DESIGN AND FABRICATE MINI BIOGAS DIGESTER

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JUDUL **DESIGN AND FABRICATE THE MINI BIOGAS DIGESTER**

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DESIGN AND FABRICATE MINI BIOGAS DIGESTER

AHMAD AIZAD BIN JAMIL
(MB08044)

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

Faculty of Mechanical Engineering
University Malaysia Pahang

NOVEMBER 2010

SUPERVISOR'S DECLARATION

I declare that I have read and make a check on this project report, and in my opinion this report is in sufficient in aspects quality for the Diploma of Mechanical Engineering award.

Signature : ……

Name of Supervisor : Puan Norhaida Binti Ab. Razak

Position : ……

Date : …….

AUTHOR'S DECLARATION

I declare that this report titled "Design and Fabricate Mini Biogas Digester" and the result that from my research based on the references that have been used in order to complete it. This project report not been accepted for degree, and not submit in candidature of any other degree.

Signature : ……..
Name of Student : Ahmad Aizad Bin Jamil
ID Number : MB08044
Date : ……...

DEDICATION

To my parents especially and friends, also for whom with their effort to support me in order for me to pursue study in higher education, and also in order to complete this project and project report to fulfil the requirement for Diploma of Mechanical Engineering award.

To my supervisor too, Puan Norhaida Binti Ab. Razak and all the Mechanical Stuff with their helpful suggestions, guidance and assistance in order for me complete this Final Year Project for diploma course.

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ABSTRACT

This project is about designing and fabricate the mini biogas digester to fermentation of waste product in order to produce and collect methane gas. Nowadays, people know that the methane that not only cheap in price, but has many advantages such as to replace cooking gas and to generate electricity. To produce and collect the methane gas, they need a biogas digester that usually bigger in size, but the people need a biogas digester that suitable to use at home and portable. So, based on the objective for this project is in order to help them, a mini biogas digester is designed by considering the ergonomic factors for the people use. After the designing complete, it is needed to be transform into the real product. The materials that used to fabricate this product are selected, and they are round hollow steel, square hollow steel, sheet mild steel and wood. The processes involved are welding, drilling, and grinding, riveting, fastening and using glue to assemble all the parts. This project design is generated by using the other current biogas digester and do the comparisons between them, then make the new concept to make it more portable and user friendly compared to the current product.

ABSTRAK

Projek ini mengenai merekebentuk dan mencipta pencerna biogas mini untuk melakukan proses pemeraman bahan-bahan atau sisi-sisa buangan dalam usaha untuk mengumpul gas metana. Pada masa kini, ramai penduduk sudah mengetahui tentang gas metana, bahawa gas tersebut bukan sahaja murah, tapi mempunyai pelbagai kegunaan seperti untuk menggantikan gas memasak dan untuk menjana elektrik, oleh sebab itu mereka mahu meghasilkn gas metana di rumah. Untuk menghasilkan dan mengumpul gas metana, merekea memerlukan pencerna biogas yang biasanya bersaiz besar, tetapi mereka memerlukan pencerna biogas yang sesuai untuk digunakan di rumah dan mudah diguna. Jadi, berdasarkan objektif projek ini untuk membantu para pengguna, sebuah pencerna niogas mini telah direkabentuk dengan mengambil kira faktor ergonomik untuk kegunaan pengguna. Selepas proses merekabentuk selesai, reka bentuk tersebut perlu diubah menjadi produk sebenar. Bahan-bahan yang diperlukan untuk mencipta produk telah dipilih, dan bahan-bahan tersebut ialah besi bulat berongga, besi segi empat sama berongga, kepingan besi, dan kayu. Antara proces yang terlibat ialah mengimpal, menggerudi, melarik, merivet, mengikat dan melekat menggunakan gam untuk mencantum setiap bahagian dan komponen. Reka bentuk projek ini dihasilkan dengan menggunakan pencerna biogas yang sedia ada dan proses perbandingan dilakukan di antara mereka, kemudian konsep baru dihasilkan bagi menjadikan produk ini lebih mudah digunakan dan mesra pengguna berbanding dengan produk yang sedia ada.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT SYNOPSIS

1.1.1 General Project Synopsis

The concept will be little bit different with the others current designs or concept of biogas digesters. In producing the new design of mini biogas digester, there are including with the process of generating concept, design the concept and fabrication.

The mini biogas digester is just equipped with all the required materials that are square, welding, riveting and fastening method to joint all the part. This mini biogas digester also equipped with rollers to make it more portability and make it to be friendlier to the user. The rollers are sheet, and hollow steel, rubber sheet and plywood with the manufacturing skills process such as join at the base of the digester and be likely as a trolley that seen more flexible to move. The body of this mini biogas digester is designed to decrease it weight as light as possible to increase its portability characteristic and its volume of the body also designed to get the bigger size as possible but still suit with it characteristic of portability and the mini size.

The digester is designed mostly like the large size digester that commonly use to run the fermentation of materials that can produce methane gas and contain of higher content of ammonia for example cow manure, but it will be develop to be in mini size. Even though it is in mini size, the process stills same as the larger size digester which is

to produce methane gas to be use to replaced cooking gas as the example, and all the function still can operate like usual but the volume is limited. The process of developing this digester is still considering the suitable to the user and its ergonomic factor.

1.1.2 Specific Project Synopsis

The project involve the developing and analysis the body shape of the digester to make it be more efficient to produce methane gas and also will concern about the structure strength, durability, ergonomic factor and convenience. The new concept of this digester is also being more focus on the strength of its body. All the specifications must be verified to avoid materials and fund wasting. Overall process to design, develop and fabricate this digester required the skills of designing and fabrication and used all the basics knowledge of Static, Industrial Design and Manufacturing Technology.

1.2 PROBLEM STATEMENT

Usually all the biogas digesters are use to produce methane gas and the size of the digesters are commonly bigger in size. Some users whom live in poor conditions which that know the uses and the advantages of using methane gas wanted to have a biogas digester at home and wanted to use the methane gas for replacing the cooking gas and to generate electricity, because they cannot afford to buy cooking gas and pay the monthly electric fee.

So, because of that they wanted to have a biogas digester, but according to their affordability, they still cannot have the biogas digester which is usually bigger in size. The only solution for them to solve this problem is to produce a mini biogas digester that has same function with the bigger digester.

1.3 PROJECT'S OBJECTIVE

The objective for this project is:

i) To design a portable mini biogas digester.
ii) To fabricate a portable mini biogas digester.

1.4 PROJECT'S SCOPE

Usually, the biogas digesters are bigger in size that commonly use for the fermentation of waste products to produce methane gas for generating electricity as the example. By this project, the biogas digester is design and be fabricate to be in smaller scale with the dimension of 59cm x 59cm x 90cm. The materials use is mild steel because of it better characteristics. The design is visualize by using SolidWorks software.

1.5 THE PROJECT PLANNING

By following to the planning Gantt chart shown by Table 1.1, the project started with getting the problem statement, scope and the objective for the project. This process include with the getting the project title, first meeting with the supervisor, getting the information that regarding to this project through internet and the other sources for literature review. This planning is from week 1 until week 4.

Then, the designing stage start at studying the Morphological chart, verify the product design specifications, generate new concept, use method of screening process and select the final concept. At this stage, the new concepts is sketched and designed by using the Morphological chart, which is by pairing one concept to the other one concept. The concept screening is run on all the concepts that generated and the best concept is selected as the final concept that will continue with designing the concept by using SolidWork software and the fabrication process. This planning is running in week 3 to week 6.

For the week 5 until week 8, the materials selection is done and the fabrication process is started. All the materials are shaped and join together by using welding and fastening process, and the measurements are verified before running the cutting process. The pre-presentation and is done on week 7.

After semester break, the fabrication process on the project including with the finishing process are continue until the week 15, project report that start from week 3 is continued until week 16 and lastly the final presentation on week 16.

The real progress Gantt chart shown by Table 1.2, the differences between the planning and the real progress Gantt chart are the first one is at the literature review. On the planning Gantt chart, the process should run from week 2 until week 4, but on the progress Gantt chart, it starts from week 2 but finish at week 6.

The second difference is the design and select final concept. According to the planning Gantt chart, the process should run from week 4 until week 6, but because of lack of information, on the progress Gantt chart, it starts from week 4 but finish at week 8.

The third difference is the final report, by following the planning Gantt chart, the process should run from week 3 until week 15, but on the progress Gantt chart, it starts from week 3 but finish at week 16 because there are some problems happened during completing the project.

The last difference is on the meeting with supervisor. On the planning Gantt chart, the process should run from week 1 until week 15, but on the progress Gantt chart, it starts from week 1 but finish at week 12.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Biogas digester usually made from steel, zinc, rubber, mild steel, aluminium or combination with two or more between of them. The body of biogas digester commonly manufactured through casting process. Before humans use these types of materials to build the biogas digester, they use concrete to be the wall of the body structure.

Nowadays, many improvements have been used in manufacture the body structure of biogas digester such as change the materials to build the structure of the digester and add some ways to make the digester be more efficient to produce methane gas.

In nowadays, biogas digester is widely use among the countries in the world after humans know that the uses of methane gas which are for examples, methane gas can be use in generating electricity and also can be use to replace cooking gas. For example in India, the biogas digester widely uses at home to generate electricity and use as cooking gas.

By using biogas digester, methane gas can be produced throughout the fermentation process. Usually, the waste product such as cow manure will be using back to be fermented to produce methane gas. From the digester, the methane gas will presently flow out through the gas outlet straight to container. The biogas digester must

be build to be long lasting, has characteristic of corrosive resistance, high tensile strength, and has technical stability. The examples of the biogas digester in some of the countries are shown by the Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4, and Figure 2.5.

2.2 EXAMPLE OF THE CURRENT BIOGAS DIGESTER.

Figure 2.1: Germany [6]

Figure 2.2: Japan [7]

Figure 2.3: India [8]

Figure 2.4: Nepal [9]

Figure 2.5: Australia [10]

2.3 FUNCTION OF THE DIGESTER

Biogas digester has a function of producing the methane gas through the fermentation process. The digester usually equipped with the waste inlet where the waste product entered, waste outlet that be the way for the waste flow out, gas outlet which is where the gas will flow straight to the gas container and stirrer not widely use for bigger in size biogas digester that use to stir up the waste and make it fully mix with the water or some liquid chemical such as catalyze, and to be in a smaller particles and to increase up the rate production of methane gas. The dry waste products that push out from the digester can be use back to be fertilizer for agriculture sector.

2.4 PROCESS OF PRODUCING METHANE THROUGH FERMENTATION

There are two basic types of organic decomposition that can occur during fermentation which are aerobic that occur in the present of oxygen gas, and anaerobic that occur in the absence of oxygen gas. All waste materials, both animal manure and wasted vegetable can be broke down these two processes, but the decomposition products will be different in the two cases which are by aerobic fermentation, will produce carbon dioxide, ammonia and some other gases in small quantity, heat in large quantity and a final product that can be used as a fertilizer, while throughout anaerobic fermentation, it will produce methane, carbon dioxide, some hydrogen and other gases, too little heat and final product with higher nitrogen content than the aerobic fermentation.

Anaerobic fermentation is two stages process as specific bacteria feed on the waste materials. At the first stage, the acidic bacteria decompose the complex molecules into peptides, glycerol, alcohol and simpler sugars. When all the compounds have been produced in enough quantity, the second type bacterial start converting all the simpler compounds into methane. The bacteria that produce methane are usually influence by the ambient environment, which can slow down or halt the process to be complete.

2.5 BIOGAS DIGESTER IN OTHER COUNTRIES

2.5.1 Biogas in China

Biogas in China is recycled in the oven and lamp to generate heat for the greenhouse and at the same time, it will raise the concentration of carbon dioxide in the greenhouse and directly enhanced the process of photosynthesis. Correspondingly, the biogas lamp will provide light and warm up the eggs of the silkworm then increase the percentage to hatch as well as the cocooning commonly heated by coal heating. Methane gas also can use to produce some new products such as methanol, organic flush and many types of main chemicals to make formaldehyde, chloromethane, organic glass and thread. Methane and carbon dioxide gas will prevent metabolism process and dropping the production of ethylene in fruits to make the fruits easy to be matured.

In the southern of China, the five in one model that integrated with the pigs, digester, fruits, light trap and fishponds. The pig's manures are stream down into the biogas digester to be fermented to produce energy for cooking and generate electricity for the residents. The dried manure is used to be as fertilizer for the fruit and feed for pigs and fish. The light that trapped is directed to the fishpond to attract the pest killer.

In the northern China, there has cold wind during winter season and did not get enough sunlight, so the digester does not works at the temperature that is less than 10 degree Celsius. Form the problem happened, the pigs eat more but do not fat up and the residents also face with to be short of fresh vegetables. These problems was solved by using the eco model which is responsible for the greenhouse to plants fresh vegetables, for the protection to increase the pigs, to the digester below the pigs shed and the toilet in the big greenhouse that attached with the pig shed. The pigs which are that can grow well produce large amount of manure and the manure are rolled into the digester that collected with human waste. The biogas digester worked well because the temperature can be continuously keeps above the 10 degree Celsius. The biogas digester has responsible to

generate energy and fertilizer and also yield carbon dioxide to enhance the greenhouse for producing sufficient high quality of vegetables. [1]

2.5.2 Biogas in India

Biogas digester plants in India were announced in the year of 1930 and the investigation was concentrated in the region of the Sewage Purification Station at Dadar in Bombay, unspecified by the S.V. Desai and N.V. Joshi from the Soil Chemistry Division in Indian Agriculture Research Institute, New Delhi. After the next twenty years, Jashbhai Patel have designed and made some modifications on the current biogas digesters.

