was given that only 24 has elapsed since mixing. As this had sat for a week, it was fired up for a burn without incident.

2.3 FURNACE TWO

Figure 2.3: Flowerpot crucible furnace

This is the simplest and cheapest furnace. It just use flowerpot as crucible. Then, the charcoals are use to heat the crucible wholly but it need to be replace for a certain time. The heat source from the burning fo diesel fuel blow from a external pipe into the furnace.

Figure 2.4: Inside the furnace

2.4 FURNACE THREE

This furnace is using a rolled sheet metal as it shell. Inside it, the firebricks are arrange to form large combustion chamber.

Figure 2.5: Combustion chamber of furnace

A graphite crucible used include a lid on it. That will keep the heat are not loss while the melting process.

Figure 2.6: Graphite crucible with lid

This furnace use diedel fuel as the fire source and added an oxygen port to speed things up. The result is only 15 minutes for aluminium to melt completely.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter is discusses about all the information and data that required for this project. Methodology is a description of process, or may be expanded to include a philosophically coherent collection of theories, concepts or ideas as they relate to a particular discipline or field of inquiry.

3.2 PROJECT FLOW CHART

There were eight phase conclude in this project, which are :

(i) Phase 1 – Project discussion
(ii) Phase 2 – Literature review
(iii) Phase 3 – Sketch and design
(iv) Phase 4 – Final sketching
(v) Phase 5 – Finalize design
(vi) Phase 6 – Fabrication
(vii) Phase 7 – Test, analysis and discussion
(viii) Phase 8 – Report

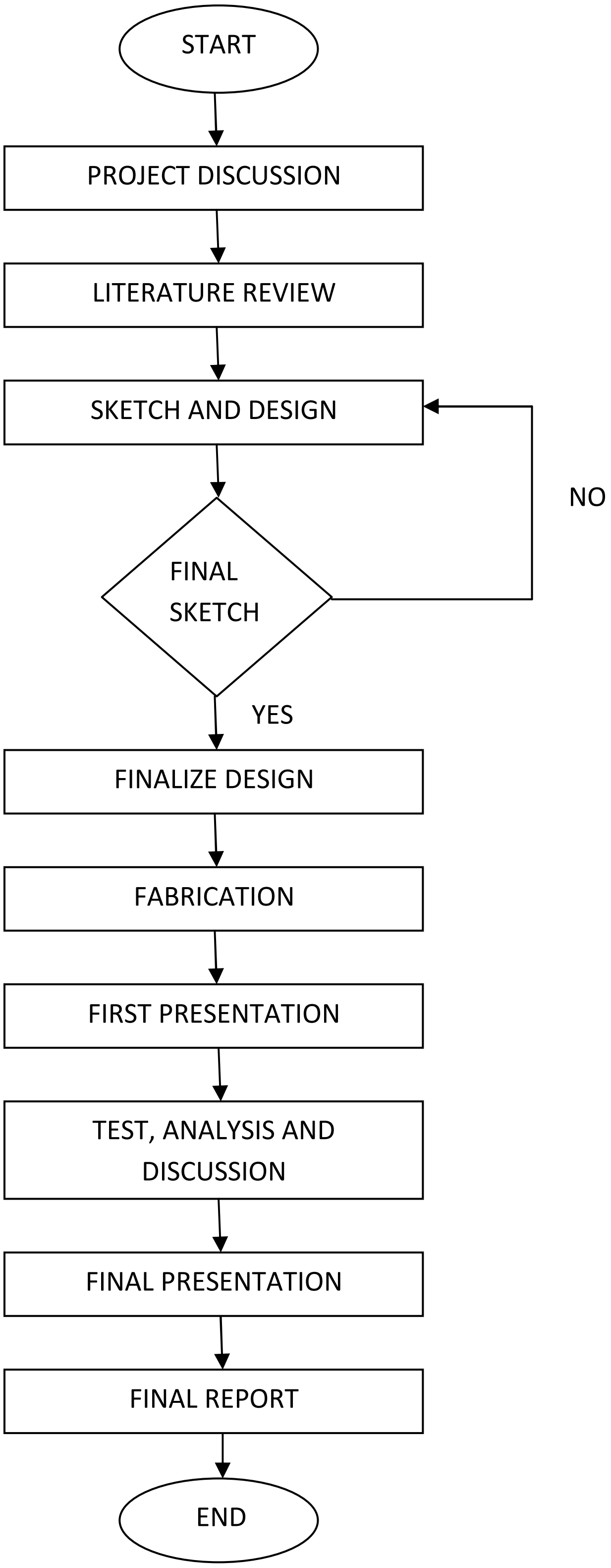

Figure 3.1: Flow chart

3.3 DESIGN GENERATION

3.3.1 First Sketch

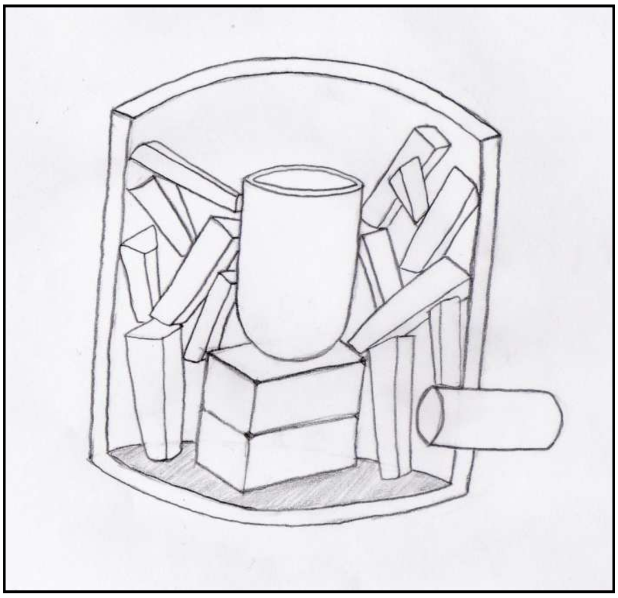

Figure 3.2: First sketch

Advantages

The crucuble is very depth and it heated by charcoal wholly.

