IMPROVEMENT OF A PRE FABRICATE BIOGAS DIGESTER TANK

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ABSTRACT

This project is about improvement of a pre fabricated biogas digester tank to fermentation of waste product in order to produce and collect methane gas. The biogas digesters are used to produce methane gas and the designs of the digesters are commonly bigger in size and have concentration pressure gas at some area such as at the edge of the tank. The effect of concentrated pressure at the edge of the biogas digester tank will cause leakage. To produce and collect the methane gas, this biogas digester design is suitable to use at home and it is portable. So, based on the objective of this project is which to help them, a biogas digester is designed by considering the ergonomic factors for the usage of people. After the design process is completed, it is needed to be transform into the real product. The materials used to fabricate this product are round hollow steel, square hollow steel, sheet mild steel and wood. The processes involved are welding, rolling, and grinding, fastening and using glue to assemble all the parts.

ABSTRAK

Projek ini adalah mengenai penambahbaikan pencerna biogas untuk melakukan proses pemeraman bahan-bahan atau sisa-sisa buangan dalam usaha untuk mengumpul gas metana. Pencerna biogas digunakan untuk menghasilkan gas metana dan reka bentuk percerna biasanya lebih besar dari segi saiz dan mempunyai kepekatan tekanan gas di beberapa kawasan seperti di pinggir dalam tangki. Kesan tekanan penumpuan di pinggir dalam biogas pencerna tangki ini akan menyebabkan berlaku kebocoran.Untuk menghasilkan dan mengumpul gas metana ini, reka bentuk biogas pencerna direka sesuai untuk digunakan di rumah dan mudah untuk dialihkan. Jadi, berdasarkan objektif projek ini adalah untuk merekabentuk pencerna biogas dengan mengambil kira faktor-faktor ergonomik untuk kegunaan orang ramai. Selepas proses merekabentuk selesai, reka bentuk tersebut perlu diubah menjadi produk sebenar. Bahan-bahan yang diperlukan 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.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

A growing interest in alternative energy is fuelling the construction of biogas facilities, which is typically produce methane gas through bacteria-based anaerobic digestion (fermentation) of animal manure and other organic wastes. The end product is essentially the same as natural gas and can be used in the same ways.

Biogas production facilities typically use large concrete digester tanks, which must be equipped with sight glasses to allow observation inside the tanks. Visual monitoring is essential because foam or crust formation can slow down the digestion process. Therefore, sight glasses are installed near the tank work platforms where operators observe the changes going on inside the tanks, and set mixing devices at optimum positions to prevent foam and crust build-up. Fast response to these changes translates into significant biogas production efficiencies. In addition, early detection of irregularities helps to ensure safe operations. Since, the methane produced is a combustible gas, and can form an explosive mixture with air, it is essential that each glass installation form a gas-tight seal to meet safety requirements.

Millions of cubic meters of methane in the form of swamp gas or biogas are produced every year by the decomposition of organic matter, both animal and vegetable. It is almost identical to the natural gas pumped out of the ground by the oil companies and used by many of us for heating our houses and cooking our meals. In the past, however, biogas has been treated as a dangerous by-product that must be removed as quickly as possible, instead of being harnessed for any useful purposes. It is only really in very recent times that a few people have started to view biogas in an entirely different light, as a new source of power for the future.

1.2 PROJECT SYNOPSIS

1.2.1 General Project Synopsis

The concept of this design as difference compared to the others current designs or concept of biogas digesters. The processes involved improvement of biogas digester design are process of generating concept, design the concept and fabrication.

The methods to fabricate of the biogas digester consist instead of with all the required materials that are square, rolling, welding, riveting and fastening method to joint all the part. It is also equipped with rollers to make it more portable and make friendly. 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 to be like a trolley which is more flexible to move. The improvement of biogas digester body design is to decrease its weight as light as possible to increase its portability characteristic. Its volume of the body also designed to reduce the concentration of gas pressure at edge area.