Even though there are other organizations were planning biogas digester plants, but the Khadi and Village Industry Commission (KVIC) choose to support the digester that designed by Patel. Although the digester is more costly compare to the other models, but it was more productive and had a long extended life and just requisite a minimal preservation. The basic digester which came to be standard as the Khadi and Village Industry Commission (KVIC) model, it consists of a deep well with a floating drum that was commonly made up by using mild steel. The system accumulates and collect the gas which is can reserve at a comparatively stable pressure.

As the higher quantity of gas is created, the drum gas container subsequently rises an as the gas is used up and the drum then fall down. The biogas waste will move over the system as the cover is higher than the outlet tank, so it will generate a hydrostatic pressure in the digester. Just only the totally digested materials that can flow up a divider wall, which were avoids the fresh materials from short circuit occur in the system and before it flowing into the outlet tank. Capacity of the plants is determined by upon the energy that requested by the users. [2]

2.5.3 Biogas in Australia

Biogas plants in Australia was recognized to suggest reasonably priced renewable energy technology to Australia as well as provided that more simple, cost efficient resolution according to the decrease the rate of greenhouse gas discharges from the agricultural waste. The professionals have over about 30 years of knowledge and research in the field of application of the renewable energy technology in Asia. This study of biogas for the project which is in combination with the University of Chiang Mai in Thailand and the German Companies believed that, at the beginning of the pathway to the number of the renewable energy plants in some country such as Thailand, Vietnam, Cambodia, Laos and India. Then they found that there are not only can be responsible for the anaerobic digester in producing methane gas for biogas, but they also have the capability to resource the gasification plants to provide for those wastes that unsuitable or inefficient to digest an aerobically.

Biogas in Australia trusts that in the direction to the Renewable Energy Plants to be effectively integrated into farming sector, they need to be common to conserve, have low running budget and should be provided by the additional income for the major producer and provide the means to reduce the on the whole farm contribution budgets. Biogas in Australia is capable to arrange for the complete solutions, there are propose to the biogas digester, and the complete the renewable energy plants that turn the waste resources into energy or generate energy, they equipped the biogas digester so it can turn the digested biogas waste to be fertilizer and trading the fertilizer and biogas products.

For the additional solutions, there are such as water purification to be reuse, regaining bio oil and proteins that are presently being studied to find the cost effective add-on technology to the renewable energy plants. In their biogas digester plants, they build the digester with the anaerobic tank, biogas storages with air supported roof, mixers, biodesulphuriser and the gases safety devices.

The benefits that Australia will gain back from this plants are the combination of manure and straw are fermented by the high proper consideration, the biogas production

and the storages at the low pressure can be ensured to be in safety condition and more consistence, the cost of construction can be reduce without divided the gas tank, employ the fewer land the land area for the biogas plant can be save about 30 percents and still can regulate the digester's process during winter. [3]

2.5.4 Biogas in Indonesia

The Indonesian Domestic Biogas Programme in Indonesia is managed and implemented by Humanist Institute for Co-operation with Developing Countries with the technical support from the Netherlands Development Organization in collaboration with the national government and the local stakeholders. The programme is funded by the Embassy of the Kingdom of Netherlands in Jakarta and was recognized in close collaboration with the Indonesian Ministry of Energy and Mineral Resources.

The technical capability of small scale biogas technology has continually been verified in field tests and lead projects, but mass distribution of this technology has not been accomplished in Indonesia. Main restriction consist of the need of penning up the animals for effective collection of dung or manure, the ownership of a sufficient number of livestock to generate continuous flows of biogas and the high initial costs of installations. In the past, firewood was still available for free of costs and the subsidize kerosene. Now, due to the higher kerosene prices and depletion of firewood, the interest in using of biogas is growing up.

The program that was started in May of 2009, will initiate the activities in the cooperation with the entire local partners in at least three of the provinces in Indonesia by constructing between 75 to 150 biogas installations before the end of the year of 2009.Through its multi-sector approach, the program will activate some business partner such as the private sector, NGOs, cooperative, and the government sector that focusing on to the clusters of high density livestock areas aiming at farmers with at least have stabled number of cows.

The Indonesian Domestic Biogas Program is a five year of joining effort of Humanist Institute for the Co-operation with the Developing Countries and Embassy of the Kingdom of Netherlands. Humanist Institute for Co-operation with Developing Countries provides the overall program management and coordinates with the program participants and will be responsible for the planning, the monitoring and reporting, the technical assistance, the management of knowledge, the policy dialogue, the stakeholder transportation, the advocacy and the communication. The Embassy of the Kingdom of Netherlands will assume to have the responsibility for the effective exchange of knowledge generated through its engagement in the set up and realization of national program in the other countries.

This related to the organizational and the development institutes, for the planning and implementation of program activities such as the promotion, the training, the quality control, the extension, and biogas development, the financial services related to the construction companies, the social enclosure and environmental sustainability. The advisory Committee and a Technical Committee are established to ensure the programmatic and technical liability. The legislative body from the Embassy of the Kingdom of the Netherlands in Jakarta and the Indonesian Ministry of Energy and Mineral Resources will have places in the Advisory Committee. [4]

2.5.5 Biogas in Malaysia

There is a rubber strand factory near Kuala Lumpur that determines to manufacture biogas everyday from its waste-water products. The plant is located in area of Batang Kali in Selangor which is around 40 kilometres north of Kuala Lumpur. The biogas will represent oil as a fuel for the thermal oil boilers at the factory. In the past, the food and agro-industries in ASEAN, for example such as breweries, sugar and palm oil mills as well as the thickener and rubber industries used to eradicate their waste products by releasing them to the courtyard ponds or into near rivers.

These waste products that predominantly have high Biological Oxygen Demand (BOD) and therefore they reflected on as the very harmful pollutants. Under the pressure from the Department of Environment of Malaysia, the Heveafil Sdn. Bhd, the rubber thread manufacturer has targeted to put into practice the problem by acquiring a plant which is combines the two types of process, which are the aerobic decomposition and anaerobic decomposition process as well as biogas combustion. The biogas product such as methane is produced through the fermentation process and will be used as a fuel to deputize part of the fuel oil engulfed or digested by the boilers for the manufacturing of steam that used in the rubber strand production process.

The plant will involve with the physic and chemical treatments and produce biogas through anaerobic decomposition. The products consists about two million kilo calories and one million kilo calories volume by just using two gas burners, and with the enhanced aerobic treatments. [5]

2.6 JOINING METHOD

The joining methods that used to assemble all the parts are the permanent and non-permanent joining process. The permanent joining method that will be use is welding process and riveting, while the non-permanent joining process is fastening which is by using bolt and nut and using glue. The welding process that is Metal Inert Gas Welding (MIG) shown in Figure 2.6, and riveting shown in Figure 2.9 and Figure 2.10, will be use to assemble all the body parts. The fastening method shown in Figure 2.8 and using glue shown in Figure 2.7 will be used to assemble the body together with the base of the digester and other parts.

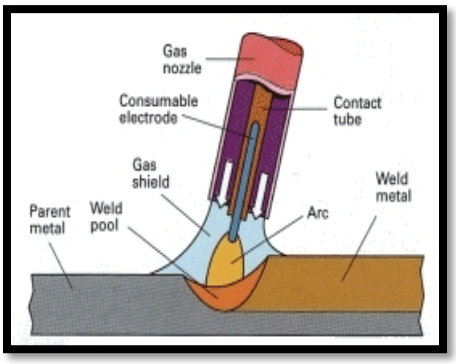


Figure 2.6: MIG welding

Figure 2.7: Glue

Figure 2.8: Fastening

Figure 2.9: Rivet

Figure 2.10: Riveter

2.6.1 Types of Welding

1) Arc Welding: A process utilizing the concentrated heat of an electric arc to join metal by fusion of the parent metal and the addition of metal to joint usually provided by a consumable electrode.

2) Electro slag Welding: Deposits the weld metal into the weld cavity between the two plates to be joined.

3) Fluxed-Core Arc Welding: Uses a tubular electrode filled with flux that is much less brittle than the coatings on SMAW electrodes while preserving most of its potential alloying benefits.

4) Gas Metal-Arc Welding: Shields the weld zone with an external gas such as argon, helium, carbon dioxide, or gas mixtures.

5) Gas Tungsten-Arc Welding: Uses tungsten electrodes as one pole of the arc to generate the heat required. The gas is usually argon, helium, or a mixture of the two.

6) Plasma Arc Welding: Uses electrodes and ionized gases to generate an extremely hot plasma jet aimed at the weld area.

7) Shielded-Metal Arc Welding: Arc is generated by touching the tip of a coated electrode to the work piece and withdrawing it quickly to an appropriate distance to maintain the arc.

8) Submerged Arc Welding: Using a granular flux fed into the weld zone forming a thick layer that completely covers the molten zone and prevents spatter and sparks.

9) Metal Inert Gas Welding: Uses an aluminium alloy wire as a combined electrode and filler material.

10) Tungsten Inert Gas Welding: Uses a permanent non-melting electrode made of tungsten.

2.7 HOLES PREPARATION

The holes preparation is the most important aspect during fastening process and riveting process. A hole in a solid body can be produced by using several type processes such as punching and drilling, but to select the right method is depend to the type of materials, properties and thickness, the diameter of the tool or fasteners too. The types of machine use to make a hole are such as table drilling machine (Figure 2.11), portable hand drill (Figure 2.12) and punching machine (Figure 2.13).

Figure 2.11: Drilling machine

Figure 2.12: Portable hand drill

Figure 2.13: Punching machine [11]

2.8 CUTTING PROCESS

The cutting process is also one of the important processes where all the material that will be use to the parts of the digester body into it desired shape according to it specific dimensions. This process is carry out by using cutting machine such as pneumatics or hydraulic cutting machine and also by using disc cutter and divide all the materials one by one to be parts by parts. The machine uses is according to the types of materials that need to be cut into desired shape following the specific dimensions. The types of cutting machine are wood vertical bend saw (Figure 2.14), steel vertical bend saw (Figure 2.15), steel horizontal bend saw (Figure 2.16), shearing machine (Figure 2.17) and disc cutter (Figure 2.18).

2.8.1 Type of Cutter

1) Wood vertical bend saw

Figure 2.14: Wood vertical bend saw

2) Steel vertical bend saw

Figure 2.15: Steel vertical bend saw

3) Horizontal bend saw

Figure 2.16: Horizontal bend saw

4) Shearing machine

Figure 2.17: Shearing machine

5) Disc cutter

Figure 2.18: Disc cutter

CHAPTER 3

METHODOLOGY

3.1 PROJECT FLOW CHART

By following the flow chart that shown by the Figure 3.1, this project starts with the process of defining the projects title project's problem statement, project's scope and the project's objective. These items are the most important to specify the project flow until this project finish.

Then, this project continues by the literature review and searching some information that related to this project. The process of gathering all the information has been done by searching through the internet and some book that have the information that relate to the project. In the literature review, some of the current concept of the biogas digester, the specifications of the biogas digester and the various functions of the current biogas are viewed. From the literature review, the project has been done through the information to determine the new concept of the biogas digester in the concept selection process.

After the literature review, this project continues with the process of designing, sketching and concept selection. For this step, the information from the literature review and the knowledge are use to make the sketching, designing and to the select the suitable concept for the project.

There are five new concepts of the project generated and from the sketches one concept is selected by using the Pugh Concept. The selected concept is run by continue to

draw it into the engineering drawing using the SolidWorks software. All the project parts are draw into the desired shape and assembled to be the actual shape of the mini biogas digester.

This project is continuing with the measuring, material preparation and fabrication processes. According to the drawing, the dimensions are specified for the measurements of the project. All the dimensions are important and used to get the desired size for the project materials during the material preparation process. In this step, the material that will be use for the project are specified and if some of the materials for the project are not easy to get, the selected concept will be redesigned according to the available material.

For all the materials which not come in the needed size are cut through cutting process to get the desired shape and size or dimension. Then, the fabrication process is continues to run on the project, the processes that include in the fabrications process are measuring process, cutting process, welding process, some fastening process and assemble all the digester parts. The parts are assembled into the desired or actual project concept shape.

Figure 3.1: Flow chart

3.2 DESIGN

The design for the project must consider all the aspects and be done carefully to make it easy to fabricate and to ensure that all the parts are functioning. The aspects that must be considered in designing the concept for the biogas digester are:

1) Body Structure Strength.
2) Dynamic Resistance.
3) Ergonomic.
4) Suitable to the environment.
5) Technical Stability.
6) Capacity.
7) Efficiency.
8) Easy To Fabricate.

3.3 DRAWING

The drawings are divided into two categories which are sketching and drawing the designs that have been sketch using the SolidWorks software.

On the sketching process stage, all the ideas for the biogas digester are sketched on the paper to ensure that the ideas selection can be made after this. The sketching process just uses raw hand to visualize the concept without any other engineering drawing tools.

By using the SolidWorks software, the selected design or selected concept that have been sketched is then transfer into 3D solid modelling and engineering drawing by using the engineering software.

3.4 DESIGN SPECIFICATION

The design of the digester must be compatible with the digester structure so that it can endure the specifications, so it can gives the real function as the digester, which are:

1) Base with four rollers.
2) Has volume capacity about 0.384 m^3.
3) Range weight about 40 kg.
4) Rectangular-dome shape.
5) Height about 1.4 meters.
6) Technical stability.
7) Portable.
8) Convenience.
9) User friendly.

