DESIGN OF SCRUBBER SYSTEM FOR TREATMENT OF WELDING GASES

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This report is submitted

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DECLARATION

I declare that this report entitled "Design of Scrubber System for Treatment of Welding Gases" is the result of my own work except for quotes as cited in the references.

Signature : ……

Author : MUHAMMAD NASRULLAH BIN ROZI

Date : ……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Mechanical Engineering with Honours.

Signature : ……

Supervisor Name : PROF. MADYA Ir. Dr. Ts. ABDUL TALIB BIN DIN.

Date : ……

ABSTRACT

In the history of industrial development, until today, it is customary in the manufacturing process that the production of the products from the metals are carried out mostly using welding process to produce certain product. During the welding process, welders will be exposed to fume that is released as a result from the welding rod burning which is harmful to their health. This problem should be prevented to comply occupational safety and health requirement by the Department of Occupational Safety and Health Malaysia, by using specially designed scrubber that used to scrub the welding fume before it is released to the atmosphere. The purpose of this project is to design and fabricate a scrubber system that can remove welding fume to ensure that the fume is sucked out from the welding working space and later on scrubbed in a scrubber chamber thus create safe and healthy working environment and surrounding. The scrubber system that was selected to be used in this project is a wet scrubber system. As we know nowadays, the scrubber technology has been widely used in various application not only in cleaning the welding fume but also in all gases scrubbing in all kind of industries that release flue gases. The fabricated scrubber system was then tested in a welding workshop to assess its performance and efficiency in scrubbing the welding fume before released to the open atmosphere.

ABSTRAK

Dalam sejarah pembangunan perindustrian, sehingga hari ini, adalah menjadi kebiasaan dalam proses pembuatan bahawa pengeluaran produk dari logam dijalankan kebanyakannya menggunakan proses kimpalan untuk menghasilkan sesuatu produk tertentu. Semasa proses kimpalan dijalankan, kebiasaannya pengimpal akan terdedah kepada asap yang dibebaskan akibat pembakaran rod kimpalan yang membahayakan kesihatan mereka. Masalah ini harus dicegah untuk mematuhi peraturan keperluan keselamatan dan kesihatan pekerjaan oleh jabatan keselamatan dan kesihatan pekerjaan Malaysia, dengan menggunakan scrubber yang direka khas yang digunakan untuk merawat asap kimpalan sebelum dilepaskan ke atmosfera. Tujuan projek ini adalah untuk mereka bentuk dan menghasilkan sistem scrubber yang boleh mengeluarkan asap kimpalan yang bersih dan untuk memastikan bahawa asap disedut dari ruang kerja kimpalan dan kemudian disejukkan di ruang penggelek sehingga mewujudkan persekitaran kerja yang selamat dan sihat. Sistem scrubber yang telah dipilih untuk digunakan dalam projek ini adalah sistem scrubber basah. Pada masa kini seperti yang kita tahu, teknologi scrubber telah digunakan secara meluas dalam pelbagai aplikasi bukan sahaja dalam membersihkan asap kimpalan tetapi juga semua gas dalam semua jenis industri yang melepaskan gas dari serombong. Sistem scrubber yang dihasilkan kemudian diuji dalam bengkel kimpalan bagi menilai prestasi dan kecekapannya dalam merawat asap kimpalan sebelum dilepaskan ke persekitaran terbuka.

DEDICATION

I dedicate this thesis to my supervisor, Prof. Madya Ir. Dr. Ts. Abdul Talib bin Din and to my friend Muhammad Faizal bin Mohd Akram, Ahmad Khuzairi bin Abu, Ahmad Naufal Hakimi bin Aminuddin who have guide me throughout this project. This thesis is also dedicated to my parents who have been a great source of support mentally and physically.

ACKNOWLEDGEMENT

In the name of ALLAH, the most gracious, the most merciful, with the highest praise to Allah that I manage to complete this final year project successfully without difficulty.

Prof. Madya Ir. Dr. Ts. Abdul Talib bin Din, my respected supervisor. His kindness, unwavering patience and mentoring guided me through the process, his easily understood explanations and open-mindedness allowed me to grow and learn so that I am now a better researcher. In addition, I would like to express my gratitude to the technicians, Mohd Yuszrin bin Md Yacob and Nor Izwan bin Junoh for their kind supervision, advice and guidance, as well as to explain me throughout the study with meaningful experiences.

Last but not least, entire family especially my beloved father and mother, En Rozi bin Yusoff and Pn. Zamilah binti Daud and family members for their continuous supports from the preliminary of this project till the end of it. All my fellow friends should also be recognized for their support. Their tips and views are indeed very useful.

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SO_2	-	Sulfur Dioxide
CI_2	-	Chlorine
PM	-	Particulate Matter
CO2	-	Carbon Dioxide
CO	-	Carbon Monoxide
NOX	-	Nitrogen Oxides
SO2	-	Sulphur Dioxide
O3	-	Ozone
SMAW	-	Shielded Metal Arc Welding
GMAW	-	Gas Metal Arc Welding
FCAW / MIG	-	Flux Cored Arc Welding
GTAW / TIG	-	Gas Tungsten Arc Gas Welding

GRE	-	Glass Reinforced Epoxy
QFD	-	Quality Function Development
HOQ	-	House Of Quality
PVC	-	Polyvinyl Chloride
AC	-	Alternating Current
L/G	-	Liquid-To-Gas
NDIR	-	Non-Dispersion Infrared
LCD	-	Liquid Crystal Display
RPM	-	Revolutions Per Minute
TDS	-	Total Dissolved Solids
PPM	-	Parts Per Million
EPA	-	Environmental Protection Agency
Q	-	Flow Rate
A	-	Area
V	-	Velocity

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter covers the background of study, problem statement, objectives, and scopes of this project. The chapter overview is also included in this chapter.

1.1 BACKGROUND STUDY

In the process of developing a developed country, the environment is an important element of stable development. Under the Malaysian environmental quality (1974) law, the environment means the physical factors surrounding human life. It includes soil, water, climate, sound, odor, taste, biological factors and social factors that depend on each other, between biological factors and physical factors.

A wet scrubber system is one form of scrubber that is used to take away harmful gases from industrial exhaust gases known as flue gas before they are discharged into the atmosphere. It absolutely was the initial form of cleansing system, and utilizes a wet substance to get rid of acidic gases that contribute to acid precipitation. The scrubber system also uses a water spray system to remove acidic and toxic gases because this water spray can absorb dirty smoke at the same time that it can contribute to acid rain (Bashir, 2014)

When smoke comes in the scrubber. The first process of the smoke will be sprayed by water and the clean smoke will rise up and be released. When the gas is sprayed with liquids, the heavier contaminants are pulled out of the gas and attached to the liquid due to its

chemical composition. The chemicals can be used together with water. These chemicals are specifically selected to react with certain air pollutants-typically acidic gas. Burning exhaust gas may contain substances that are considered harmful to the environment, and the cleaner can remove or neutralize it. Wet scrubber system are used to clean air, fuel gas or other gases from a variety of contaminants and dust particles such as sulfur dioxide (SO_2) and chlorine (CI_2) (Thipichpon, 2016)

1.2 PROBLEM STATEMENT

The Industry welding grows quickly and rapidly from year to year. Technological advances are increasingly sophisticated but many ignore the responsibility to safeguard the environment, which will affect both human health and the environment. The environment will be affected if this air pollution problem is not controlled by every industry or plant. Industry that liberates and emits polluted smoke into the air due to burning and also the process of producing a product will cause air pollution. To solve this problem, we need to generate a device that can take care and protect the environment from being affected as a result of smoke and contaminated material and control which greatly reduced the contaminated air during welding work and boost the productivity of the factory. Most welding procedures, by their task mode and the mechanical hardware utilized, majorly affect nature and contamination is not at all insignificant (Popovic, 2014)

1.3 OBJECTIVES OF THE PROJECT

The aim of this study is to improve the production of scrubber system for environment especially health of welder and to take care and make sure to be safe from

fumes and gases during the process of welding operation. Therefore, the objectives of this project are:

1. To design a prototype of scrubber system for the treatment of welding fume during the process or operation and releasing the clean gases to the environment.
2. To design a scrubber system using the CATIA V5R21 software and chose the right dimension for this design.