The digester is designed mostly like the large size digester that use to run the fermentation of materials that can produce methane gas and contain of higher content of ammonia for example cow manure. Even though the shape of body is difference the purpose is still same as the current digester which is to produce methane gas to be use as cooking gas for an 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.

1.2.2 Specific Project Synopsis

The project involve the developing and analysis the body shape, the suitable shape that use for develop digester to make it more efficient flow to produce methane gas. This project also will concern about the structure strength, durability, ergonomic factor and convenience. The new concept design of this digester is also being more focus on the strength of its body and to reduce the concentration at the edge and to improve the gases flow in the tank. 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.

1.3 PROBLEM STATEMENT

The biogas digester is used to produce methane gas. The designs of the digesters are commonly in rectangular and in a huge scale. The effect of the pressure in certain part in the biogas digester tank will cause leakage.

To reduce the effect of the pressure in edge part of the bio digester, the bio digester will be redesign. The focus on redesign is to reduce the edge in the tank. The only solution for them to solve this problem is to produce an efficient gas flow in biogas digester that has same function with the bigger digester.

1.4 PROJECT'S OBJECTIVE

The main objectives are as following:

1. To re-design portable Biogas Digester Tank.
2. To re-fabricate the Biogas Digester Tank.

1.5 PROJECT'S SCOPE

Current product of 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. In this project, the biogas digester is to improve in design and fabricating to be in smaller and portable with lightweight, good in durability, and user friendly. The materials use is mild steel because of it better characteristics. Solidwork software was used to design the digester and fabrication includes basic engineering technical such as cutting, drilling, welding, grinding, and rolling and so on.

1.6 THE PROJECT PLANNING

This project starts with investigation and literature review via internet, reference books, supervisor and other relevant academic material that related to this project. To make this project more accurate and suitable, study more about this topic and more than two week to make a literature review. Every week, improvement of knowledge needed to make sure this project will be performed very well.

Beginning week, need to do some schedule management for this project which included schedule management to make sure the project run smoothly. Draft the schedule applies in a table to make a Gantt chart. It takes a week to accomplish all schedules.

Then, discuss with supervisor and continue detail research about improve of the design. The good design must be chosen to make the precise design. The next task is mid-preparation of progress presentation. These tasks take two week to be finished. On that particular week, preparation needed to make a presentation.

Fabrication process started after midterm. Get the form to come out the raw material from FKM central store and get approve from supervisor. When get the raw material, mark the measuring needed to easy for cutting process. Start to cut the raw material. Use the sheering machine for sheet metal mild steel and use the disc cutting.

Continue the fabrication process with shape the part of the biogas digester. Use the sheet metal rolling to shape the mild steel. The arc welding is used for joining process. This task scheduled takes several weeks to finish. Due to the some problem that will be discuss in the other chapter, all these task still cannot be done when this report written except the type of pressure transducer get.

Lastly, the final report writing and prepare the presentation. This takes about one week to be arranged and accomplished. A report is guided by UMP thesis format and also guidance from supervisor. Due to all problems that student facing, the management have agreed to extend the time to submit a report and presentation. All task are scheduled to be finished fourteen weeks.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This project is focused on redesign the current biogas digester and improves the functionality. This instrument used to produce the gas need for efficient, safe cost effective and stability. Although, the selection of the material is most importance to ensure the biogas digester can last the pressure of waste or filth animal.

The current product of Biogas digester usually made from concrete of semen, steel, zinc, rubber, mild steel, aluminium or combination with two or more between of them. The main part of the biogas digester is body and it commonly uses steel which is casting process. Old biogas digesters are use concrete to be the wall of the body structure.

Today, many improvements have been carried out in manufacturing the body structure of biogas digester. For example, 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.

Nowadays, the human knowledge about the biogas digester is widely spread and after humans knows the process and uses of methane gas. An example, methane gas can be used to generate electricity and also can be used 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 like animal manure such as cow will be reused and 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, Figure 2.5, Figure 2.6 and Figure 2.7.