Disadvantages

The crucible not stand properly. The charcoal used need to be replace.

3.3.2 Second Sketch

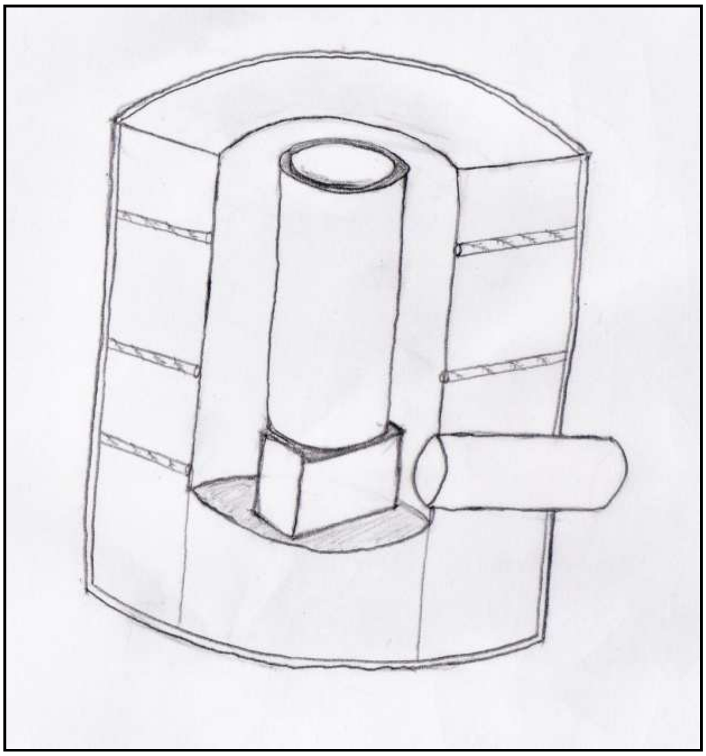

Figure 3.3: Second sketch

Advantages

This design idea has a very thick wall of castable. It also have a very depth of crucible.

Disadvantages

The thick of wall cause the shell was heavy weight. The wall also may crack as it does not use firebrick.

3.3.3 Third Sketch

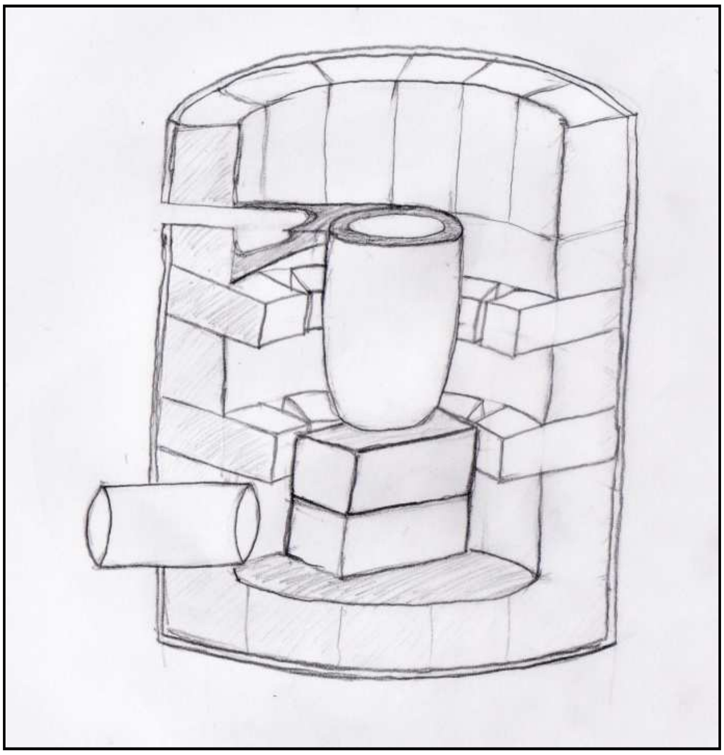

Figure 3.4: Third sketch

Advantages

The buffers use are from firebricks that attach to the wall. So, the crucible are wholly heat.

Disadvantages

However, only a small crucible can be put. As there are many firebricks use, the shell become very weight.

3.3.4 Fourth Sketch

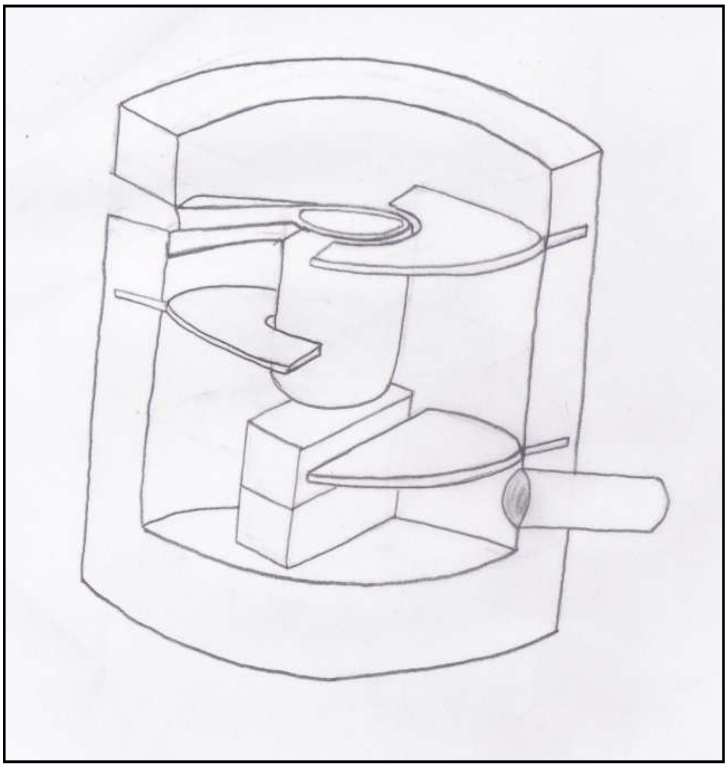

Figure 3.5: Fourth sketch

Advantages

This furnace use buffers metal plate to keep the heat. So, the crucible are heat wholly. It also can decrease the weight of shell.