1.4 SCOPE OF RESEARCH WORK

This research aim is a study in production of design of scrubber system for treatment of welding fume. To obtain the research objective, three elements have been identified to be studied in this experiment. The three elements are:

I. To design a tool that can absorb welding fume that is harmful to human health.
II. To study and read research literature on how to solve environmental pollution problems that have taken place.
III. This machine will be attached with some mechanism like Motor, Smoke Extractor Fan, filter and switch.

1.5 ORGANIZATION OF REPORT

The report is divided into several chapters and these chapters will explain about the information of the study. The organization of this report will be as follows; Chapter 1, the Introduction covers the project introduction, objective of the project, problem statement, and scope of study and brief description of the methodology. Next comes, Chapter 2, the Literature Review that covers the scrubber system process. Chapter 3 is about Methodology where it touches on method that is used including the design of the system. Then, Chapter 4 will tell

about the result and discussion obtained along the study. Finally, Chapter 5 includes the conclusion and recommendation for this project.

CHAPTER 2

LITERATURE REVIEW

2.0 LITERATURE REVIEW

This chapter contains the literature review that based on the objectives and scope of the project. This chapter is conducted in order to complete this research. This chapter contains welding process, scrubber process, fumes and gases management process, design optimization, piping system, electric application and the component of scrubber system.

2.1 THE SCRUBBER SYSTEM PROCESS.

Scrubber system is a tool that is used to filter and absorb the contaminated smoke caused by several factors, namely combustion, exhaust fumes from the plant, welding fumes, smoke from the vehicles, and many others. This scrubber system uses clean water drainage to trap and absorb the contaminated gases. The Government has set the rules and laws that must be followed by every industry. As an alternative or a way to preserve the environment from pollution is caused by the emancipation of pollution of smoke. Among the tools that can be used to clean the contaminated smoke is a wet scrubber system. It can reduce the toxic gases such as sulfur dioxide and chore through the exhaust drainage (Thipichpon, 2016)

2.2 SCRUBBER TYPE

There are a number of different types of scrubbers which vary in terms of both function and performance.

2.2.1 SPRAY TOWER

The simplest and most commonly used scrubber type is the type of spray tower. The nozzle spray will connect the liquid spray on the upper space where the liquid will be applied to the incoming gases. This type of scrubber can be mounted vertically or horizontally. Figure 2.1 shows the flow of incoming gas from the bottom space and will flow upwards. Water spray down from the nozzle attached to the center of the tower (Mussatti, 2002)

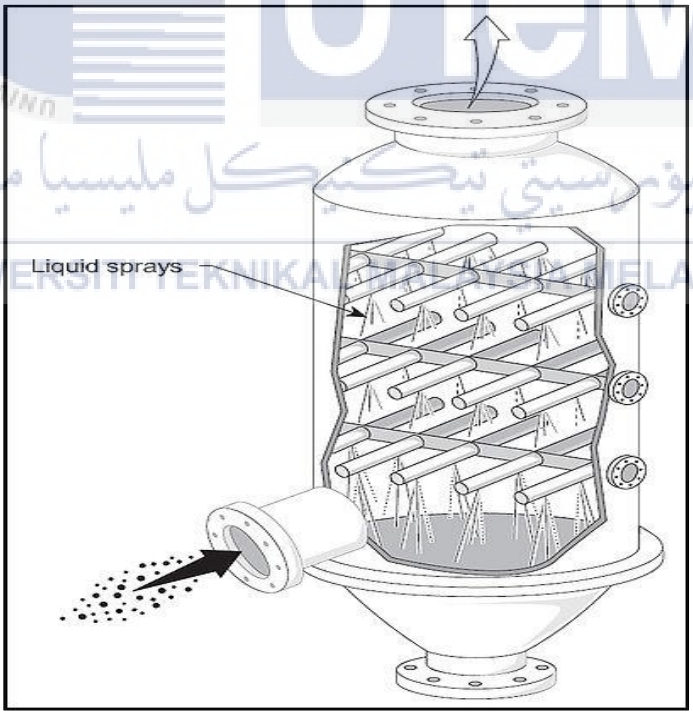


Figure 2.1: The Spray Tower Scrubber

Based on literature review, It can conclude is that this type of spray tower works very well because the air or dirty smoke coming in will be sprayed with water through the nozzle head. With that strong water pressure will be more effective to clear the smoke. Such a design, dirty smoke will be difficult to be released through exhaust scrubber system, thus mostly it would be scrubbed in the scrubbing chamber.

2.2.2 VENTURI SCRUBBER

Water is included with low pressure into the venturi where the gas stream passes at high velocity. The energy of the gas atomizes the liquid, which allows the particles and pollutants to be inserted into the drip. Venturi scrub has high accumulation efficiency for particle pollution and is easy to install and maintain. Venturi scrubbers are more costly than shower tower (Mussatti, 2002)

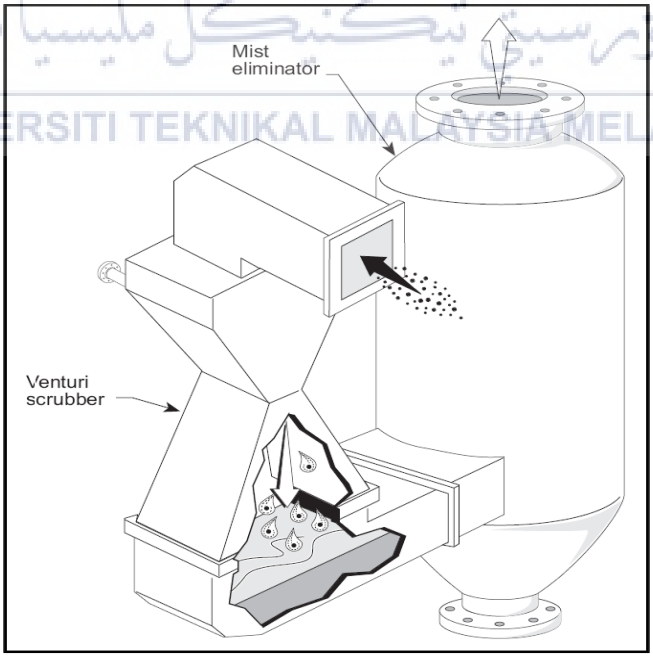


Figure 2.2: Schematic of Typical Scrubber System

2.3 GAS PARTICLE SEPARATION

Wet scrubber system has been used for the control of gas and particulate matter (PM) emission from production industries. They can collect flammable and explosive particle matter (PM) contaminant safely, absorb gaseous pollutant and can remove odor. Gas and particle separation in wet scrubber system is a process by which a polluted particle contained in particulate matter (PM) is carried upward by the gas stream and the particles collide with liquid droplets formed by atomization of a spray nozzle situated across the flow passage. In addition, operation of welding can generate fumes to surrounding such as gaseous pollutants include carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ozone (O_3) (Popovic, 2014)

2.4 DESIGN SCRUBBER SYSTEM

Based on the research, scrubber system properties need to be taken into consideration especially with the cost of installing the scrubber system. The components in the scrubber need to be selected correctly to get the scrubber's performance properly and perfectly. In addition, to make it easier for users to use scrubber design systems, flexibility should be taken into account. At the same time, with a flexible scrubber system can facilitate replacement of components in the scrubber system. Furthermore, a mechanical system is used to trap heavy loads before the input into the scrubber (Kashdan, 1981)