3.5 SKETCHING AND DRAWING SELECTION

The drawings that come from the combination of all the parts that have specific criteria which are will give the specific functions to the product. The parts are selected from the Morphological chart shown in Table 3.1, and from the combination, five concepts are generated. From the existing ideas, there five concept and one datum concept that had been choose to be considered as the final concepts. From the concepts, there are the aspects and the specifications that must have to the digesters and the concepts were drawn, there are Design A (Figure 3.2), Design B (Figure 3.3), Design C (Figure 3.4), Design D (Figure 3.5), Design E (Figure 3.6), and Design F (Figure 3.7).

Table 3.1: Morphological chart

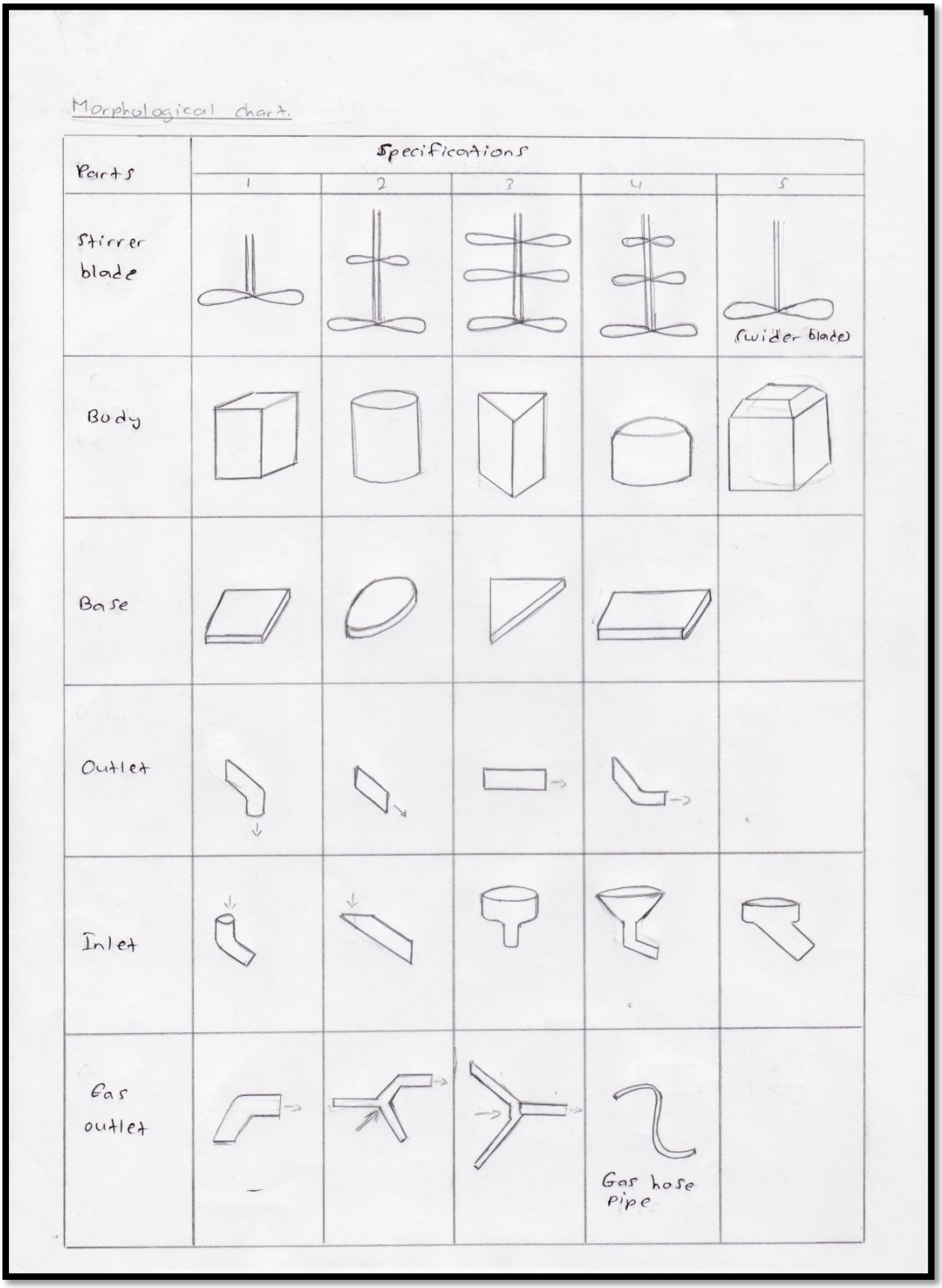
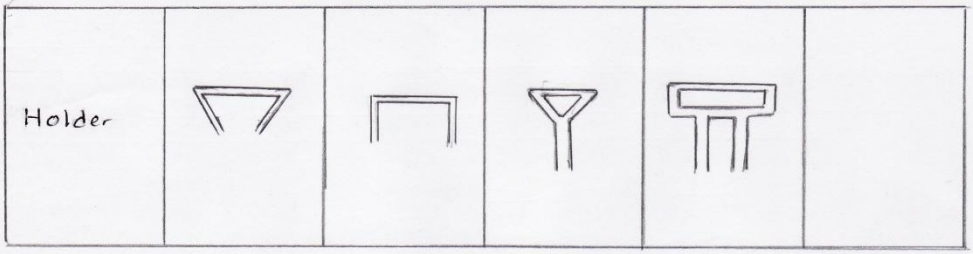


Table 3.1: Morphological chart (continue)



a) Sketch A (datum)