Disadvantage

It only use a medium size crucible.

3.4 CONCEPT SCREENING

A problem that often faced while making a decisions to choose the best design is there are many different people with many different opinions. Concept screening use a simple matrix between a number of options and typically done with a representative team of cross-functional people. Then , the concepts will be compare against each criterias tha have been decided. Each concept has its score totalled to show its overall score and then will be rank.

Table 3.1: Concept screening

Characteristics	**Datum**	**Design**			
		1	**2**	**3**	**4**
Weight	0	+	-	-	0
Crucible size	0	0	0	-	-
Combustion chamber area	0	+	0	0	+
Crucible supporter	0	-	-	+	+
Heat performance	0	+	0	+	+
Use of buffers	0	-	-	+	+
Ease of manufacture	0	+	+	-	+
Sum of (+)	-	4	1	3	5
Sum of (0)	7	1	3	1	1
Sum of (-)	-	2	3	3	1
Net score	-	2	-2	0	4
Rank	-	2	4	3	1

3.5 FINALIZE DESIGN

The data from concept screening show that the fourth design was batter from the others three design. So, fourth design will be finalize design.

3.5.1 Solid Work

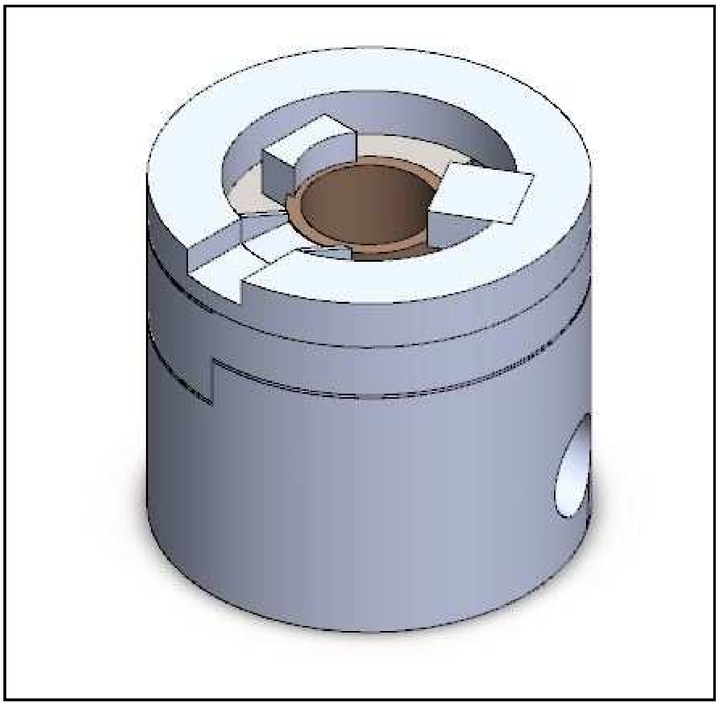

Figure 3.6: External view

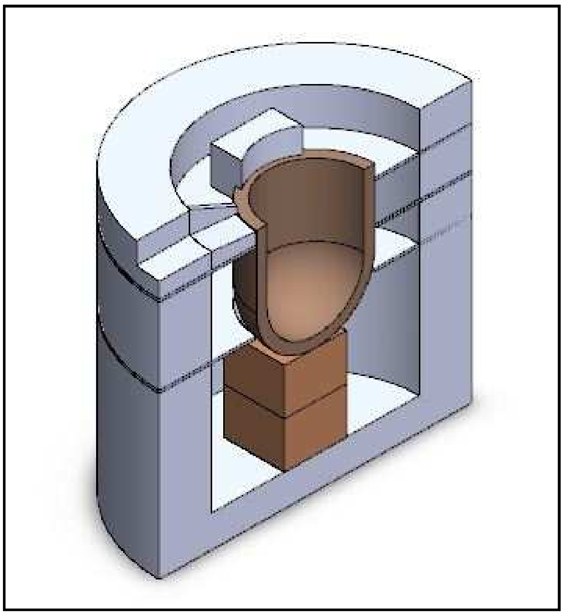

Figure 3.7: Cross sectionl view

3.5.2 Design Dimension

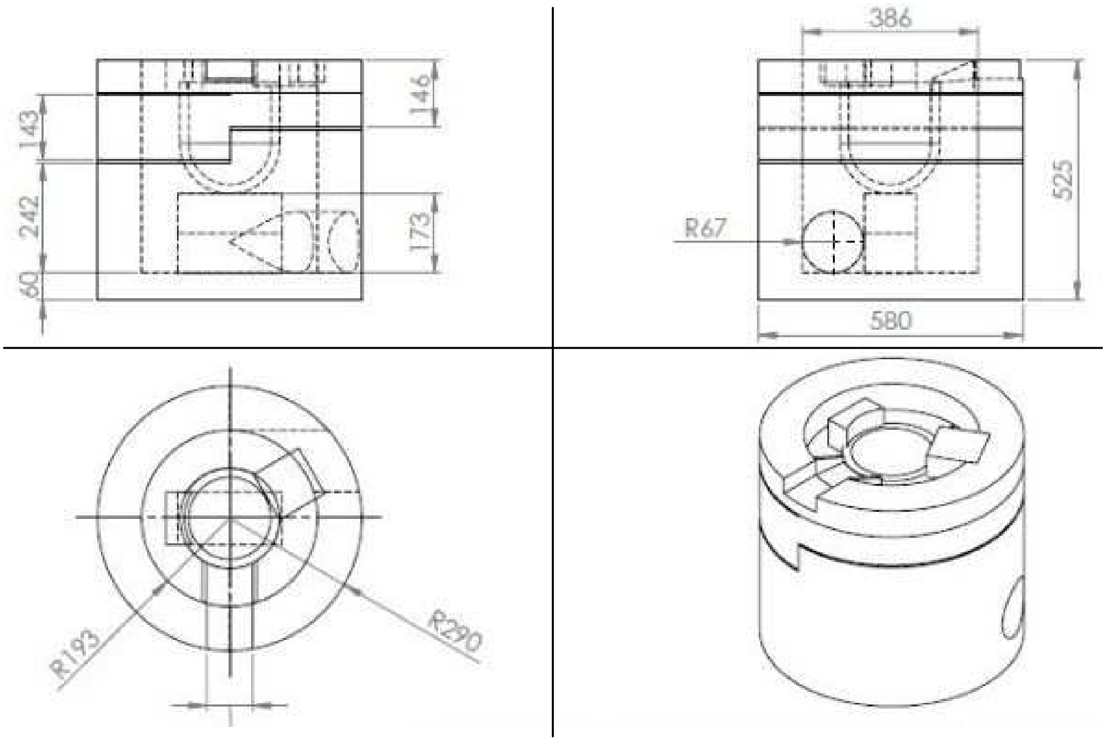

Figure 3.8: Dimension of design

3.6 MATERIALS SELECTION

3.6.1 Stainless Steel Sheet

Stainless steels are alloys and therefore do not melt and freeze at a fixed temperature as do metallic elements, but over a temperature range depending on the chemical composition of the steel. The melting range of stainless steel is 1375-1400 ºC for type 316.

Figure 3.9: Stainless steel sheet

Table 3.2: Elements in 316-stainless steel

ELEMENT	PERCENTAGES
C	0.08
Cr	18 max
Fe	82
Mn	2
Mo	3 max
Ni	14 max
P	0.045
S	0.03
Si	1

Stainless steel sheet will be use to make buffers. With 4mm thickness, it can support the fire that blow in the furnace.

3.6.2 Stainless Steel Rod

Stainless steel rod are remarkably strong and resistant to the elements. It manufactured using a low alloy composition, with high level of chromium. With that stength, it can support the center firebricks at the bottom of the furnace.

Figure 3.10: Stainless steel rod

3.6.3 Graphite Crucible