2.2 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.

2.3 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 broken down these two processes, but the decomposition products will be different in the two cases which are by aerobic fermentation, which produces 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. [14]

2.4 BIOGAS IN DEVELOPING NATION

Domestic biogas plants convert livestock manure and night soil into biogas and slurry, the fermented manure. This technology is feasible for small holders with livestock producing 50 kg manure per day, an equivalent of about 6 pigs or 3 cows. This manure has to be collectable to mix it with water and feed it into the plant. Toilets can be connected. Another precondition is the temperature that affects the fermentation process. With an optimum at 36 C° the technology especially applies for those living in a (sub) tropical climate. This makes the technology for small holders in developing countries often suitable refer Figure 2.1.

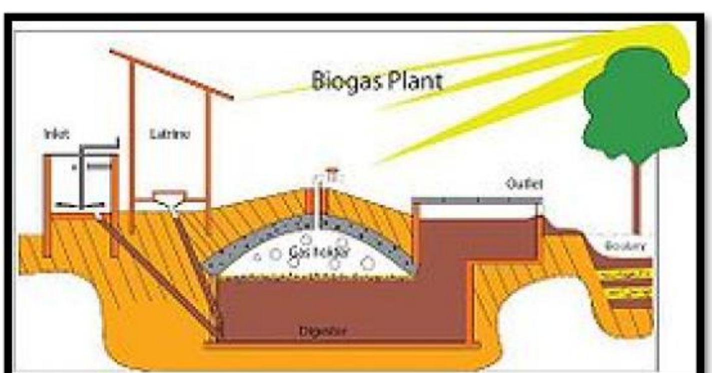

Figure 2.1: System of biogas digester [1]

Depending on size and location, a typical brick made fixed dome biogas plant can be installed at the yard of a rural household with the investment between 300 to 500 US $ in Asian countries and up to 1400 US $ in the African context. A high quality biogas plant needs minimum maintenance costs and can produce gas for at least 15–20 years without major problems and re-investments. For the user, biogas provides clean cooking energy, reduces indoor air pollution, and reduces the time needed for traditional biomass collection, especially for women and children. The slurry is a clean organic fertilizer that potentially increases agricultural productivity.

Domestic biogas technology is a proven and established technology in many parts of the world, especially Asia. Several countries in this region have embarked on large-scale programmes on domestic biogas, such as China and India. The Netherlands Development Organisation, SNV, supports national programmes on domestic biogas that aim to establish commercial-viable domestic biogas sectors in which local companies market, install and service biogas plants for households. In Asia, SNV is working in Nepal, Vietnam, Bangladesh , Bhutan, Cambodia, Lao PDR, Pakistan and Indonesia, and in Africa; Rwanda, Senegal, Burkina Faso, Ethiopia, Tanzania, Uganda, Kenya, Benin and Cameroon.[1]

2.5 EXAMPLE BIOGAS DIGESTER.

List of an example the current product design in the world are show in Figure 2.2, 2.3, 2.4, 2.5, 2.6, 2.7.

Figure 2.2: Germany [2]

Figure 2.3: Japan [3]

Figure 2.4: India [4]

Figure 2.5: Nepal [5]

Figure 2.6: Australia [6]

Figure 2.7: America [7]

2.6 BIOGAS DIGESTER IN OTHER COUNTRIES

2.6.1 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. [8]

2.6.2 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. [9]

2.6.3 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. [10]

2.6.4 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. [11]

2.6.5 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 nearby 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.[12]

2.6.6 Biogas in America

The biogas in America patent is now being legally exploited by Western Plains Energy LLC ("WPE") at its 50 MMGPY plant in Oakley, Kansas. The rest of the ethanol industry in the U.S. is encouraged to contact about integrating Waste-to-Energy (biogas) plants with ethanol plants, if they would like to legally attain the same measurable, significant benefits.