2.4.1 COST

Wet scrubber system design is described. The design of the scrubber system has been widely used in every industry. Almost every major type of air pollution in the industry has been controlled by the scrubber system. Scrubber system also has a lot of advantages that one of them, is that if we compare between all types of air pollution control equipment. Scrubber system is the smallest investment for the construction costs of pollution control system. In addition, the cost is cheap indeed be an option for every industry (Steiner, 1977)

2.5 WELDING PROCESS

The applicant concerned with welding smoke. Welding smoke is a smoke that contains chemicals that are harmful to both human health and the environment. The mixed particles will form harmful smoke. There are several types of welding commonly used in every industry or individual such as Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW / MIG), Flux Cored Arc Welding (FCAW) and Gas Tungsten Arc Gas Welding (GTAW / TIG). The difference between the smokes generated by each type of welding varies. The welding fume generated through welding activity affords great potential as an environmental and pollution impact. In addition, welding smoke can also cause problems to humans for example metal fume fever, to long-term lung damage and neurological disorders, such as lung cancer and Parkinson's disease (Popovic, 2014)

2.5.1 SHIELDED METAL ARC WELDING

Shielded Metal Arc Welding (SMAW) or Stick welding is a process which melts and joins metals by heating them with an arc between a coated metal electrode and the work piece. When the electrode is moved along the work piece at the correct speed the metal deposits in a uniform layer called a bead (Popovic, 2014)

2.6 COMPONENT OF SCRUBBER SYSTEM

2.6.1 THE MIST ELIMINATORS

Mist eliminators are used to remove liquid from various gas streams and are found regularly in cooling towers, ventilation systems and air scrubbers. They work from changing the direction of the gas flow and centrifugal force to various filters. Mist eliminators are primarily used for the following:

a) Improve product purity (process gas cleaning)

b) Prevent air pollution (exhaust gas cleaning)

c) Prevent downstream corrosion & eliminate contamination

Figure 2.3: Mist Eliminators

Mist elimination is a requirement for each scrubber system. Mist eliminators remove scrubber-liquid droplets in the flue gas and return the liquid to the scrubber. Poor mist elimination, an all too common problem, may have serious consequences, including downstream corrosion, increased loading of particle outlets, increased power requirements for reheat, and increased reheat. Horizontal gas flow mist eliminators have solely recently been employed in this country, though they're common in Japan and Germany. This kind of mist eliminator has higher voidance than vertical flow varieties, however area necessities area unit larger. (Kashdan, 1981)

2.6.2 ELECTRIC APPLICATION

Electric will be used in the system to run the process filter smoke or fumes into the scrubber system by using Smoke Extractor Fan. It is more practical and save cost in term of equipment and tools, workspace and works humanity. In addition, scrubber system must use the two switches for open and off operation scrubber system such as at the inlet fume from the welding process.

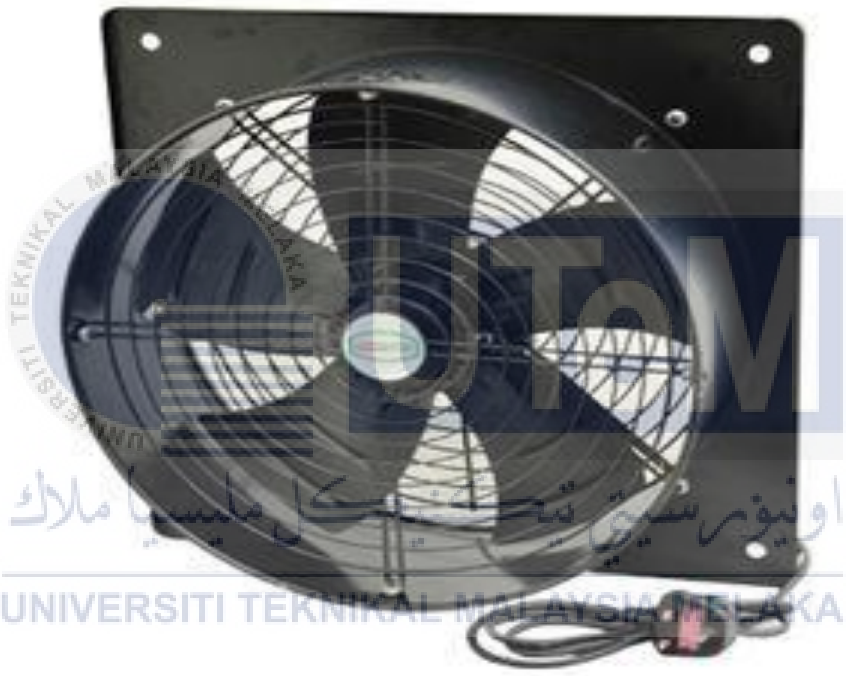


Figure 2.4: Smoke Extractor Fan

2.6.3 WATER FILTER PROCESS

The scrubber system usually uses recycled water to avoid wastage and to save operating costs. Contaminated water due to the chemical mixture in the scrubber system will be filtered before reuse. This water will be filtered using beach sand. This is very effective to isolate the chemicals in the water for reuse. For the care of the performance of this scrubber

system and as a clean beach sand maintenance will be replaced when chemicals are attached to the old sandy beach.

Water filter is one of the most enjoyable in the scrubber system. Water filters using to filter different foreign particles that may be contained in them because the water has been mixed with foreign material into the scrubber system during process. Water filtration using water filters is, of course, aimed at filtering water to separate harmful substance sand other particles from water. Water will be cleaner and healthier in the scrubber system for reuse. One of the water filter materials that are often used in filtering water is sand. Several studies have shown that good removal efficiency is achieved by sand filters (Nico, 2015)

Figure 2.5: Beach Sand

2.7 PIPING SYSTEM

Drainage for water entry in the scrubber using clean water. Clean water or sources of tap water will be discharged to the nozzle head. The nozzle head has 3 parts to spray on a dirty smoke. The pump system will be used to supply a strong water pressure. Whereas the water mixed with dirty material will fall down. Scrubber system at the bottom has a water filter and the clean water will be reused and will be pumped again to bring the water to the spray nozzle.

The water that flows out of the scrubbers is acidic and corrosive materials therefore special pipe materials are required. Similar to inert gas coolant on tanker, pipe steel with polyethylene or rubber coating can be used. Alternatively, the approved GRE pipe has been made known to perform satisfactorily. Valves should be lined with butterfly type or stainless steel suitable grade steel. In closed loop systems, washing water will be considered corrosive to the point where the water contains alkali material and the pH is increased.

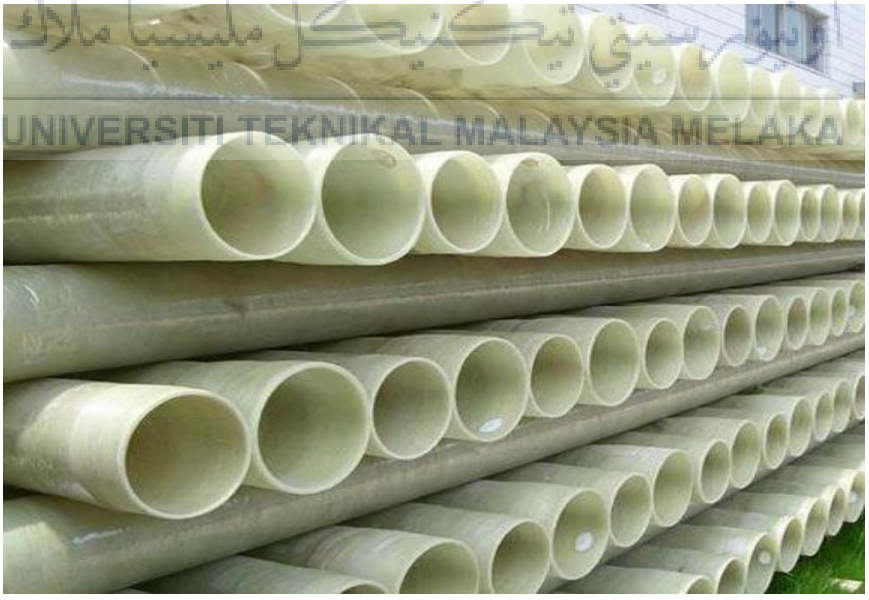


Figure 2.6: GRE Pipe

Based on literature review, it can be concluded is that the choice of suitable pipes is important to ensure that every drain works well and will not have any problems in the future. The rubber pipe that is suitable for use in this scrubber system. This is because the rubber pipe can withstand the acidic corrosion.