A crucible is needed to withstand the extreme temperatures encountered in melting metals. The crucible material must have a much higher melting point than that of the metal being melted and it must have good strength even when white hot. The crucible have two type, that are ‘Bilge’ shape and ‘A’ shape. For this project, it will use ‘A’ shape crucible.

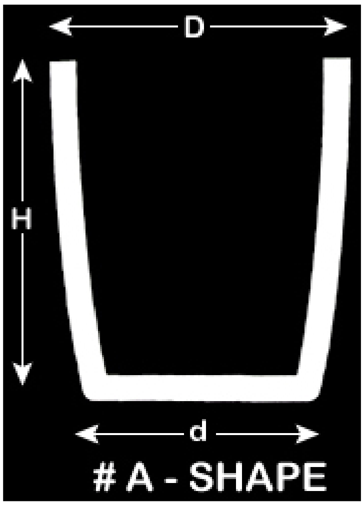

Figure 3.11: Cross section of 'A' shape crucible

Figure 3.12: The 'A' type graphite crucible

The 'A' shape crucible has straighter sides that taper outward. Note that there is no 'Bilge' diameter for an 'A' shape because the diameter constantly increases from the bottom to the top. This shape is easier to make than the bilge shape and therefore is lower cost. Also note that 'A' shape sizes and capacities don't correspond to 'Bilge' shape sizes and capacities.

3.6.4 Firebrick

A firebrick is built primarily to withstand high temperature, but should also usually have a low thermal conductivity to save energy. In any case, firebricks should not spall under rapid temperature change, and their strength should hold up well during rapid temperature changes.

Figure 3.13: A few of firebricks

Firebricks usually contain 30-40% aluminium oxide and 50% silicon dioxide. For extreme use, the aluminium oxide content can be as high as 50-80% and silicon carbide may also be present. The silica firebricks could stand at 1650ºC.

3.6.5 Castable Refractory

Castable are use to coat the firebricks. It can withstand the heat about 1427ºC. The whole of combustion surface are finish with that. It just mix with water to stick on firebrick.

Figure 3.14: Castable before mix up with water

3.7 BILL OF MATERIAL

Table 3.3: Bill of material

Parts	**Material**	**Size (mm)**	**Quantity**
Crucible	Graphite	Height : 245 Internal Diameter : 200 External Diameter : 220	1
Buffer	Stainless steel	Length : 1260 Width : 580 Hight : 4	1
Rod	Stainless steel	Length : 1000 Diameter : 10	1
Firebrick	Ceramic	Length : 230 Hight : 115 Width : 77	23
Refractory	Castable	25 kg/bag	4

3.8 FABRICATION

3.8.1 Cutting Process

The process of cutting involve two parts. The first one is to cut the stainless steel sheet to form buffers. As the sheet is thick and hard, the plasma cutting machine was use.