The application is to commercial livestock farms, which produced enough electricity to power the equivalent of 41,000 homes. The EPA's AgSTAR program reported in 2010 that about 8,000 U.S. farms could support biogas recovery systems, providing about 1,600 megawatts of energy and reducing emissions of global warming pollution by about 1.8 million metric tons of methane -- the equivalent of taking 6.5 million cars off the road.

This digester alone will boost the total on-farm biogas production in the USA by 10%. Anaerobic Digestion ("AD") consumes waste and neutralizes odor of a massive feedlot as well as other organic wastes. Enhanced, Integrated Ethanol Production ("EIEP") technology will result in a 10% boost to ethanol output at WPE with no extra costs. WPE's ethanol plant will go off-grid, resulting in a dramatic decrease of its carbon intensity ("CI") across 100% of its production.

Employment in Kansas will be 100,000 man-hours of design, engineering and construction, with an annual 20,000 man-hours per year thereafter. They were produce 6 million gallons of AD capacity will generate over 100,000,000.00 BTU of renewable energy every hour of every day. The plant expansion is allowed agreement with WPE (to over 10 million gallons of AD capacity). The matter that use is animal barns/coops, open-pen feedlots, sand-laden dairy farms and other organic waste generators and this plant biogas cleaning/conditioning capability. Besides that, they also operate electrical generator (co-gen unit), or heat/electricity exchangers. [13]

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The focus improvement of this project is to redesign current product and to reduce the concentration the gas pressure in the tank. In this chapter, the processes of design include the current product and try to improve and ignore neglect the function and ergonomic.

3.2 PROJECT FLOW CHART

By following flow chart, the project starts with the defining the projects title project's problem statement, project's scope and the project's objective. These items are the most important as the guide line to specify the project flow until this project finish.

After that it is continue with literature review and research about the related on these project topics which are the biogas digester. These tasks have been done through research on the internet, books, magazines and others sources that have the information which related to the project. For this task, the knowledge of some current concept, specifications and 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 that, the project undergo to designing, sketching and concept selection process. In this step, the knowledge and information gathered from the review, is used to make a sketch, designing and to the select the suitable concept for the project.

After several design sketched, design consideration have been made and one design have been chosen. Selecting process one concept from five new concepts that has been sketch, applied the Pugh Concept.The selected design sketched is the transfer to solid modeling and engineering drawing using SolidWorks. All the project parts are draw into the desired shape and assembled to be the actual shape of the biogas digester.

The next step is selecting the material, measuring, material preparation and fabrication processes. From the drawing, specific dimension is important to get the exact size and selection of the right material.

Later, the drawing will be used as a reference for the next process, which it is fabrication stage. This process consists fabricate the parts that have design before by following the entire exact dimension that suitable use. All the material is not come with needed size and need through cutting process to get the desired shape and size or dimension.

Then, the fabrication process continues to run on the project, the processes that include in the fabrications process are measuring, cutting, rolling, welding, some fastening and assemble all the digester parts. The parts are assembled into the desired or actual project concept shape.

Finally, when all the process mentioned above is done, the material for report writing is gathered. The report writing process was guided by the UMP final year report writing guide. This process also included the presentation slide making for the final presentation of the project. The project ended after the submission of the report and the presentation slide has been presented on the last of study week.