2.8 MESH PAD SEPARATORS

Wire or plastic is used in another design to form mesh pads (Figure 2.7). These separators are about 10 to 15 cm (4 to 6 in.) thick and fit across the scrubber's entire diameter. The mesh allows droplets to affect the surface of the material, to agglomerate with other droplets, and to drain by gravity. The pad is usually slanted to allow the liquid to drain off (no more than a few degrees). With pressure drops of approximately 1.0 to 15 cm (0.5 to 6 in.) of water, the collection of droplets larger than 3 μm is better than 95 percent. (The drop in pressure depends on the fiber depth and compaction). The disadvantage of mesh pads is that they are subject to plugging in their small passages. Some trapped material can be removed by periodically spraying pads from both below and above.

Figure 2.7: Mesh Pad Separators

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes about the investigation method that is used to achieve the objectives. Among the methods used to determine the perfect design scrubber system. Identify problems, literature reviews, concept designs, materials used, Morphological charts, sketching design and flow charts are included in this chapter. Designing requires a structured process flow to come out with a good product in the end. Next, the planning process starts with market outlook, and then the use of Quality Function Development (QFD). This report requires that we use House of Quality (HOQ) where it is a key tool for QFD, this method to simplify translation of customer requirements into engineering specifications. The selection of materials and tools used to carry out this project should also be assessed accurately to ensure the project runs smoothly and perfectly. Last but not list, the design for scrubber system to treatment the welding gases by using software before to fabricate.

3.2 FLOW CHAT

Flow chart is used to show on how the progress of the project has been done from the beginning until finishing. This in to make sure the work has been done smoothly by the following the true path.

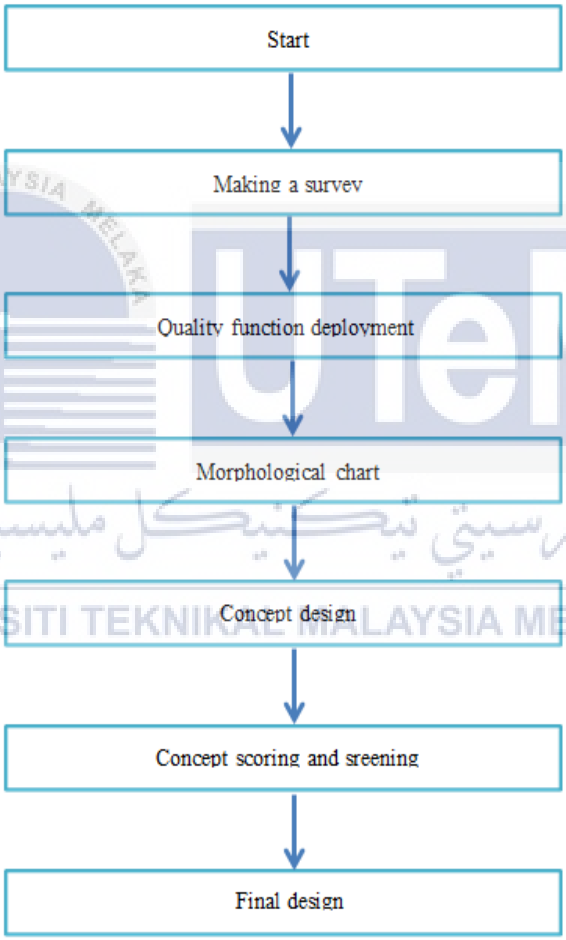


Figure 3.1 Flow Chart (i)

…continuation

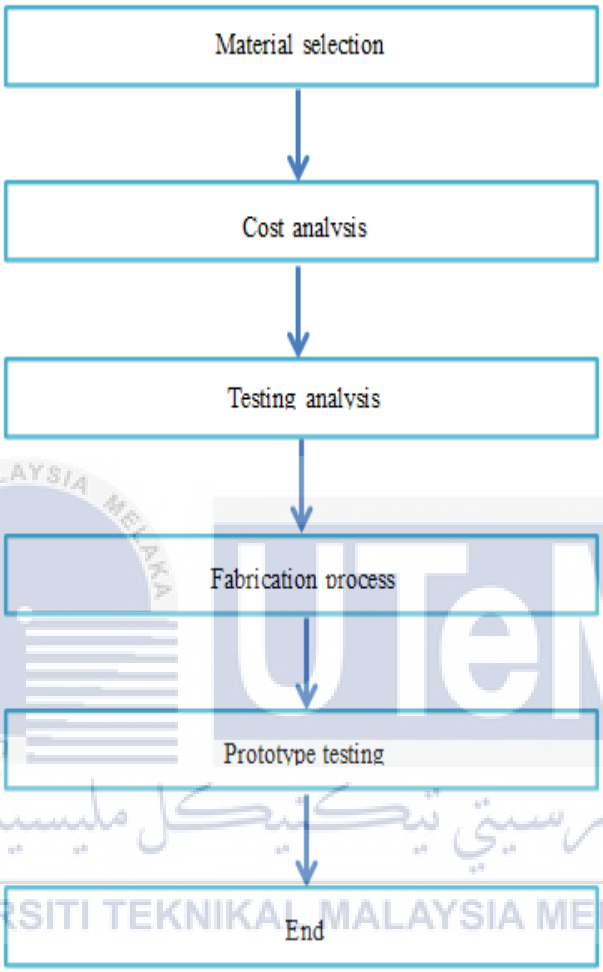


Figure 3.2: Flow Chart (ii)

3.3 GANTT CHART

Activities	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Brainstorming and select the title																
Meeting with supervisor																
Chapter 1:Identify introduction, problem statement, objectives and scope																
Chapter 2: Literature review																
Submission progress report 1																
Chapter 3: Methodology																
Reference and formatting																
Submission of general conduct form and logbook to supervisor																
Submission of PSM 1 reports to supervisor and examiners (Draft Final Report)																
Poster presentation																
Seminar PSM 1																

Figure 3.3: Gantt chart of PSM I

The Gantt chart is used to demonstrate the tasks to be performed to implement a project at a predetermined time. Gantt chat needs to be made before doing a project. Gantt chat is very important to know the progress of a project that has been set up such as the start of the task and also the time limit used to complete the task. All activities that have been done follow the Gantt chart. The project started from week 1 semester 1 2018/2019 where student met the supervisor and supervisor explain about the project title. At week 3, it started with chapter 1 where it about identifying the introduction, problem statement, objective and scope. The period to complete chapter 1 is two weeks. Chapter 2 starts after chapter 1 is finished at week

five. In chapter 2, it told about literature review related with the project title. The duration to complete chapter 2 is 3 weeks. Next chapter 3 is methodology. Chapter 3 aims are to identify the methods to produce new products. Prof. Madya Ir. Dr. Abdul Talib Bin Din had briefing about the project that will be going to do for this whole semester.