Figure 3.15: Using plasma cutting machine

The second part is to cut the firebrick by using portable grindle machine. The firebricks are cut to fix the arrangement on the wall and easy to place buffers.

Figure 3.16: Cutting the firebricks

3.8.2 Construction of Inner Part

This is the main part in fabrication of the furnace. It may result the strong of wall. The firebricks are arrange almost similar to the construction of wall's building. The castable was use to stick between the firebricks and also with the inner surface of shell. It also use to make finishing on the surface of wall.

Figure 3.17: Arrangement of firebrick before finishing

Figure 3.18: Finishing on the surface of wall

After that, a graphite crucible is place on two firebricks at the center of shell. That firebricks was support with four stainless steel rod planting in the floor before coated with castable. The crucible was support with the castable that stick with firebrick under it and also buffers at the circumference. Additional supporter was placed at the top of crucible.

Figure 3.19: Firebricks under the crucible

Figure 3.20: Graphite crucible support by buffers

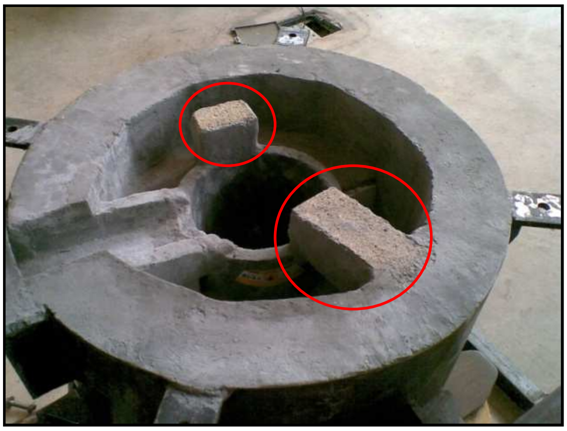

Figure 3.21: Top crucible’s supporter (in the red circle)

Buffers are place between two firebricks. Before that, the buffers was coated with castable on it surface to increase its strength while the combustion process.

Figure 3.22: Coated buffer

Figure 3.23: The position of first buffer

Figure 3.24: Second buffer position

Figure 3.25: Third buffer position

Last but not least, the output channel between the crucible and shell. This channel will act as a bridge to flow the melting metal inside the crucible.

Figure 3.26: Output channel

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter is explained about result and discussion of this project. The final fabrication of the inner part furnace is done from only limited times due to several problems occur in this project. In this chapter will discuss the result after fabrication process and mainly about the problems encountered during the whole project was been carried out. The final product will be highlight and there are some explaination about the whole system inside the furnace.

4.2 FINAL PRODUCT

The final product was finally fabriated. The step of fabrication is followed according to the project planning.

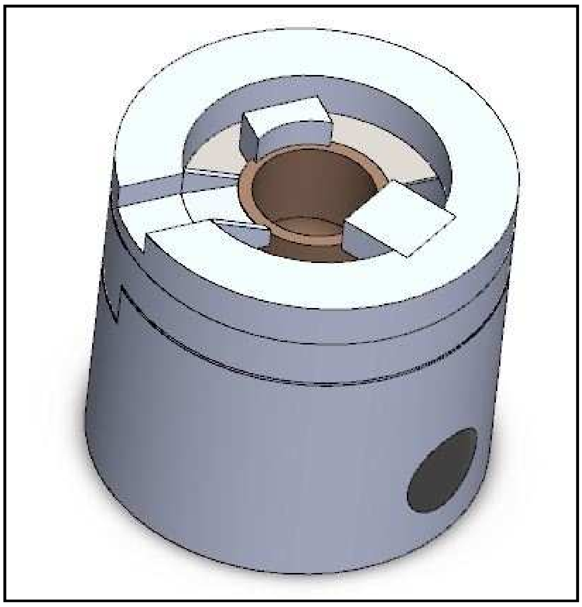

Figure 4.1: Final design drawing

Figure 4.2: Final product

4.2.1 Part of Product

The part for this product are supporter, wall, buffer, blower hole, output channel and crucible as shown in figure 4.3.