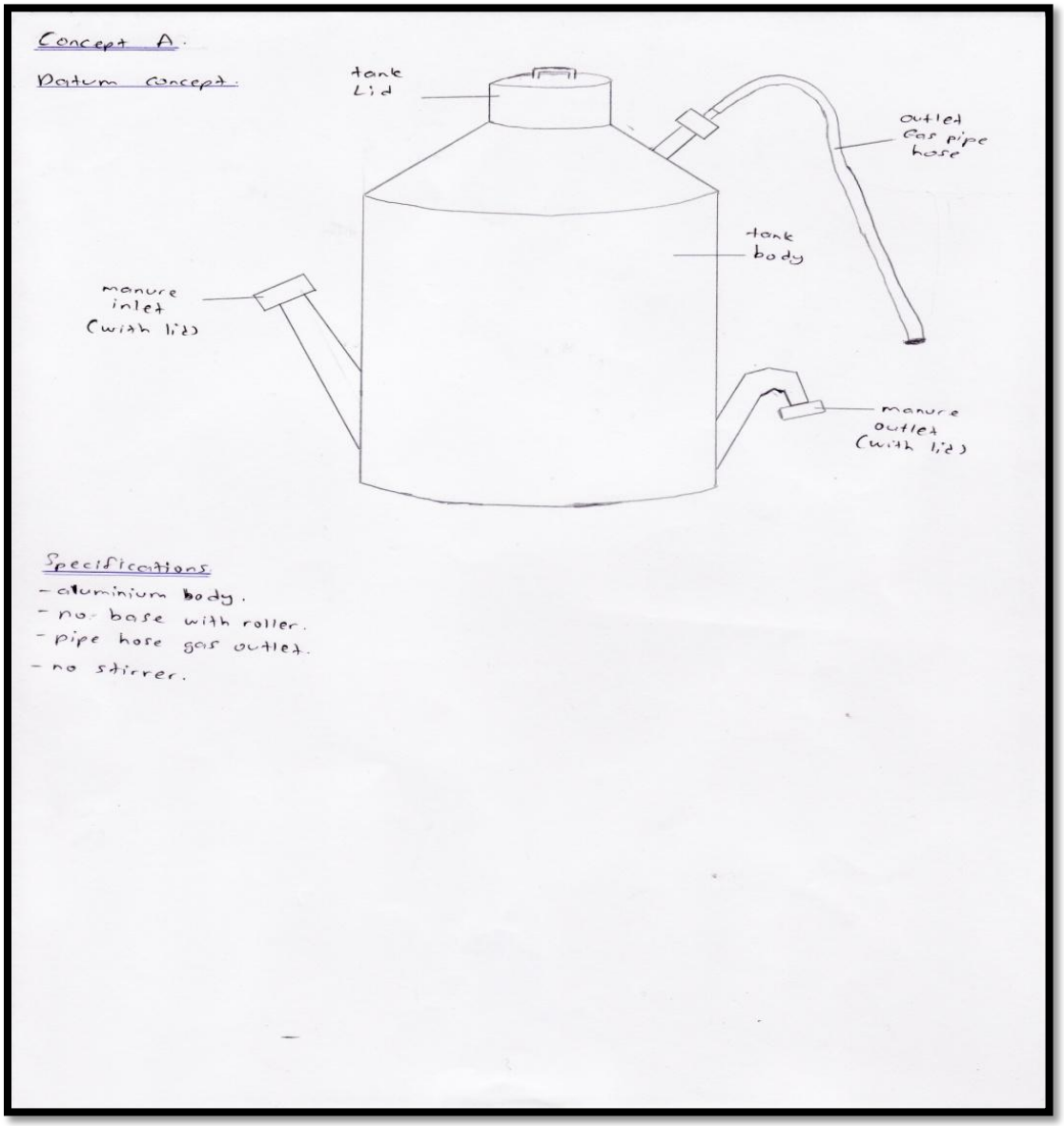


Figure 3.2: Design A

b) Sketch B

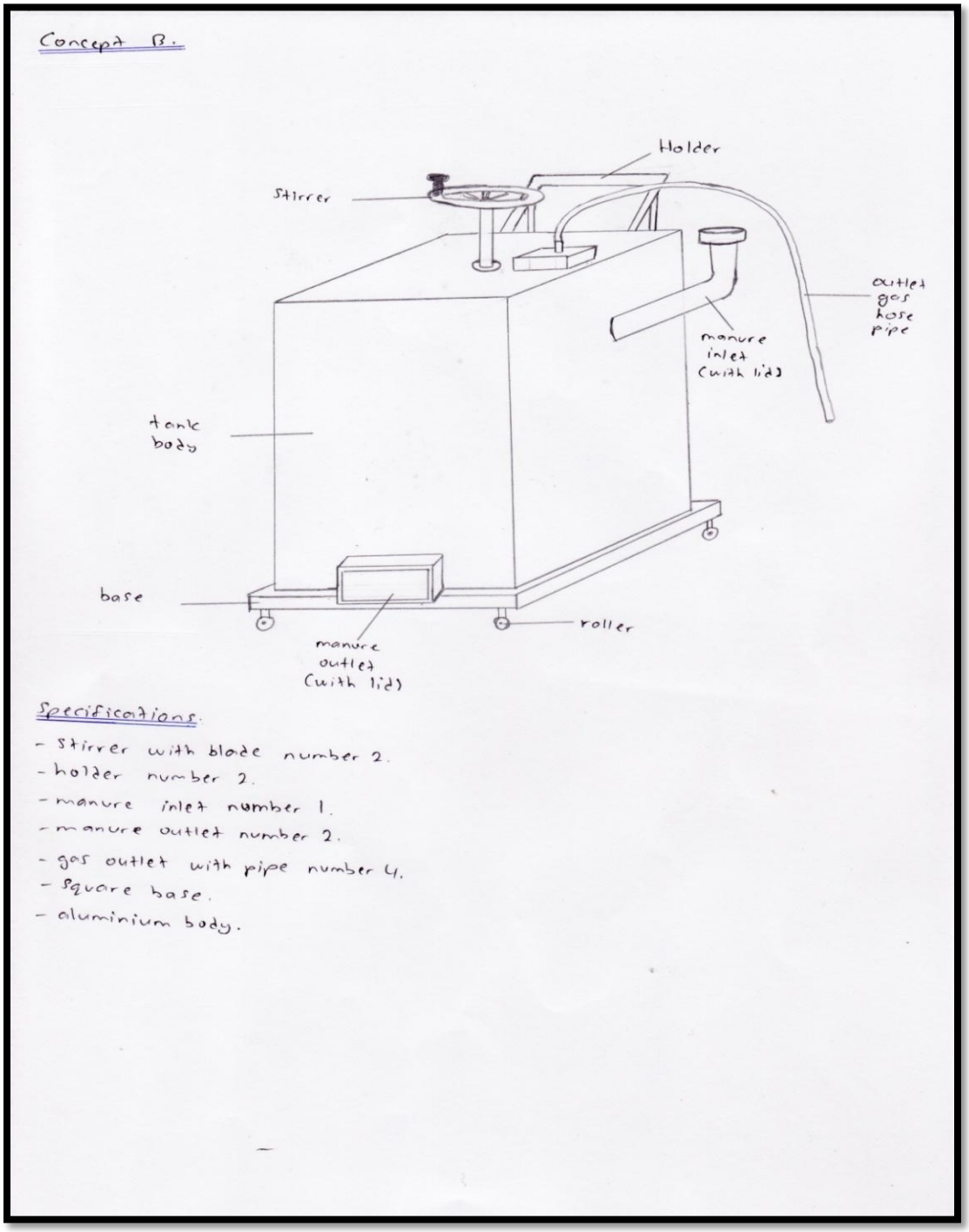


Figure 3.3: Design B

c) Sketch C

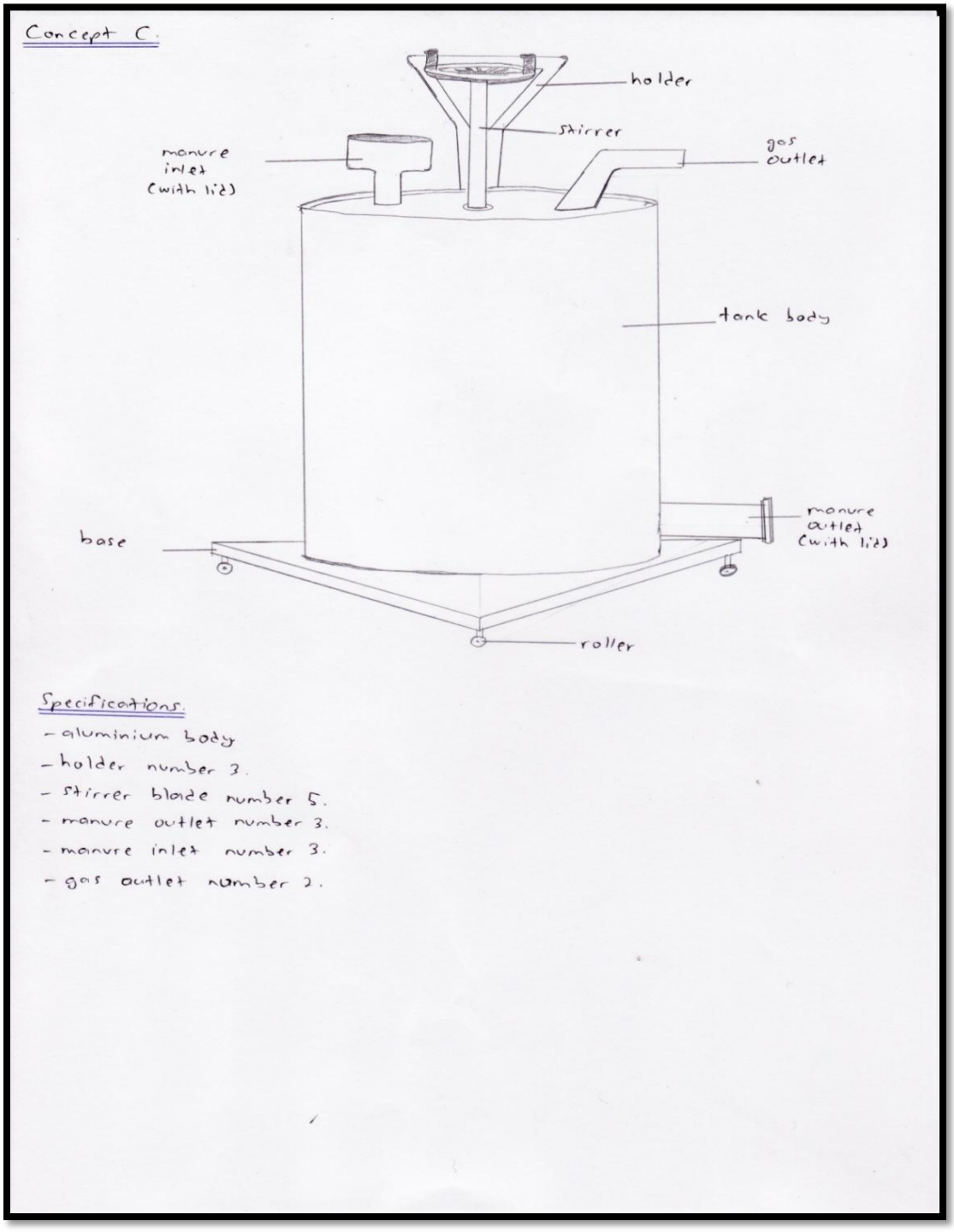


Figure 3.4: Design C

d) Sketch D

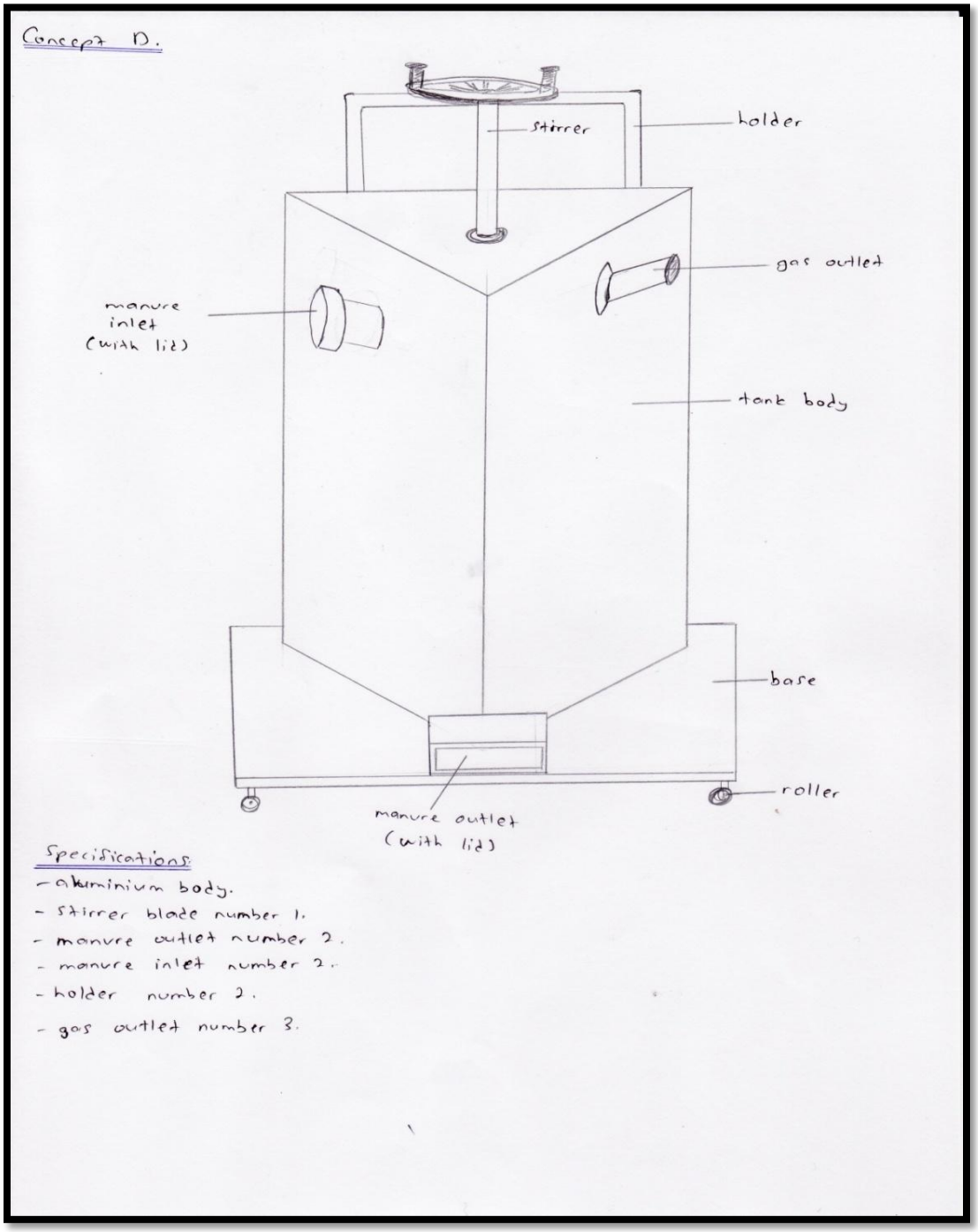


Figure 3.5: Design D

e) Sketch E

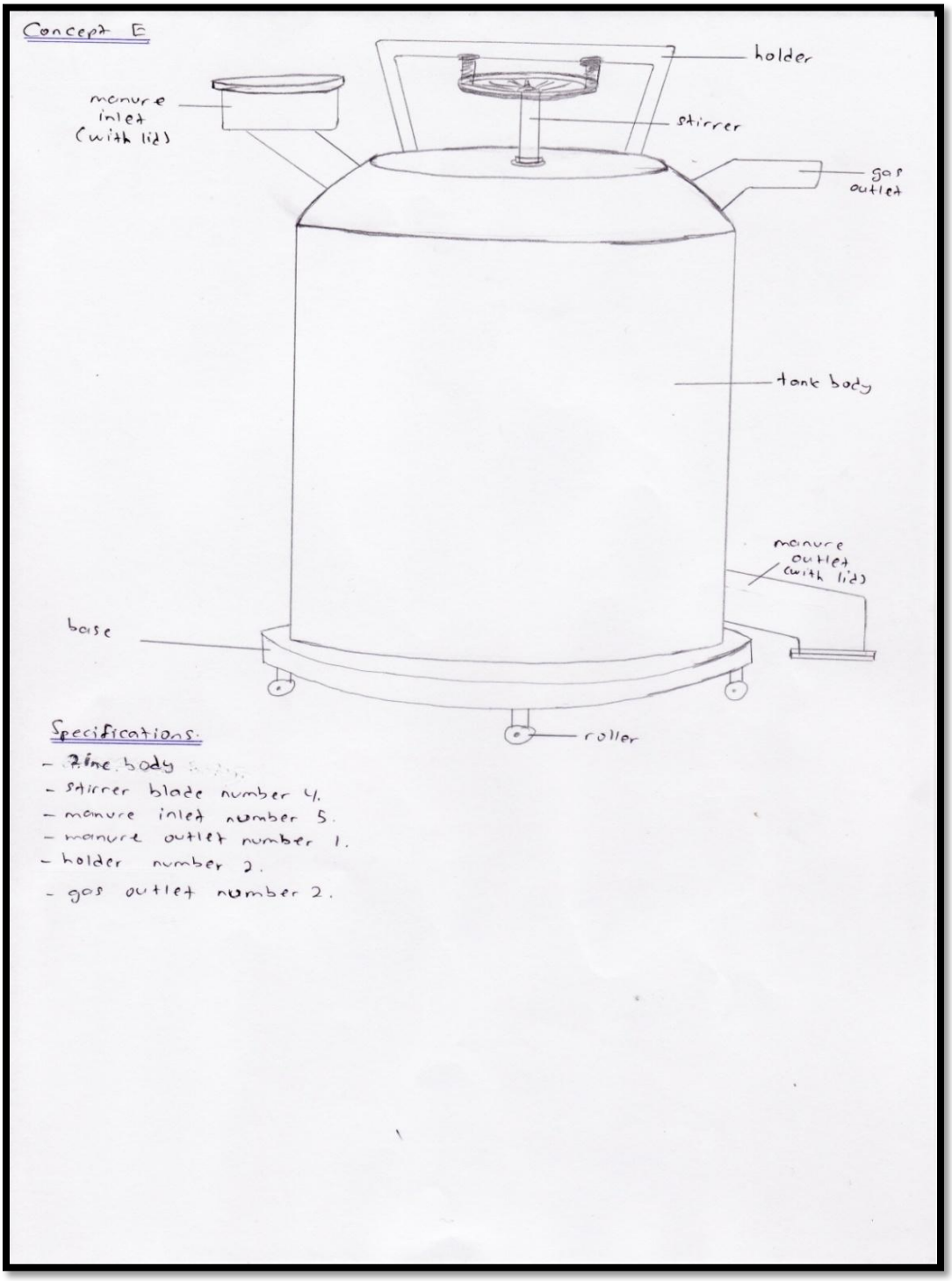


Figure 3.6: Design E

f) Sketch F

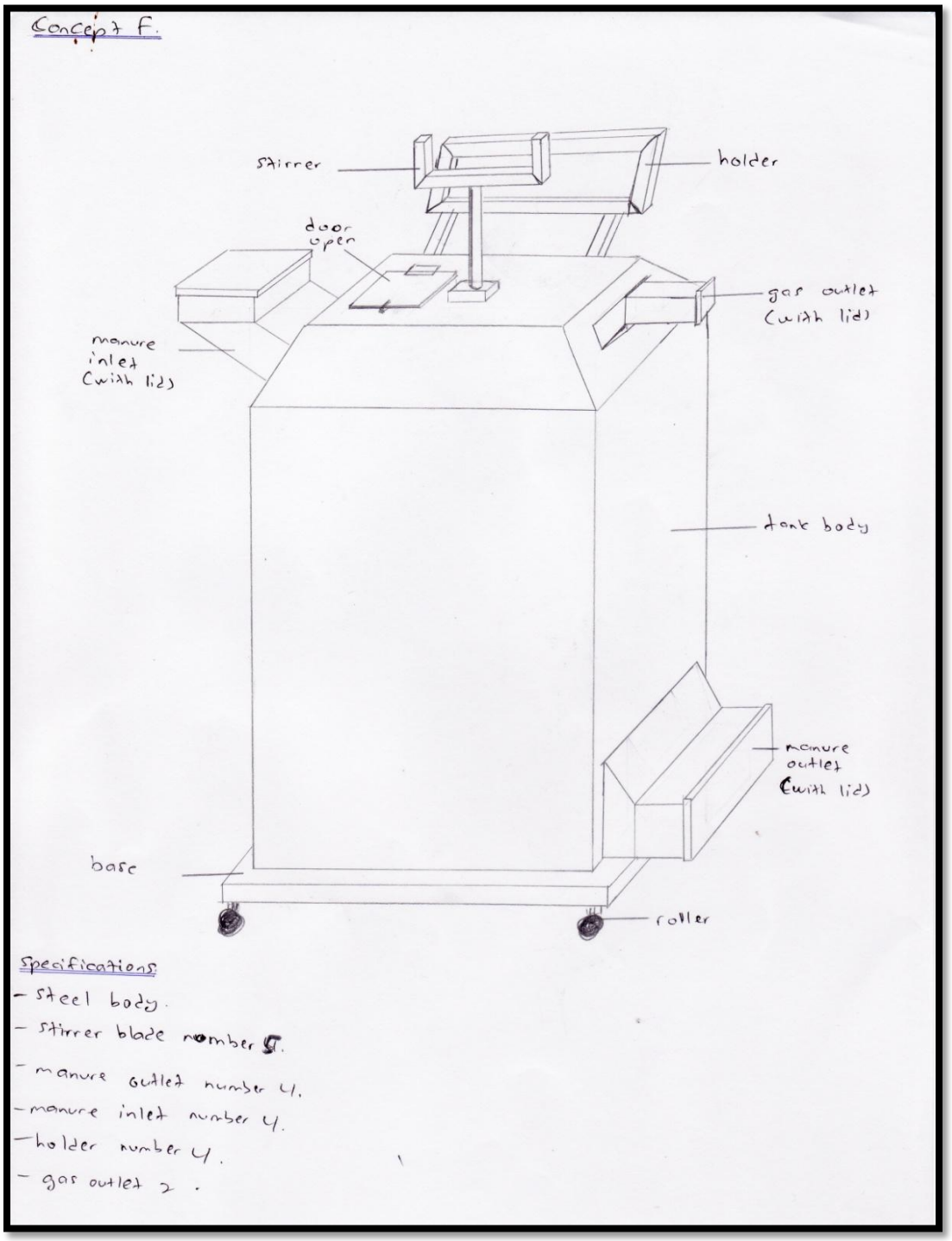


Figure 3.7: Design F

3.6 CONCEPT GENERATION AND EVALUATION

Five concepts with one datum are generated and developed. These concepts are compared against the datum by using the Pugh Concept Selection. The comparison between all the concepts with the datum was showed in the table below. From the comparison, the results are used back to determine which design will be choose. The results are in the Table 3.2.