3.4 MAKING A SURVEY

The Survey method is the technique of gathering data by asking questions to people who are thought to have desired information. A formal list of questionnaire is prepared. Generally a non-disguised approach is used. The respondents are asked questions on their demographic interest opinion. The survey is very important to know what the customer really want before the product is produced. Survey method is also the first step to get information about the product to be produced according to the costumer requirement. Survey method can be broadly divided into three categories such as mail survey, telephone survey, and personal interview. To create the survey method by using telephone survey there are 11 questions that have been made regarding the concept design scrubber system. A total of 20 responses have been answered by this question. With the results obtained it can be a guide to produce a better product. In addition, this survey has been answered by most of the student's faculty of mechanical engineering and faculty of engineering technology which are more vulnerable to welding machines as they learn.

3.4.1 SURVEY QUESTION

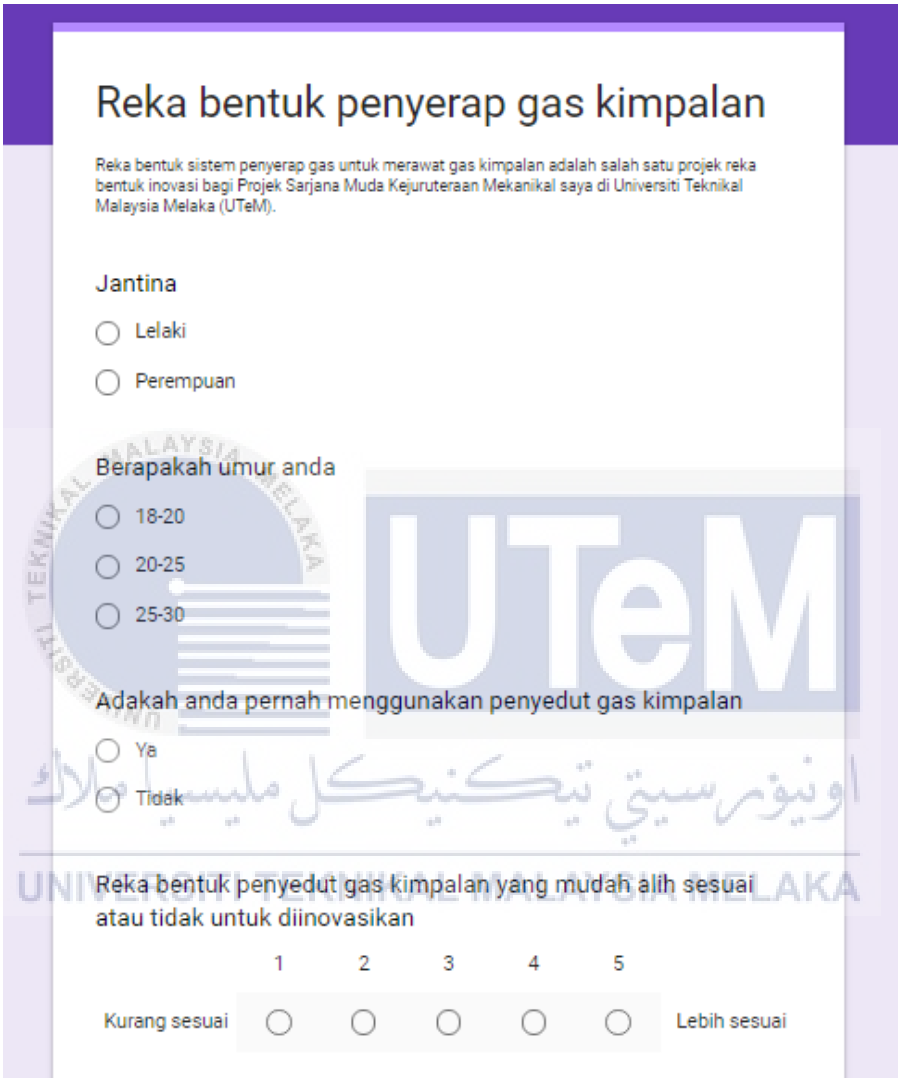


Figure 3.4: Survey Question 1

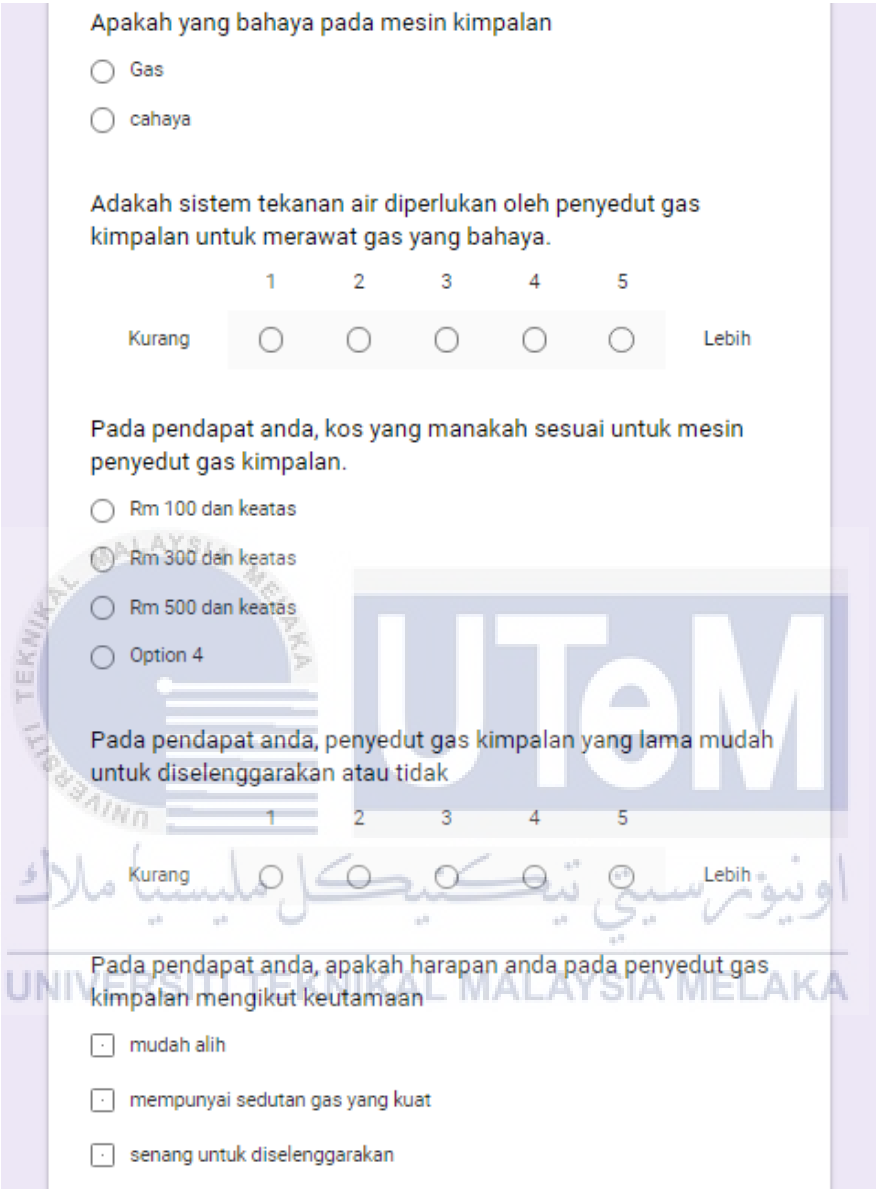


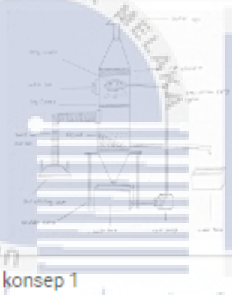
Figure 3.5: Survey Question 2

Pada pendapat anda, penyedut gas yang bagaimana yang anda perlukan untuk kegunaan anda mengikut keutamaan