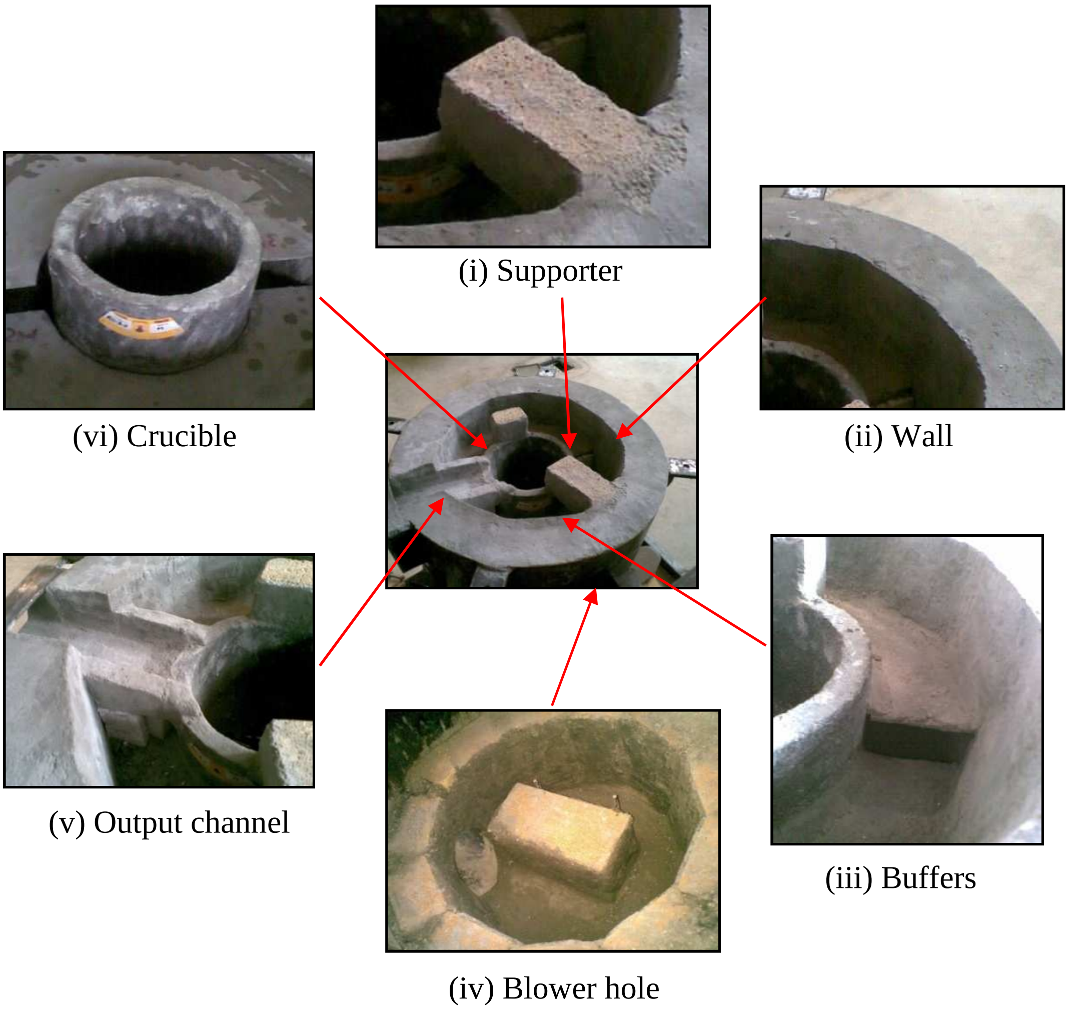

Figure 4.3: Parts of product

4.2.2 Function of Parts

Table 4.1 shows the function of every part on the product.

Table 4.1: Function of part

Part	**Picture**	**Function**
Supporter		To support and prevent crucible from fall down.
Wall		To ensure the fire flow in rotation and keep the heat inside the furnace.
Buffer		To keep and focus the heat at the crucible.
Blower hole		As an entrance of fire to blow through combustion chamber.
Output channel		Act as bridge to flow the melting metal from crucible to the outside.
Crucible		A place where the metal is put to melt.

4.3 DISCUSSION

There were many problems facing during makes this project. Here will be discuss about the problem start from the begining until the finishing of this product.

4.3.1 Project Problems

(i) Literature review

The ideas of this project are not wide because the manufacturer commonly made the furnace for industrial use only. In other word, they make the furnace in a large scale using the complex system. Beside that, there are many furnaces that propose for home use and it was custom made. Student should come with their ideas on the project.

(ii) Material Preparation

Some of important material is not already in the laboratory. So, it should buy with material's provider and its took saveral week to achieve that things. Because of this problem, the fabrication process cannot be run according to schedule.

4.3.2 Problems during Fabrication Process

(i) Cutting Process

The problem is when to cut the stainless steel sheet. As the sheet has 4 mm thickness, this metal are very tough to cut. The best way is using the plasma cutting machine. However, it need to be grind to form semi-circle shape. Once the metal at high temperature (while using plasma cutting), the molecule structure will change and the sheet metal become more tough. So, it was very difficult to grind to form needed shape.

(ii) Building Wall

The wall was built from firebricks that stick by castable refractory. As the shell has small in diameter, there were narrow space for the construction of wall. Beside that, the castable refractory is difficult to stick on the surface of wall. It need to do little by little and this will effect the times in fabrication process.

(iii) Castable Refractory

Castable refractory is a medium that use to stick the firebricks. Packing in 25 kg per bag, this refractory only need to mix with water. However, before it can be mix, it need to filter to remove small rough stones inside it. This is to ensure the surface of wall are not rough.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This final chapter represent about conclusion and recommendation for the project. The conclusion also focus on all the process involved while making this project. The recommendation will discuss so that the project can be improve in the future.

5.2 CONCLUSION

For the conclusion, the project to manufacture the inner part of diesel furnace was achieves the objective successfully. This project was done by following all the step such as literature riview, design, fabrication process and others.

Overall perception of the project carried out was good. This project gains my knowledge by searching information from books and internet mostly. Communication skill also was improve after make presentation and discussion with supervisor every week. This project was generates my capability to make a good research report in thesis form.

This project also was train my capable of doing work and more independent. I also had learned a lot of skills and method of using several machines in the laboratory such as plasma cutting machine, portable hand grindle and others. The skills of using Solidwork application was gain while making the project design.

5.3 RECOMMENDATIONS

These are several recommendations to improve the product in the future.

5.3.1 Size of Crucible

A large size of crucible can be replace with the present as the product already design for crucible replacement. By replace with the bigger one, the furnace can melt in large volume of metal in a time.

5.3.2 Buffer Position

The product was design by adding some buffers inside it. It position are perpendicular with the surface of the wall and this make fire is difficult to flow to the top. So, it is better if the buffers are place with some angle like a drill tool’s slot. By that, the fire can rotate through the buffer to the top smoothly.