Table 3.2: Pugh concept selection table

Selection criteria	**Concept**					
	A	**B**	**C**	**D**	**E**	**F**
Capacity	0	+	-	-	0	+
Portability	0	+	+	+	+	+
Easy to use	0	+	-	-	+	+
Efficiency	0	-	-	-	0	+
Highest rate of methane produce	0	-	-	-	+	0
Technical stability	0	-	-	-	+	+
Cost- effectiveness	0	+	+	-	0	0
Easy to fabricate	0	+	+	-	-	0
∑0	8	0	0	0	1	3
∑+	0	5	3	1	5	5
∑-	0	3	5	7	2	0
Net score	**0**	**2**	**-2**	**-6**	**3**	**5**
Ranking	**4**	**3**	**5**	**6**	**2**	**1**

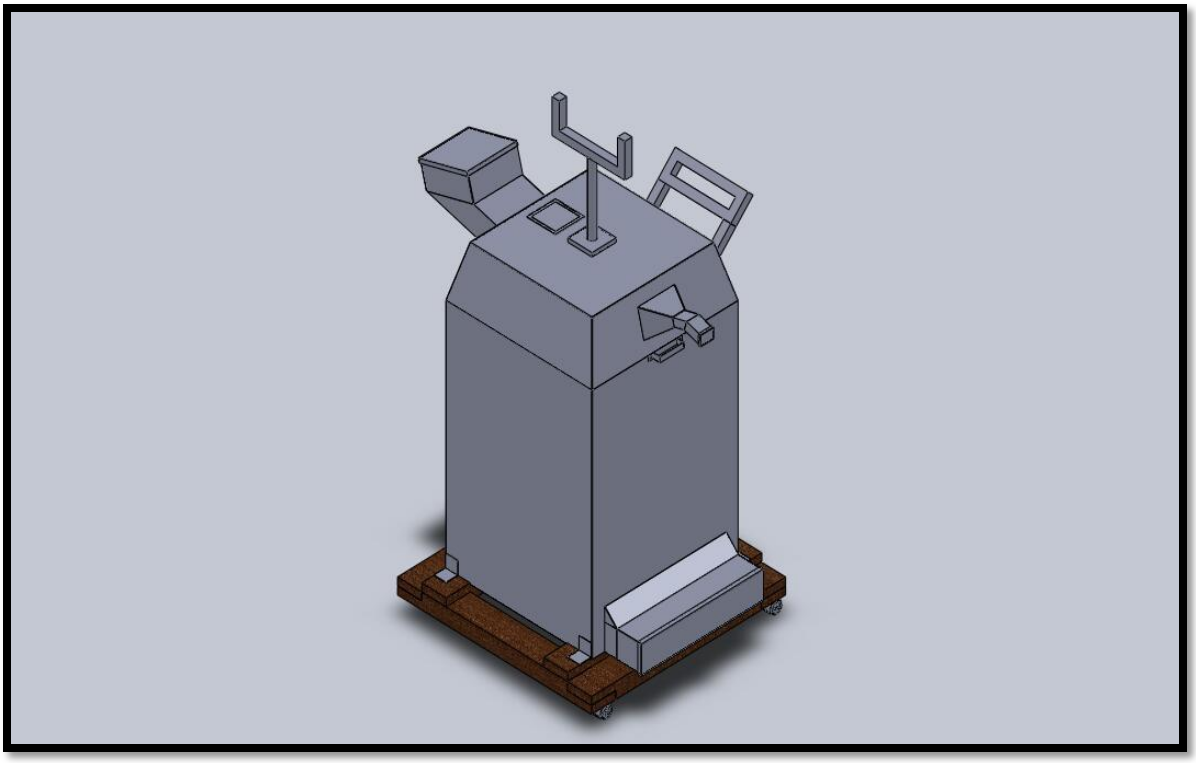


Figure 3.8: 3D model

According to the result, the Concept F is choose because it more convenience and more user friendly. It is more efficiency, easy to fabricate, portable, more technical stability and more resistance to the environment effects. The Figure 3.8 shows the 3D model for the Concept F.

3.7 FABRICATION PROCESS

This process use the materials that selected, make the product base on the selected design and then followed by the selected dimension. In this process, many methods are used in order to make the design become reality. All the methods that can be used are drilling, cutting, welding, fastening and many more method. For this product, the methods are needed to make the inner structure, outer body and the base and all the fabrications process are used for the whole production that include the part production

until to assemble all the part with the other parts. The fabrication starts with the dimensioning by using marking and measuring process until finishing. The processes involve are as below.

Process Involved:

1) Marking and Measuring: Make mark on the materials to show the dimensions location and give precise dimensions.
2) Cutting: All the materials are been cut into the pieces desired.
3) Drilling: The marked holes are drilled to make holes for screw.
4) Joining: All the materials are joined by using welding, rivets and screws.
5) Finishing: Remove all the rough surface and finish painting.

3.8 STEP BY STEP PROCESS

The fabrication process starts with measuring the materials that to be cut into desired shape and be the parts of the digester by following the selected dimensions. Then, all the materials have been cut by using disc cutter shown in Figure 3.9, horizontal bend saw shown in Figure 3.11, shearing machine shown in Figure 3.12, and wood vertical bend saw shown in Figure 3.13 and steel vertical bend saw that specified to cut steel and wood. To make holes, marking process is needed before do the drilling process. The marks are set according to the dimensions that state the position of the holes. After set the mark by using puncher, the drilling process start, and the holes are drilled by using hand drill and vertical table drill machine.

Before start the cutting, drilling and welding process, all the Personal Protective Equipment (PPE) must be prepared and been use. During and cutting drilling process, face shield or goggles needed to protect face and eyes from injured that caused by the chips. The first joining process was carried out by using Gas Metal Arcs Welding that formerly known as Metal Inert Gas (MIG). First, the welding machine is set up to make sure that the output of the process will give satisfied result. All the Personal Protective Equipment (PPE) such as face shields, goggles and glove.

All the materials that have been cut and drilled are grinded to give smooth surface finish on the edges to make sure that joining process can be done precisely. Then, several materials that need to be bent are bending through bending process by using bending machine shown in Figure 3.14. After that, all the materials were arranged into joining position and the next step which is joining process is start.

After all the material have been cut and holes are drilled, all the materials are joined together to be the parts of the digester body. They are joined together through welding process shown in Figure 3.10, riveting, fastening and attached by using glue. The inner structure is weld first, and then follows by weld the body. All those things, which mean that, the inner structure and the body are done with tap weld first, that follow by weld the whole parts. During welding process, the minor movements of the materials will give bad effects to the joint. They are caused by the materials that expend due to the temperature changed.

After finish the welding process, the body, inlet part, gas outlet part, stirrer, outlet part and all the support parts are finish joined. Then, portable grinding machine are used to remove rough surface of the parts that been welded that causes by the spark that produced during welding process run. When the welding process finished, the woods that have cut are joined together to be the base for the digester by using nails. Then, the rollers are joined below the wooden base. Then, after finished the join process for the parts, the digester is joined to the wooden base using nails. The part is tightening the screws to ensure all the parts are joined tightly and to ensure them are in more stable condition.

The joining process is completed. The painting process shown in Figure 3.15 has started. Before that, all the parts are brush by using sand paper to remove dirt and rust. The selected colours which are green and black are used. The green paint is used to paint the whole body of the digester. The black paint is used to paint the wooden base. The project is finished.

Figure 3.9: Cutting using disc cutter

Figure 3.10: Welding

Figure 3.11: Cutting with horizontal bend saw

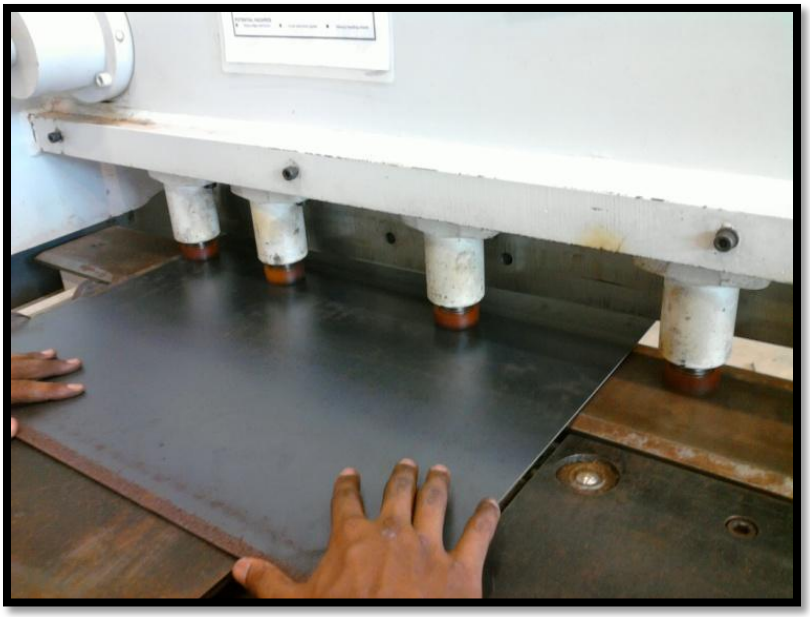


Figure 3.12: Cutting with shearing machine

Figure 3.13: Cutting with wood vertical bend saw

Figure 3.14: Bending

Figure 3.15: Painting

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

The result for the project is aimed for this chapter including the fabrication process, the project's product specifications and the problem with the cause of the project. The result will be use to find the ways to solve the problems and make some improvements to the product. After made some improvements, the comparison of the latest result and the result before the improvements for the project was run to archive the target.

4.2 DESIGNING IN SOLIDWORK

After choose the selected design for the project, the early sketch is transfer to the engineering drawing and also for the solid modelling by using the SolidWorks software to show the actual design for the mini biogas digester. The digester body that draw by using SolidWorks software is shown by Figure 4.1 below. The explode view for the digester body is shown by Explode View in Appendix I.

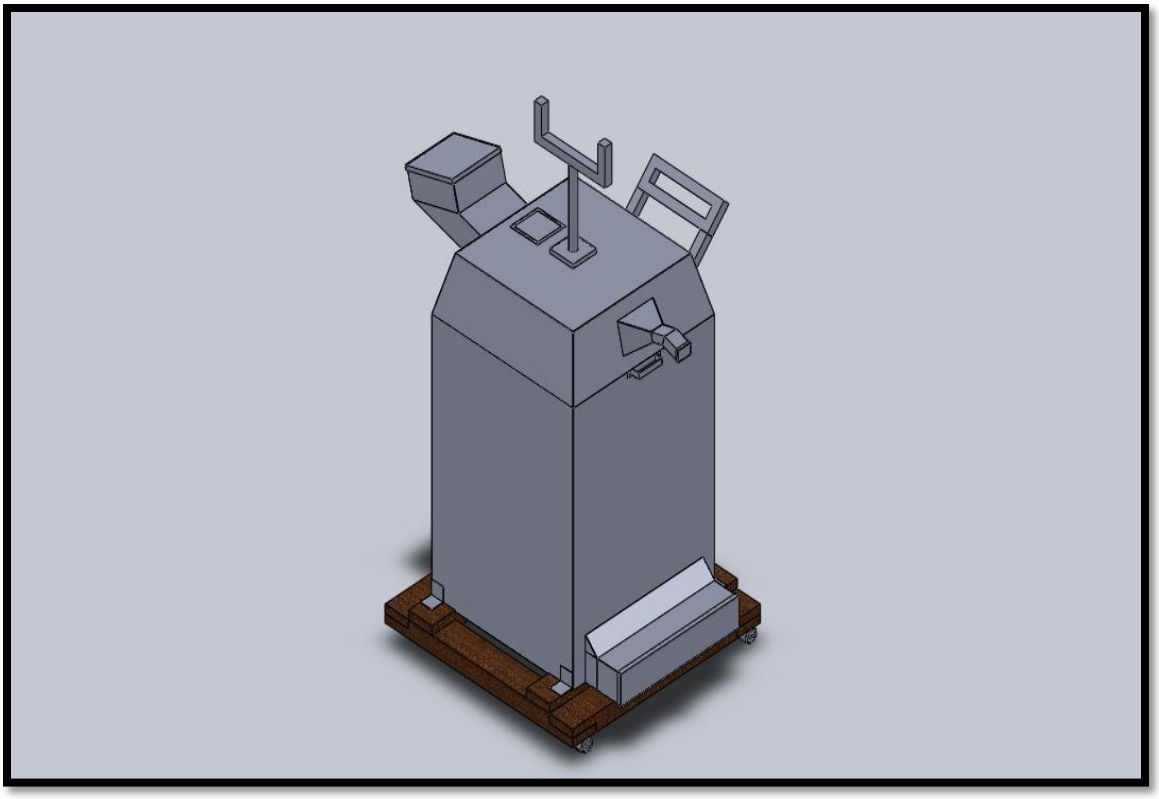


Figure 4.1: Digester body

After made a simple analysis, the body of the digester need the inner structure shown by Figure 4.2 below, to make it became more stable and be stronger. The inner structure for the digester was visualized also by using the SolidWorks software. The square hollow steels were used to make the inner structure for the digester body. The inner structure will give support to the digester body in order to hold the pressure and force that produce by the gas pressure from the inner site and the weight of the content. The explode view for the inner structure shown by Inner Structure Explode View in Appendix II.