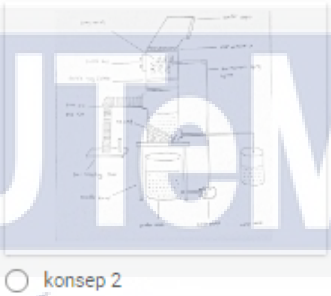
1 = kurang setuju 5 = sangat setuju

	1	2	3	4	5
mudah untuk digunakan	○	○	○	○	○
reka bentuk yang menarik	○	○	○	○	○
tidak bahaya kepada pengguna	○	○	○	○	○
penyedut yang tahan lebih lama	○	○	○	○	○

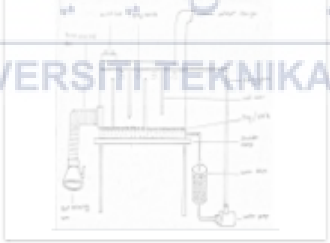
Berdasarkan pemerhatian anda konsep yang manakah lebih sesuai untuk dipilih



○ konsep 1



○ konsep 2

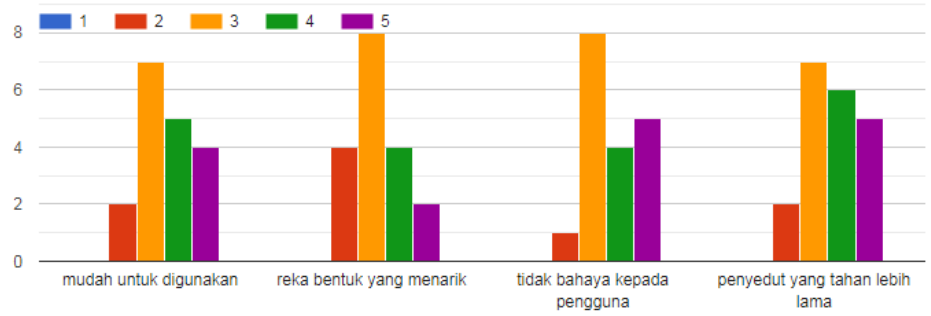


○ konsep 3

Figure 3.6: Survey Question 3

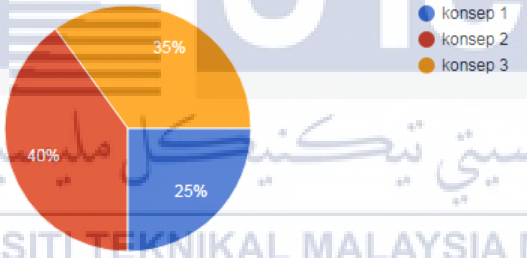
3.4.2 SURVEY RESPONSES

Pada pendapat anda, penyedut gas yang bagaimana yang anda perlukan untuk kegunaan anda mengikut keutamaan



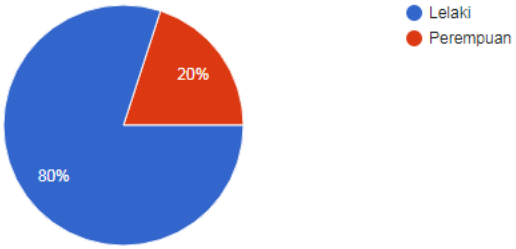
Berdasarkan pemerhatian anda konsep yang manakah lebih sesuai untuk dipilih

20 responses



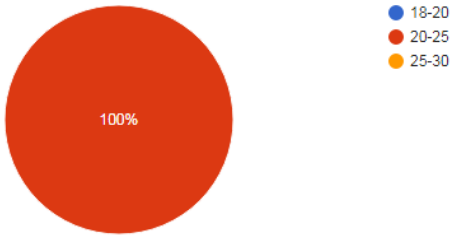
Jantina

20 responses



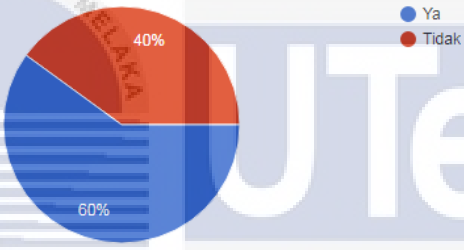
Berapakah umur anda

20 responses



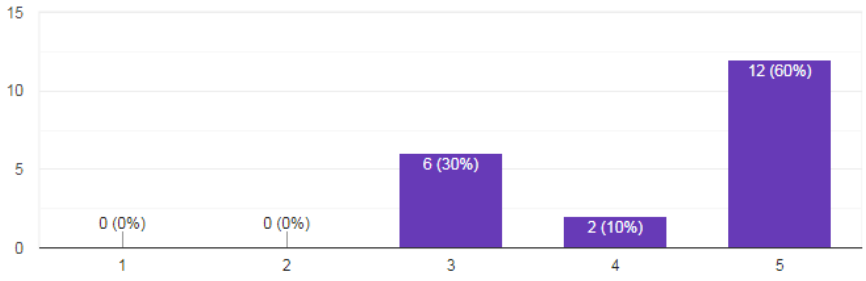
Adakah anda pernah menggunakan penyedut gas kimpalan

20 responses



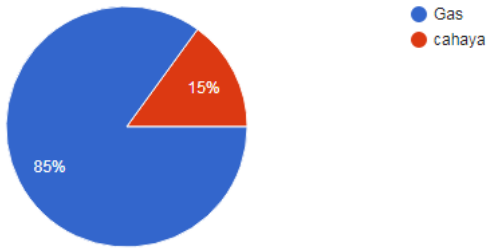
Reka bentuk penyedut gas kimpalan yang mudah alih sesuai atau tidak untuk diinovasikan

20 responses



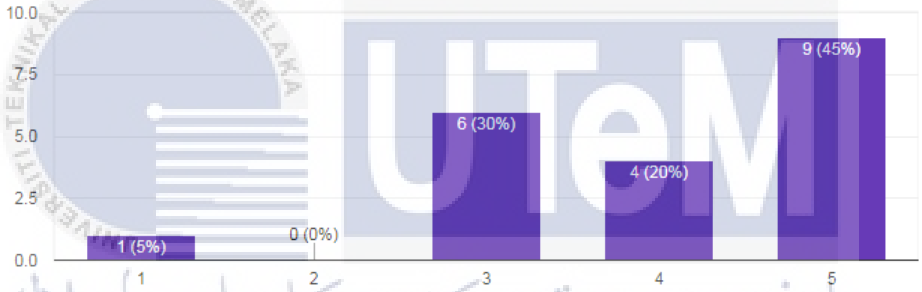
Apakah yang bahaya pada mesin kimpalan

20 responses



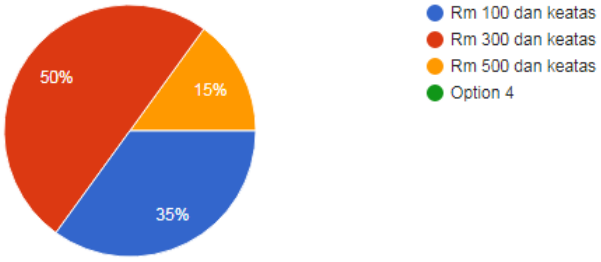
Adakah sistem tekanan air diperlukan oleh penyedut gas kimpalan untuk merawat gas yang bahaya.

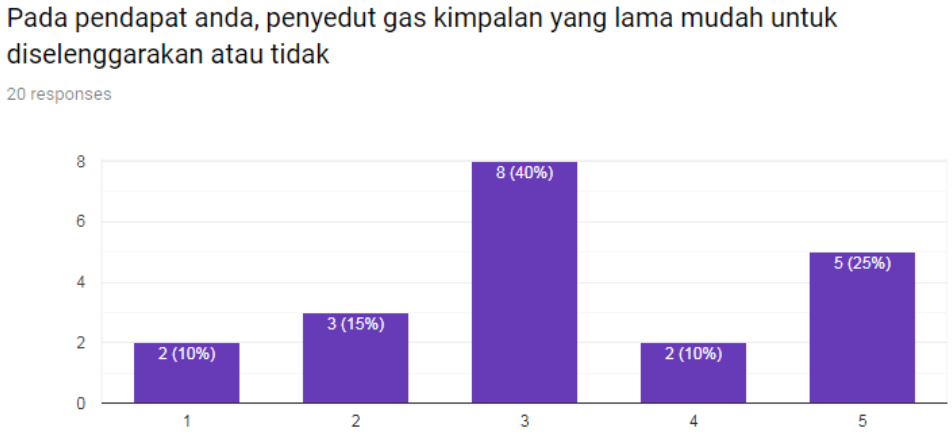
20 responses



Pada pendapat anda, kos yang manakah sesuai untuk mesin penyedut gas kimpalan.