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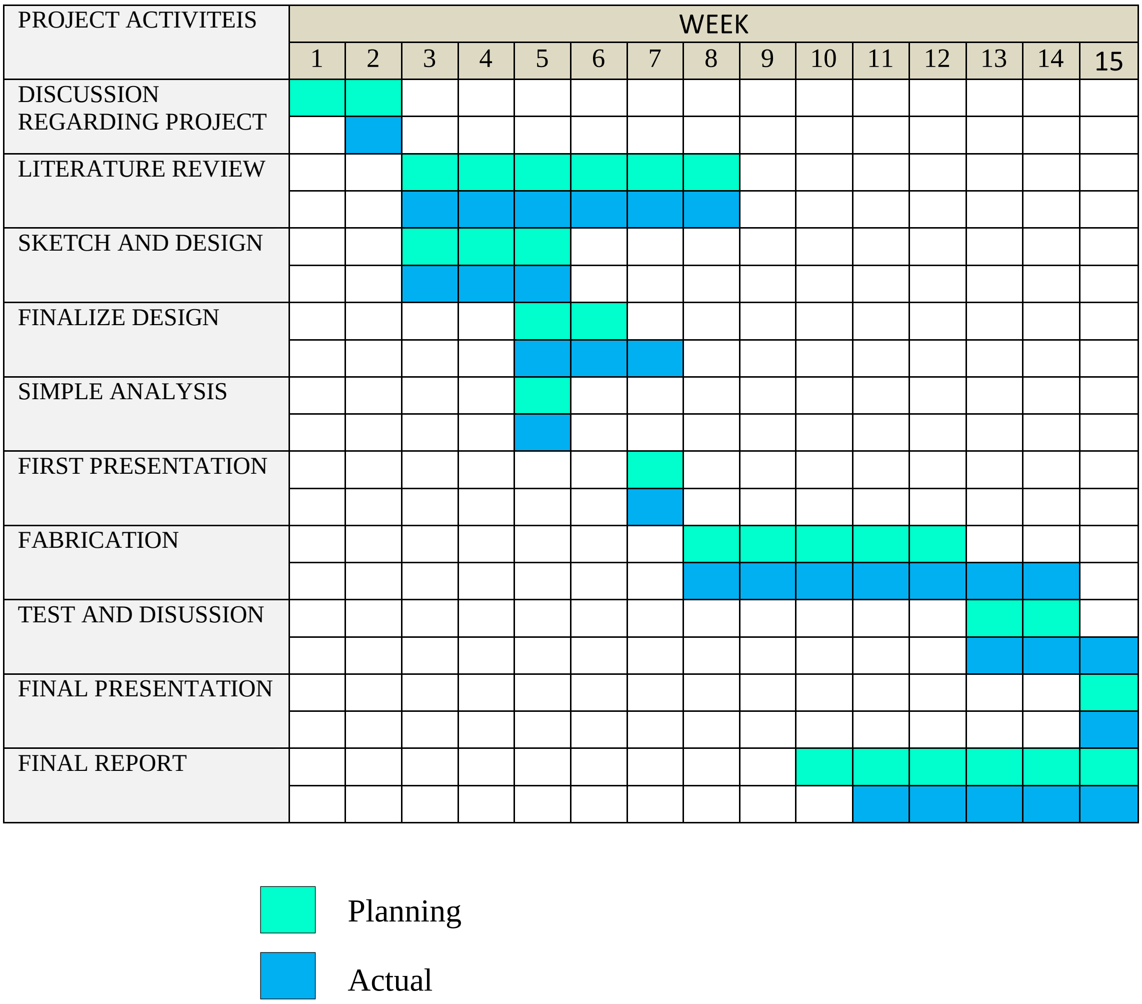
APPENDICES