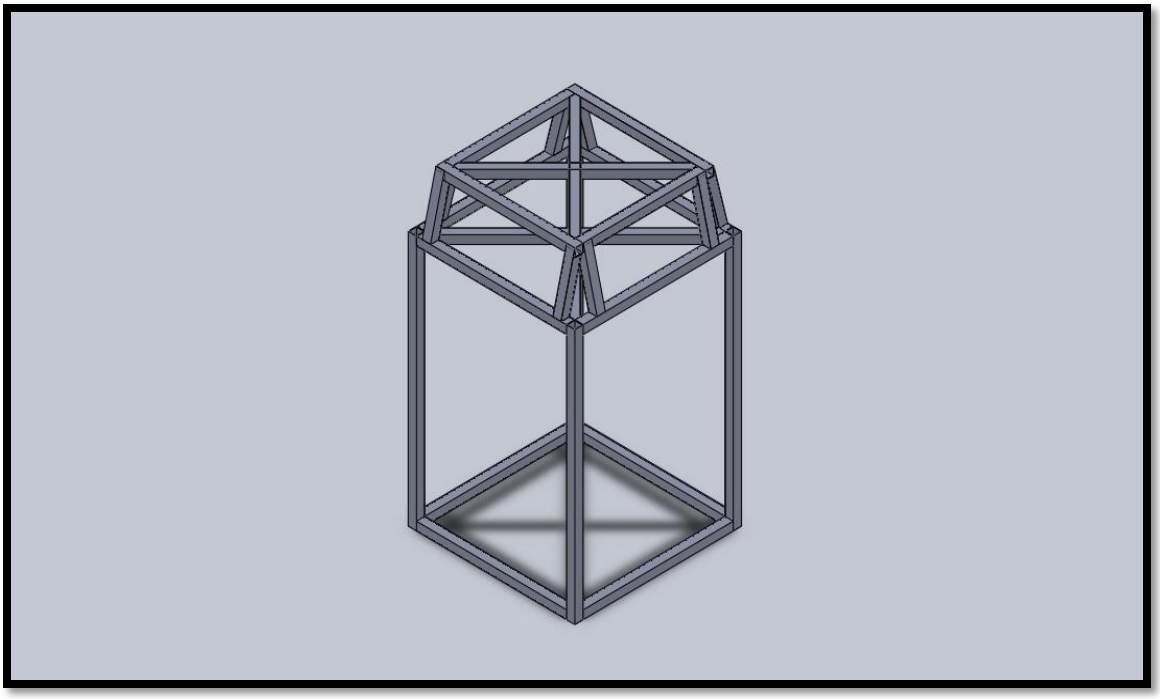


Figure 4.2: Digester inner structure

After select the design and the early sketch, the next step are set the dimension and run the dimensioning process. The dimensions were set before run the project drawing in the SolidWorks software according to the relevant dimensions by refer to the currents mini digester and the other parts to make sure all of them were fit.

After the dimensioning process, the solid modelling and the engineering drawing for all the digester parts are run by using the SolidWorks software. Part by part are been draw according to the dimensions that have been set, and after finish the drawing, all the parts were assembled to give and show the actual design for the project.

4.3 OVERALL DESIGN VIEW

4.3.1 Design Descriptions

The design shows the final idea for the Mini Biogas Digester. Most of the parts are made by using sheet steel, and then follow by the base that made by using wood, and the roller. The reason why the steel is mostly use is because of it better properties which are fair corrosion resistance, high technical stability, high temperature resistance and strong. The base that made from wood is used because it lighter that steel bar, easy to cut into the desired shape and also strong to carry the heavy load on it. The hollow steel bar is use to be the inner structure for the biogas digester because it strong but light weight. The inner structure will support the body of the digester so it will be stable and able to withstand the load, pressure and the environmental effects.

From the result after drawing, sketching selection, generate and evaluate the concept selection, the Concept F is the best design for this project to be fabricate.

4.3.2 Material

The digester body parts and the inner structure are using the sheet steel, round hollow steel, square hollow steel, and the wooden block and the other supported materials are needed.

1) Sheet steels
2) Round hollow steels
3) Square hollow steels
4) Woods
5) Rollers
6) Hinge
7) Hooks
8) Screws
9) Nails

4.3.3 Method of Joining

All the body parts such as stirrer, holder, manure inlet, manure outlet, gad outlet and the bearing protector, and the inner structure are mostly joined by using the Metal Inert Gas (MIG) welding. All places at the digester body aye weld to ensure the body is fully closed and no pore that will disturb the pressure, the quantity of gas and the process that occur in the digester.

The wooden blocks are joined together into square shape to be the base by using nails and the rollers are joined to the wooden block base by using screw. The other sub way that use in the joined method is using glue to stick the rubber at the mouth of manure inlet, manure outlet, the door open and the gas outlet, at the inner part of the mouth to unsure no open gaps.

4.3.4 Special Feature

This mini biogas digester has rollers that make it become more portable because it can be move from the other places to the other places and will make the user work be easier. The digester was completed with the holder which can ease the user to hold the digester and push it to anywhere. It also uses some of joining method, which are welding, using screws and nails, and using glue. By using all of the joining method, the digester was constructed be more stable. The product reviews are shown in Figure 4.3, Figure 4.4, Figure 4.5, Figure 4.6, Figure 4.7, and Figure 4.8.

4.3.5 The Product Review

Figure 4.3: Project view

Figure 4.4: Isometric view

Figure 4.5: Front view

Figure 4.6: Left view

Figure 4.7: Back view

Figure 4.8: Right view

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter is mainly described about all the problems that have been faced during running the project from start until finish. In this chapter will discuss about the project conclusion for the whole of this project too. All the right action that needs to do before, present and after the project is stated in this chapter.

5.2 PROJECT PROBLEM

1) Literature Review: The ideas and the concepts that review for this project are not very wide because all the information mostly just tells about the common large biogas digester and the processes that occur in the digester, not more specific to the mini biogas digester.

2) Designing The Concept: The concept ideas were mostly from the students because there was not much examples of mini biogas digester. There was the scope of the biogas digester just more to the common large digester.

3) Materials preparation: Some of the materials were not supplied by the university and the students needed to buy the materials at the city and get the materials from the supplier there.

4) Fabrication Process: The time needed by the students should be more to finish the project because of the slackness of training, so the finishing of the project was not so good but yet still can be reliable and same with the design.

5.3 CONCLUSION

The project managed to be completed in the time given and also successfully reaches the objective and the target of the project, and they are achieved. The product also be more portable and be more friendly to the users. The system of the biogas digester also was in the best performance and this project will be the best product.

5.4 RECOMMENDATION

The project planning should be start and done before the project start, do all the process on time according to the Gantt chart, so that all the process can be completed. The skills in fabrication process such as welding must be improved and well train before running the project. For addition, the project should be improve by using the materials that more light and have better properties, so they can give the best performance, the great features and more ergonomic value to the project. The time also must be managing wisely, so, all the progress on the project can be done on time. The materials that need to be use to fabricate the project must be prepare after the concept selection and designing the concept selected.

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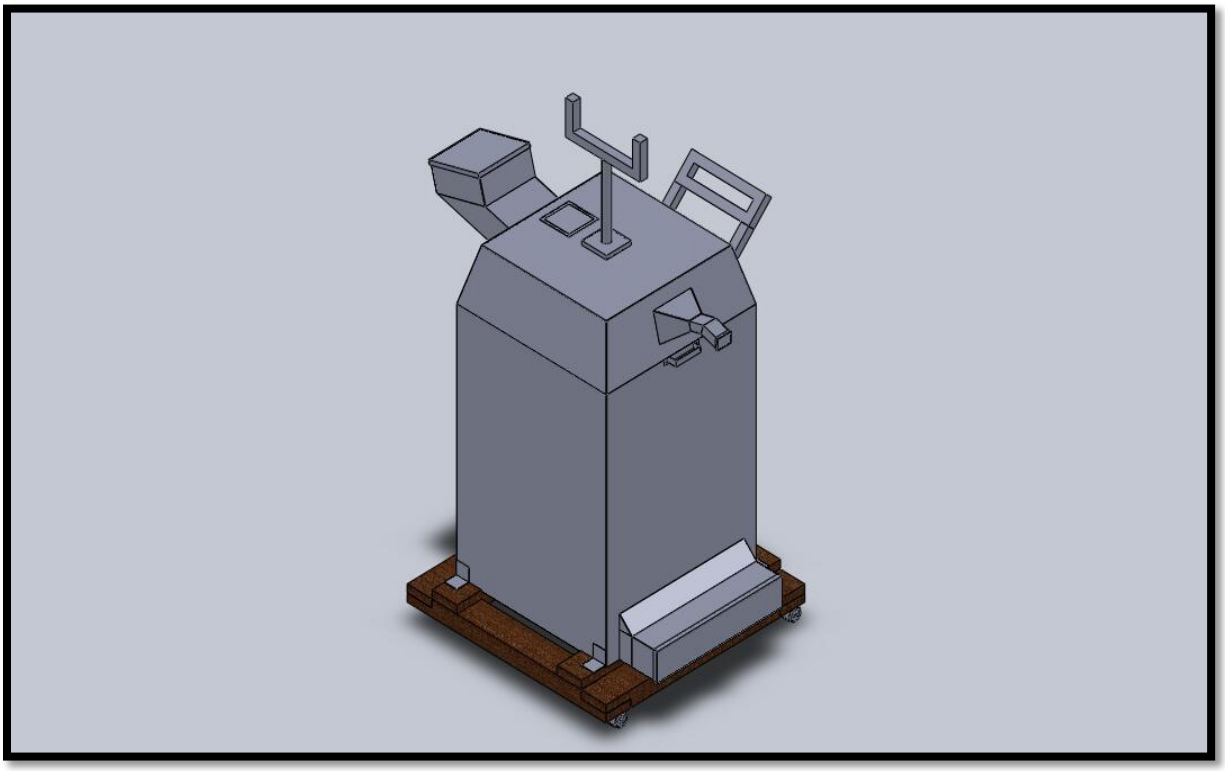
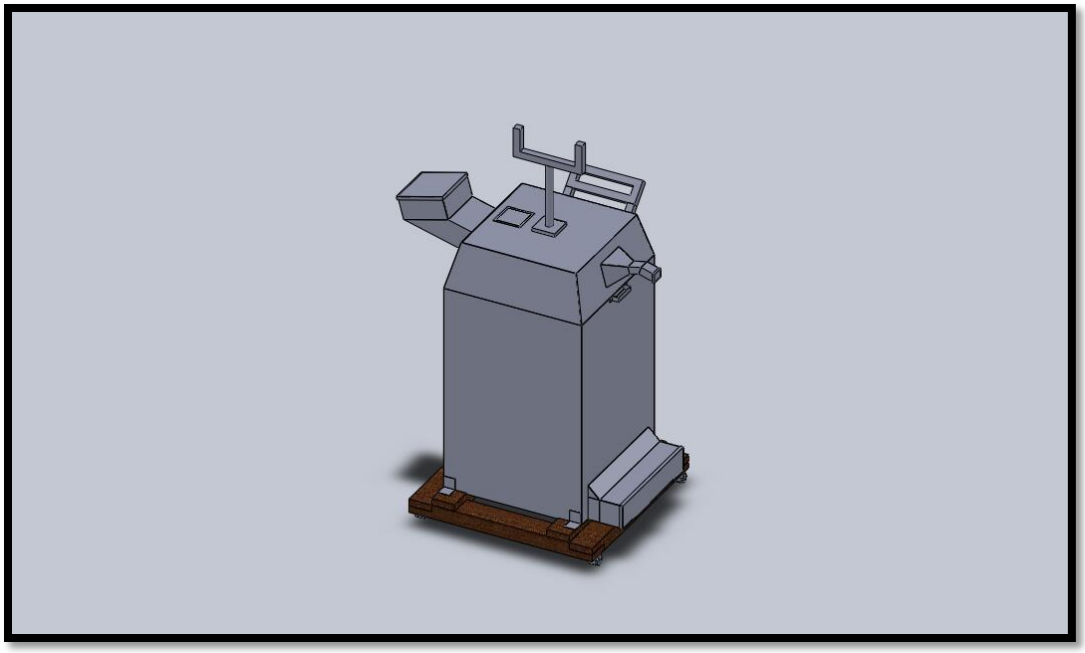
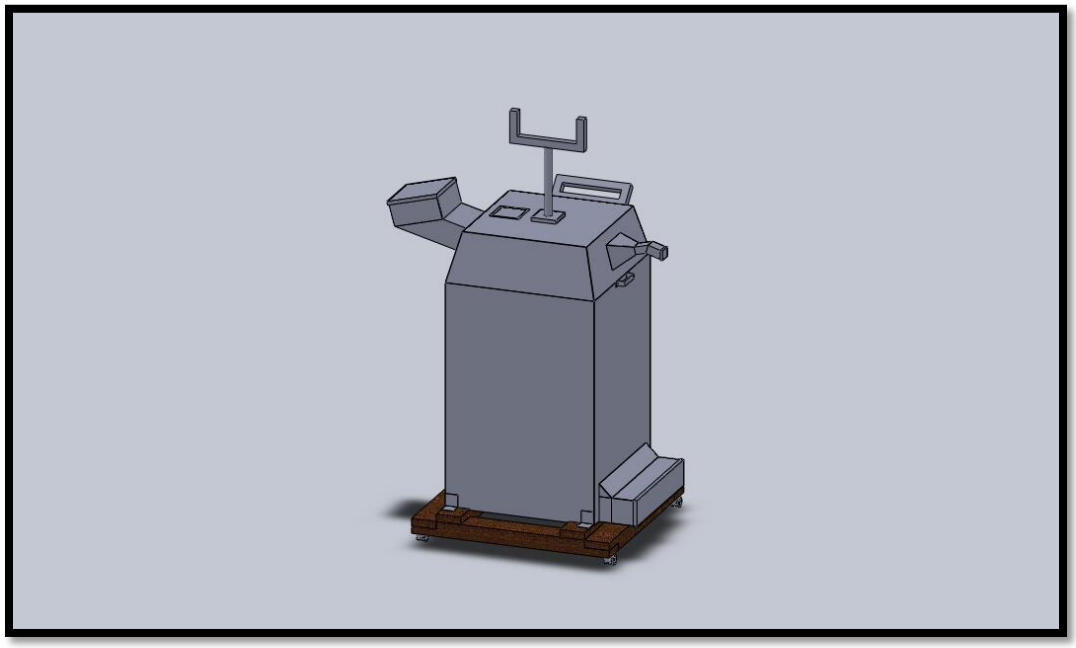
APPENDIX I