20 responses





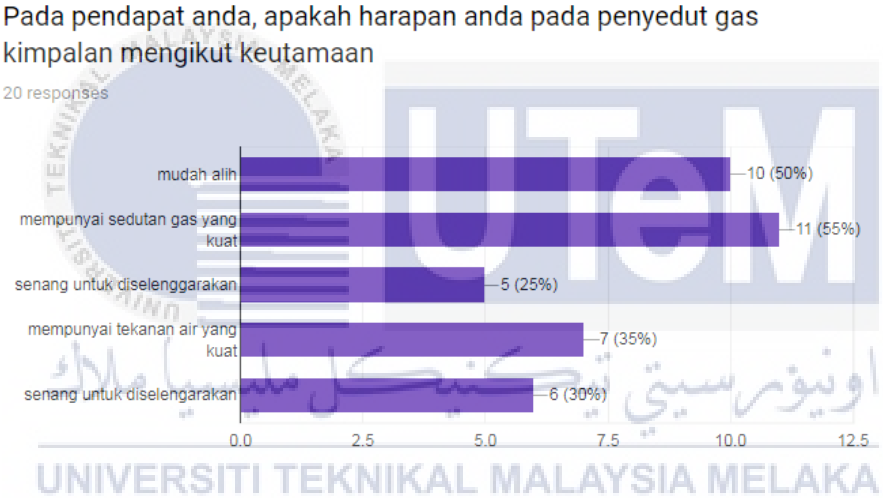


Figure 3.7: Survey Responses

3.5 HOUSE OF QUALITY

The House of Quality (HOQ) is a central tool of Quality Function Deployment (QFD). The main function is to translate customer requirements, market research and benchmarking data into prioritized engineering targets to be met by a new product design. There are several important element sections in HOQ that should be concern which is relating the customer requirements with engineering characteristics. Customer requirements can be obtained from survey form analysis. There are 8 requirements from customers which are simple operation, high durability, corrosion resistant, easy to maintenance, portable capability, easy to handling, clean water efficiency and cost effective.

○	9	Strong relationship
□	3	Medium relationship
Δ	1	Weak relationship

PROJECT TITLE: DESIGN OF SCRUBBER SYSTEM FOR TREATMENT OF WELDING GASES

DIRECTION OF IMPROVEMENTS										
ENGINEERING CHARACTERISTICS / CUSTOMER REQUIREMENTS	CUSTOMER IMPORTANCE	weigh	material	size	leaking	switching mechanisms	rotation speed fan	piping system	high presure water pump	
simple operation	4	3		3	1	3		9		
high durability	4		9					3	9	
corrosion resistant	3		9					3	1	
easy to maintanance	3	9	1	3	3			3		
portable capability	5	3		3						
easy to handling	3	1		1	9	1				
clean water efficiency	4	1	9	3	9			3		
cost effective	3	3	9	3	1	1	9	9	9	
TECHNICAL PRIORITIES (TOTAL)		70.0	129.0	60.0	79.0	18.0	29.0	105.0	66.0	556.0
PERCENTAGE OF TOTAL (%)		12.6	23.2	10.8	14.2	3.2	5.2	18.9	11.9	
RANK ORDER		4	1	6	3	8	7	2	5	

Figure 3.8: Quality Function Deployment

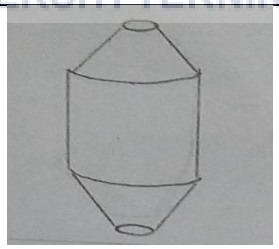
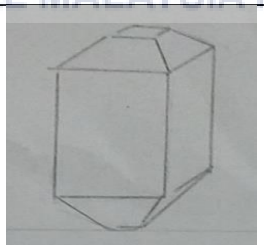
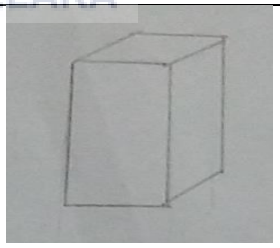
The value of customer importance decided by designer. Designer can determine the value that should be given. The values are 1 to 5 where 1 for the weakest and 5 for the strongest. The relation matrix shows the correlation in the middle box by defining the following values: 9 = very relevant, 3 = relatively relevant, 1 = weak and empty = completely irrelevant. This value is to be determined by the designer regarding the strength of the relationship between each customer requirement and each engineering characteristics

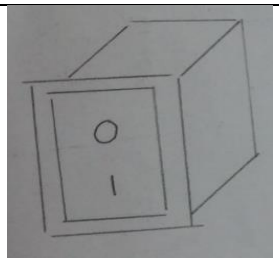
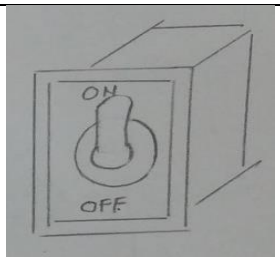
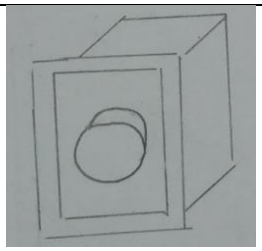
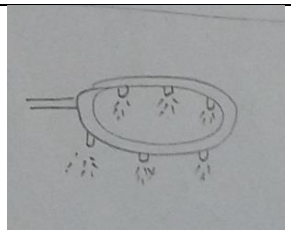
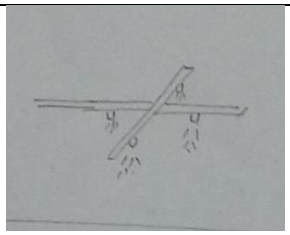
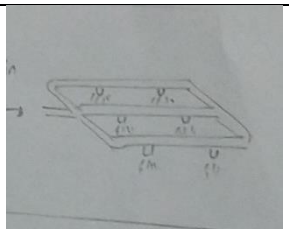
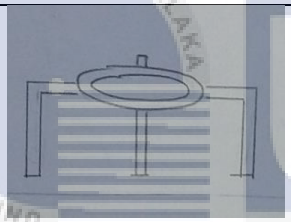
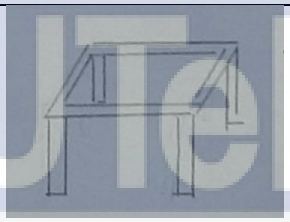
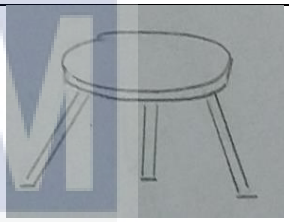
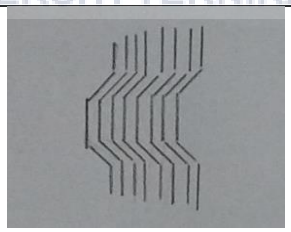
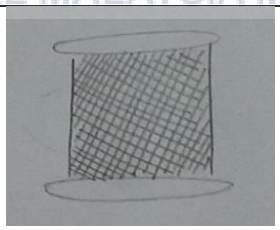
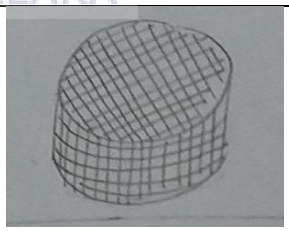
3.6 MORPHOLOGICAL ANALYSIS