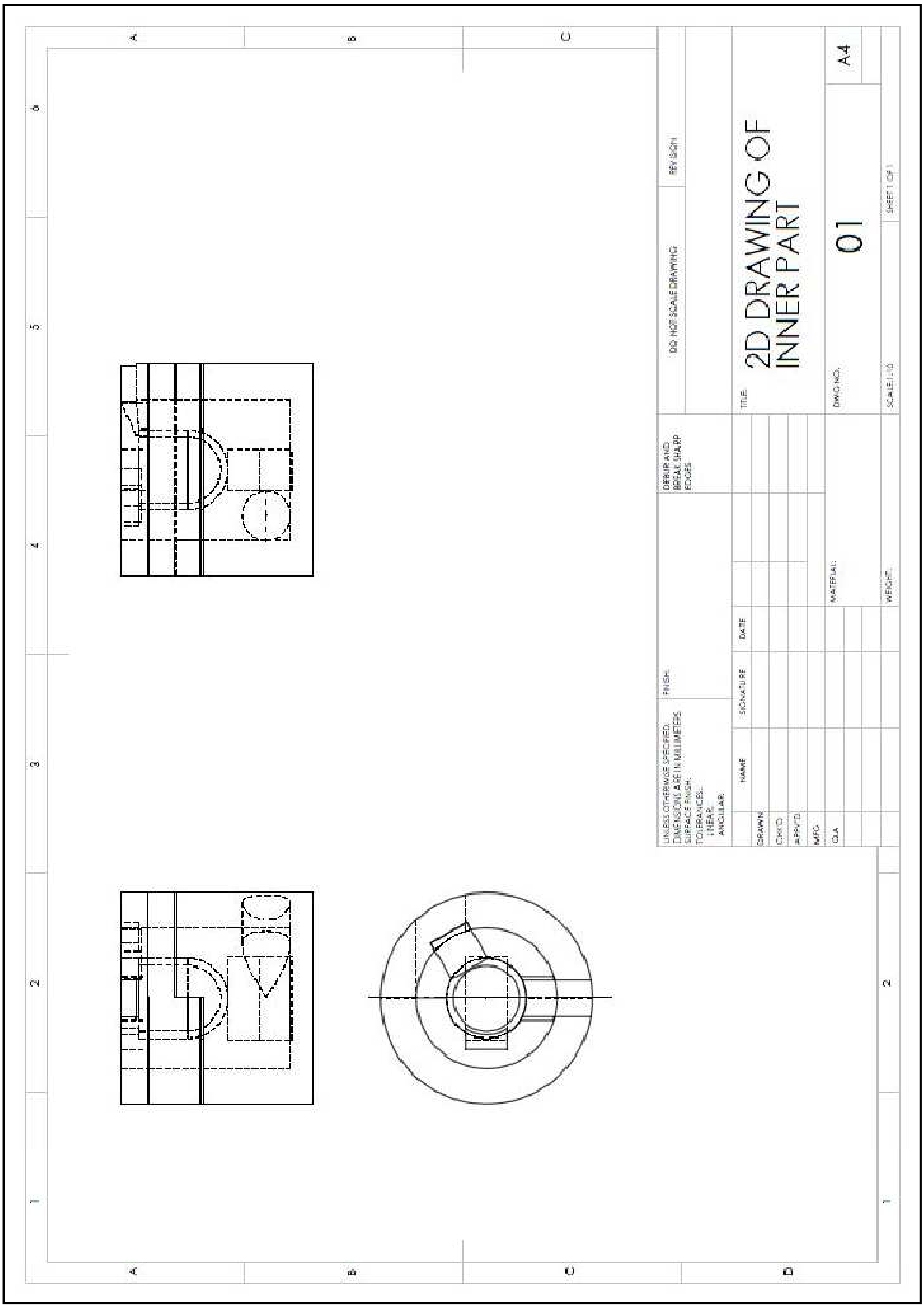
APPENDIX A
PROJECT SCHEDULE

Gantt chart



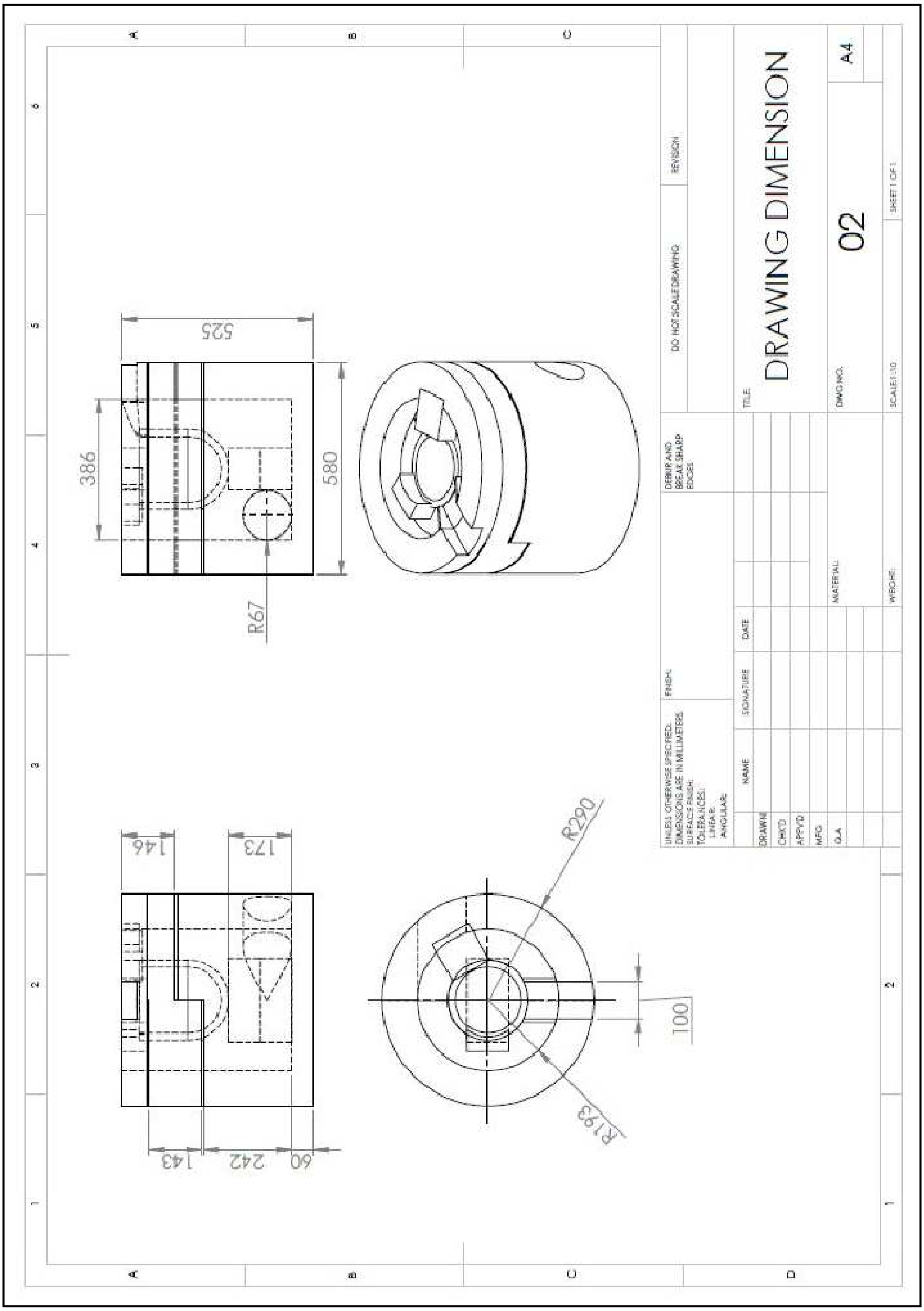
APPENDIX B

2D DRAWING



APPENDIX C

DRAWING DIMENSION



APPENDIX D

FINAL DESIGN AND FINAL PRODUCT