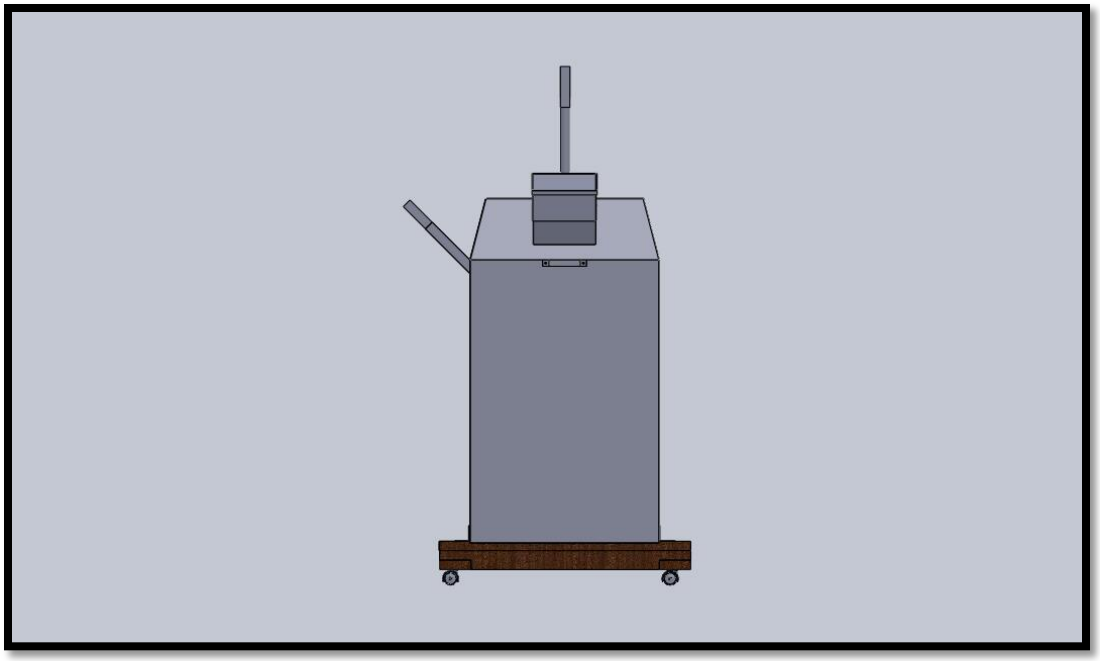
3D DESIGN'S VIEW.