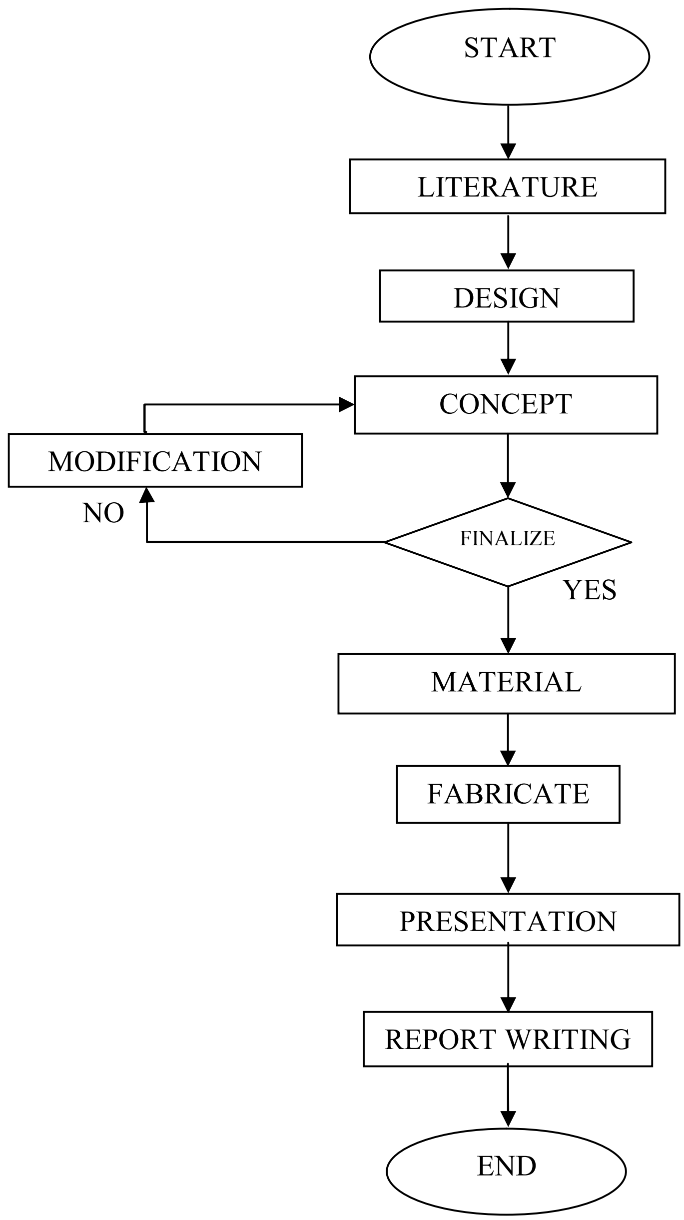

Figure 3.1: Flow Chart

3.3 DESIGN

The Design of the biogas digester must be compliance to several guidelines, criteria and aspect. The design consideration must do with carefully then the design can be fabricated and the system is functioning. The aspects that must be considered in designing the biogas digester are:

i. Durability: The biogas digester must have the durability to endure dynamic resistance continuous. The force comes in tension mode.
ii. Strength: The toughness of the body structure strength biogas digester will be the most important criteria in designing, the body it will goes highly capacity of the manure animal weight acting in order.
iii. Material: Material availability will be one of the challenges in the design consideration. The selection material must suitable to fabricate.
iv. Appearance: Since this test rig will be use at home, so the design of the system should have the good efficiency and suitable to the environment with the current technology.
v. Ergonomic: The biogas design must fulfil the customer size body and the size of the biogas digester is ideal human body.

3.4 DRAWING

The drawings process is consist two categories which are sketching and drawing the designs that have been sketch using the Solid Works software.

For sketching process, all the ideas for the biogas digester are sketched on the paper to ensure that the ideas selection can be made after this and sketch by combination the part apply Morphological cart concept and then raw hand to visualize the concept witho**u**t any other engineering drawing tools.

By using the Solid Works 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.

3.5 DESIGN SPECIFICATION

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

i. Base with four rollers.
ii. Has volume capacity about 0.384 m^3.
iii. Range weight about 50 kg.
iv. Cylinder shape.
v. Height about 1. Meters.
vi. Technical stability.
vii. Portable.
viii. Convenience.
ix. User friendly.

3.6 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 are five concepts selected to be finalized and then one datum concept that had been chosen to be considered as the final concept. 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) **Table3.1:** Morphological chart