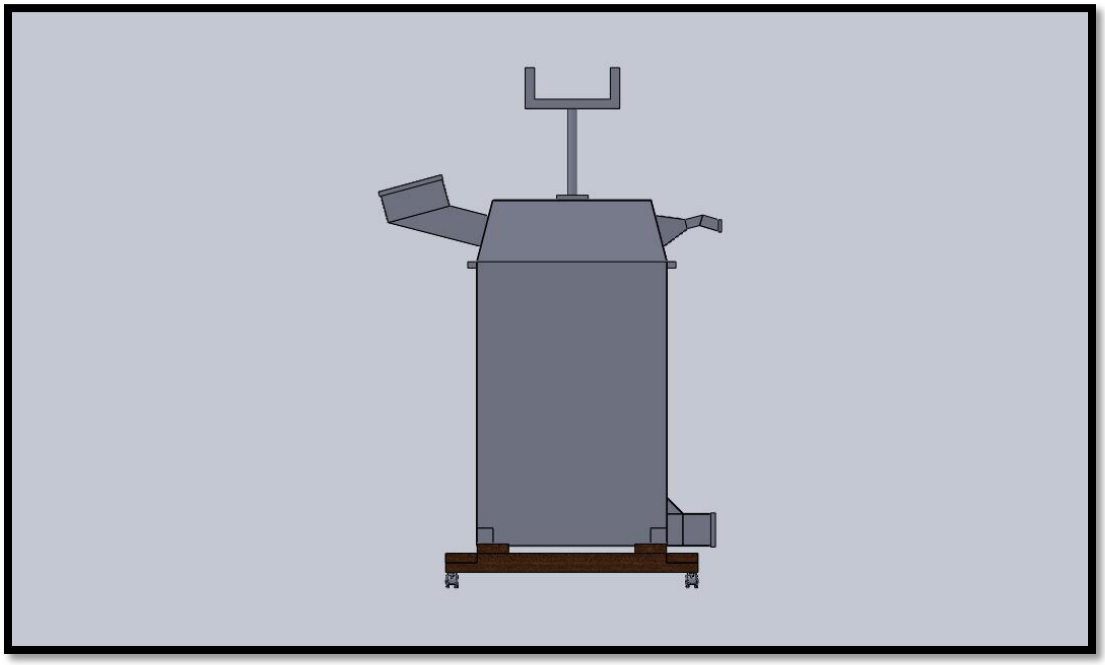
Isometric View



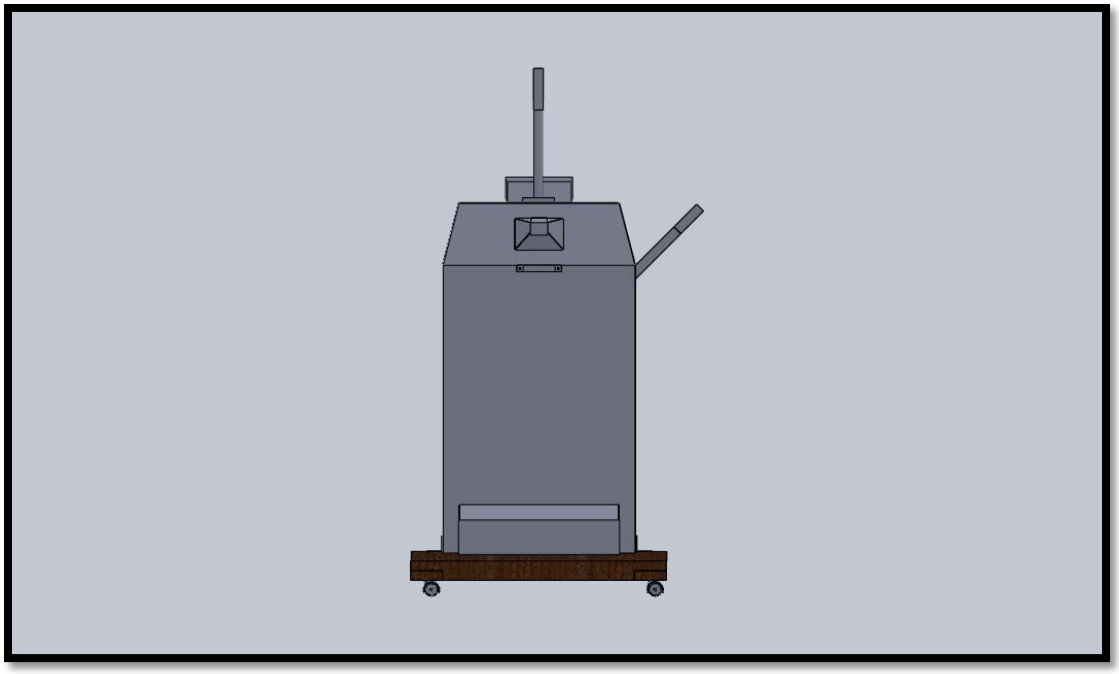




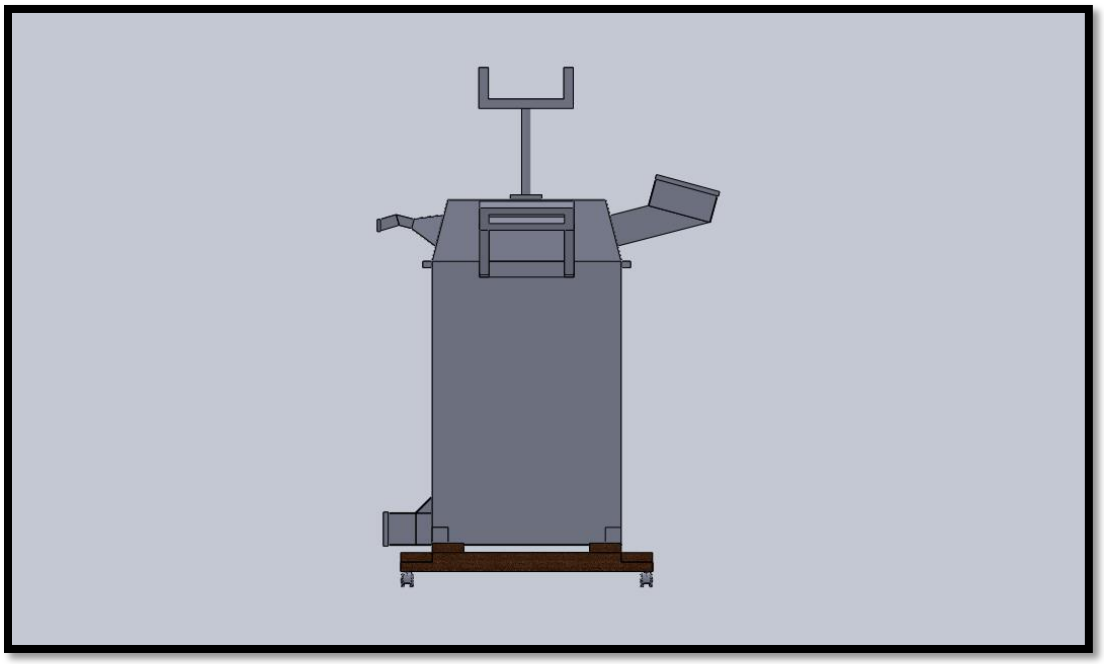
Right View



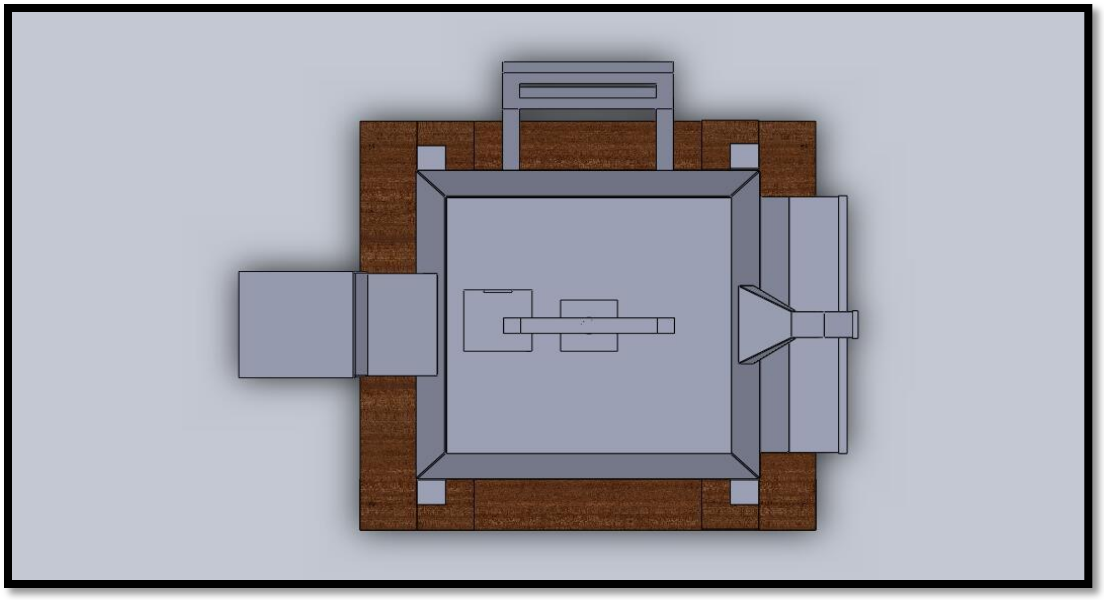
Front View



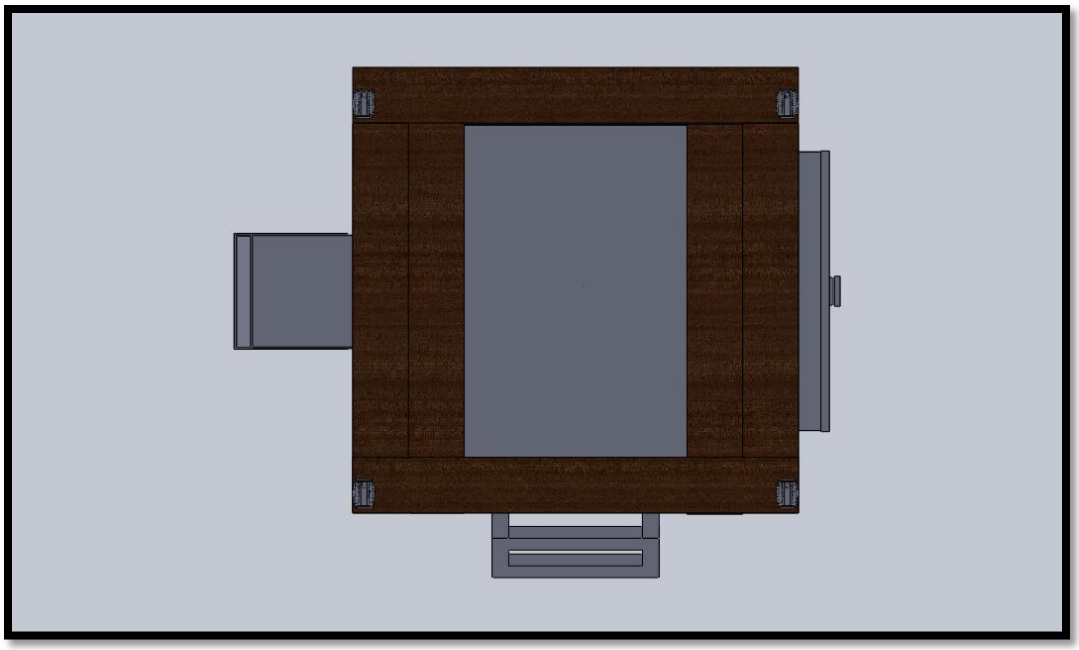
Left View



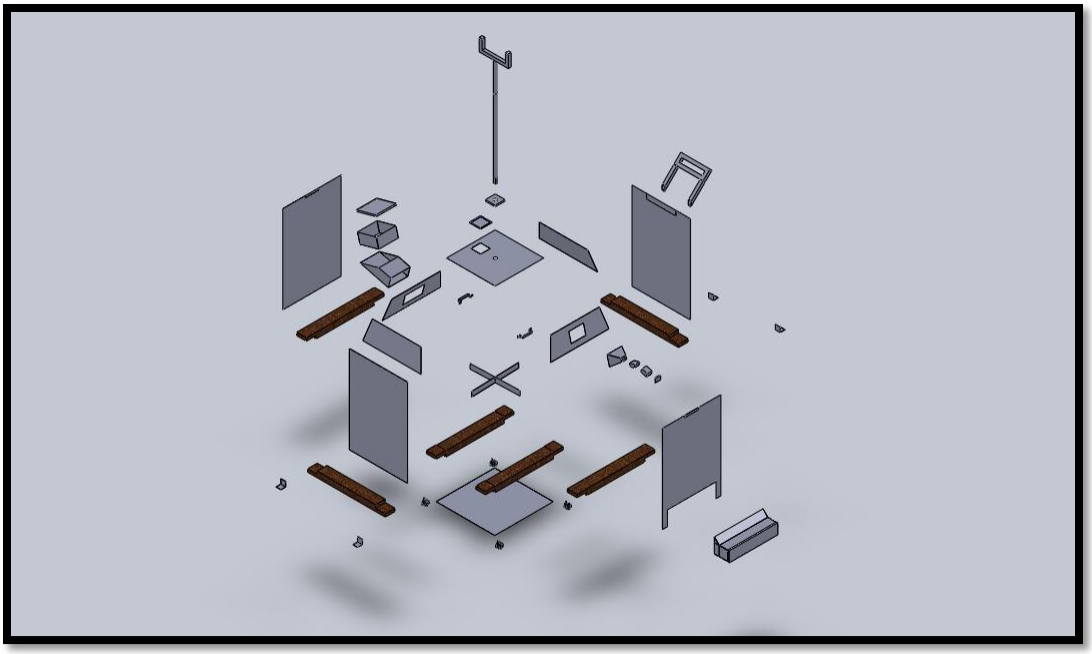
Back View



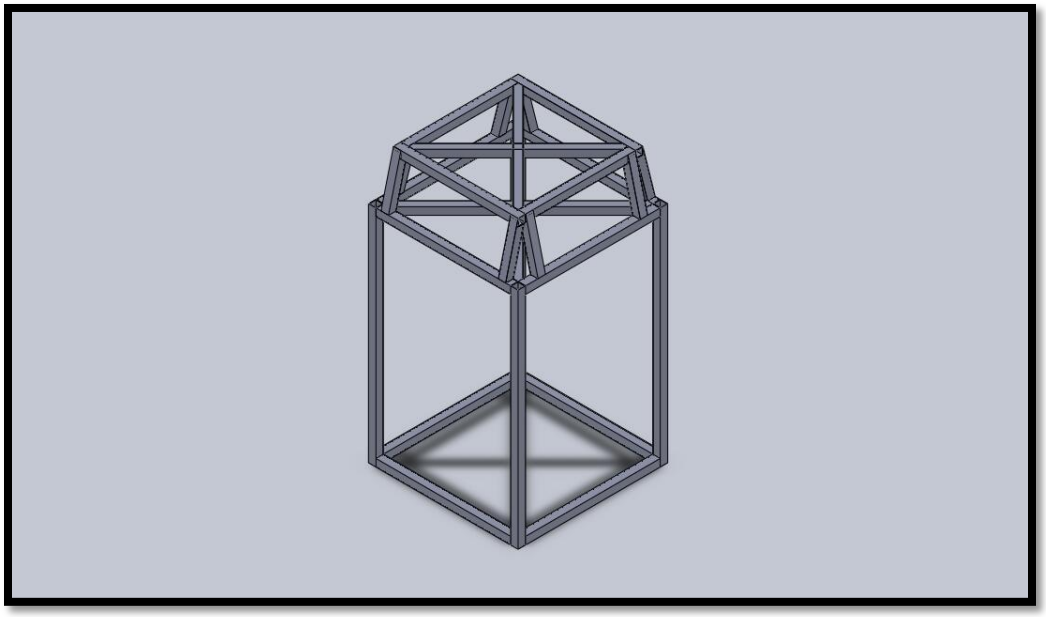
Top View



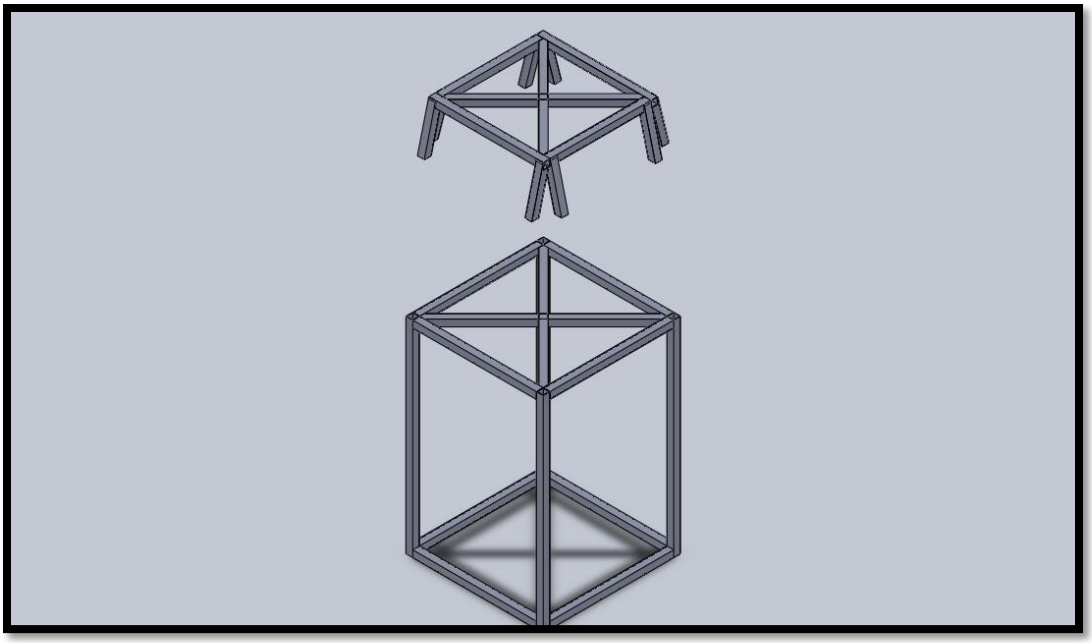
Bottom View



Explode View



Inner Structure View



Inner Structure Explode View

APPENDIX II

RESULT

Project Finished Review

Project Testing

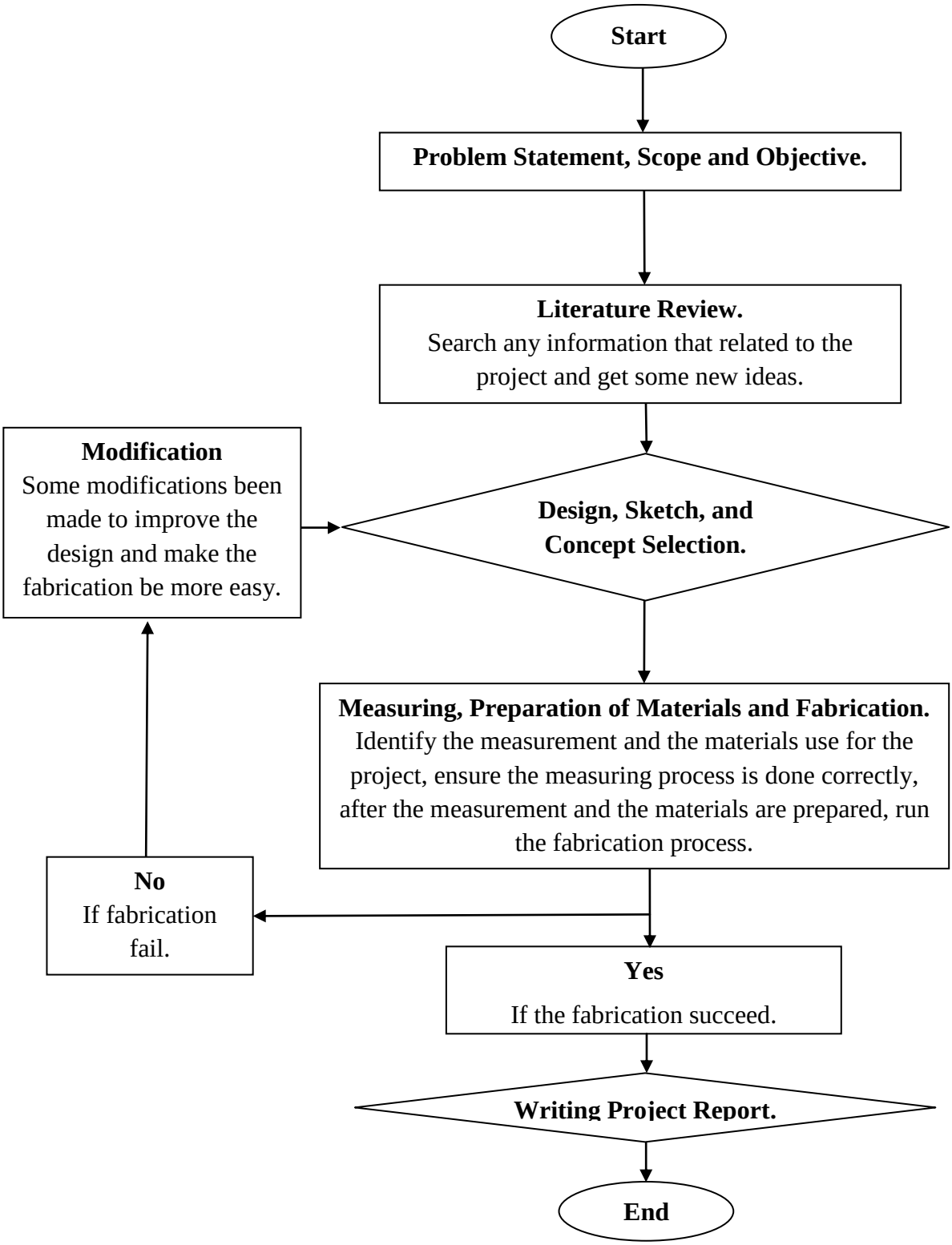


Figure 3.1: Flow chart

Table 1.1: Planning Gantt chart

Project Activities	Week															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Problem statement									**Mid Sem Holiday/ Hari Raya**							
Scope & objective																
Literature review																
Morphological chart																
Product design specification																
Concept generation																
Concept screening																
Design & select final concept																
Material selection and fabrication																
Pre-presentation																
Fabrication (continue)																
Final report																
Final presentation																
Meeting with supervisor																

Table 1.2: Progress Gant chart

Project Activities	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Problem statement									Mid Sem Holiday/ Hari Raya							
Scope & objective																
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