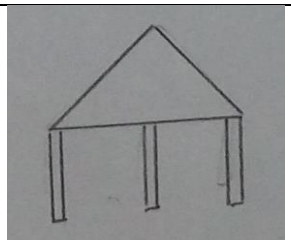
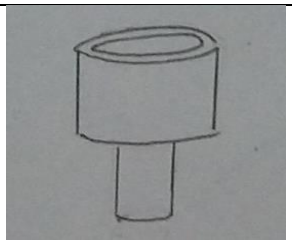
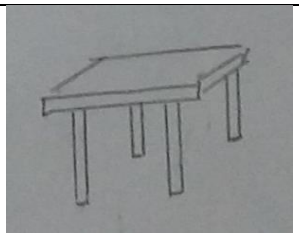
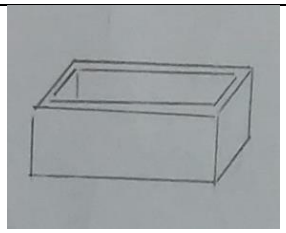
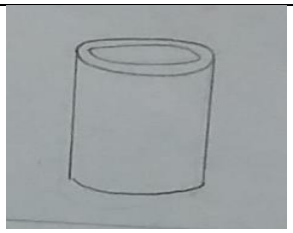
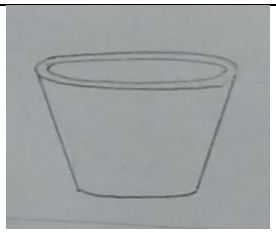
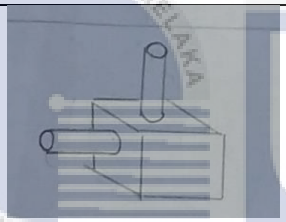
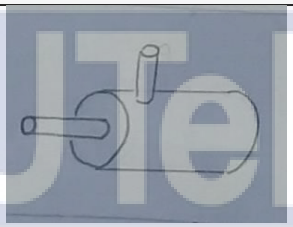
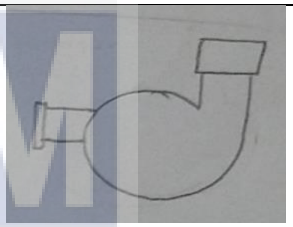
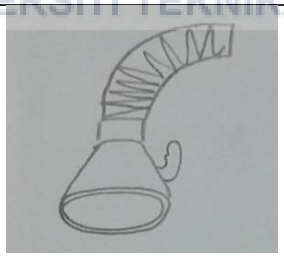
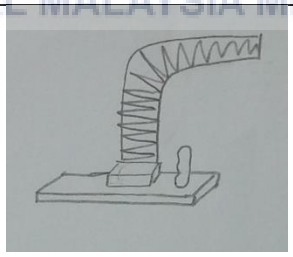
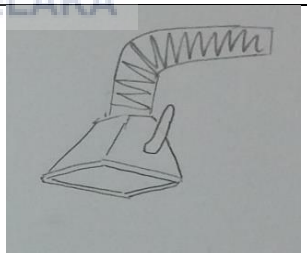
The morphological chart used is to make the selection of the appropriate components and needed by a new product. In addition, morphology is a method of generating ideas in analytical and systematic way. Comparison of concept design is based on several criteria of weights such as cost, strength, endurance, friendly user, environment friendly, communication facilities, and smooth function. There are some scrubber system products available in the market for a new design guide. Each of the existing designs has been incorporated into the morphological chart to guide the development of new products. The morphological chart is shown in table 3.1

3.6.1 MORPHOLOGICAL CHART

Table 3.1: Morphological Chart

PART	OPTION 1	OPTION 2	OPTION 3
BODY	 Cylinder and cone	 Cube and triangular	 Rectangular

SWITCH	 Rocker	 Toggle	 Pushbutton
MISTING NOZZLE	 Circle nozzle	 Junction nozzle	 Three line nozzle
SCRUBBER STAND	 Combine circle and square	 Square base stand	 Pyramid base stand
MIST ELIMINATOR	 Vane	 Chevron	 Baffle-type

WEATHER CAPS	 Pyramid chimney cap	 Follow chimney cap	 Plate chimney cap
WATER TANK	 Plastic cube tank	 Glass cylinder tank	 Plastic cone tank
WATER PUMP	 Pump aquarium	 Rotary pump	 Centrifugal pumps
FUME ARM	 Single arm portable	 Plat cover fume arm	 Standard fume arm

3.7 DESIGN CONCEPT GENERATION

The design concept is produced by combining the criteria described in the morphological chart. There are 9 components that have been listed to produce new design concepts. Each component in the morphological chart consists of 3 different component options for selection. The function of each component is different. Three conceptual designs have been generated by combining all the criteria in the morphological chart. In produce a new product these three concepts have piping systems for water drainage. The water spray system is preferred in this design concept as small particles can be absorbed by water. The electric system also needs this concept to turn on the motor of fan and motor of water pump. Concept design is a phase in the evolution of product when alternative design concepts are generated, evaluated, and selected for further development. Each concept design should different each other in term of physical, material and geometric. Fan assistance can greatly improve the effectiveness of ducted systems. Generally a small amount of deposition should be expected in ducting systems as the smoke particles are being artificially restricted, and cannot separate and spread out as they would in free air. For best results the ducting should be as short and straight as possible, with as smooth a bore as practical, so that frictional losses within the duct are kept to a minimum. This design concept also takes into account temperature resistance. The gas heat released through the welding process will be cooled by using a water spray system in the scrubber system.

3.7.1 CONCEPT 1

In Design Concept 1, as shown in Figure 3.9, this concept design is taken from wet scrubber type spray tower. Water pressure for this concept cannot be adjusted and it is only restricted to one mode only medium only no high or low. This design has one layer of sieve tray. Sieve tray can be meant as. The sieve tray is a flat perforated metal sheet. The whole diameter from 1.5 to 25 mm is very commonly used. The sieve tray layout is a typical square or equilateral triangular pitch holes. The gas flows upward through the perforation and disperses into the flowing liquid over the plate. There is no liquid seal in case of trays without down comer and the liquid weeps through the holes at low flow rates, reducing the efficiency of plate. For this reason, sieve tray has the lowest turndown ratio. Sieve tray construction is simple and relatively cheap. In addition, this design concept is also more effective in treating dangerous gases. This design has a using good electrical application which is not complicated for apply and install.

3.7.2 CONCEPT 2

In Design Concept 2, as shown in Figure 3.10, the Extractor fan is located on the fume arm suction to make it easier for gases or smoke to go up and into the body scrubber. The design for body scrubber is cylindrical. Inside this cylinder there are two parts of the filter's first filter for the gas and the second filter for the water. This concept uses 8 nozzle misting with nozzle misting this will cause gas welding quickly trapped and is a good preferment. There are two drainage systems, namely drainage for clean water and dirty water drainage. This concept uses a piping system where this piping system will connect three components as

an example of a water tank, water filter and nozzle. This design has two water tanks which are to be used after the spraying process takes place. The first water tank to store clean water and the second water tank to store dirty water from drainage water treatment.

3.7.3 CONCEPT 3

In Design Concept 3, as shown in Figure 3.11, concept design 3 uses a larger rectangular body of space. Larger rooms are more effective in process separation. Dirty water will enter one of the channels located below. This is to facilitate flowing water smoothly and well. The dirty water will then be filtered using fine sand located in the plastic cylinder. This concept has a switch box design located above the body scrubber system to make it easier for users to use it. This concept has design with a rocker switch that is easy to source at low price. This design does not have a water tank. Where the water located in the tank is to be pumped back to the misting nozzle this design is quite simple and easy to understand by both users and customers. In addition, the movement of the incoming smoke in the scrubber is also very good and perfect. This is because, the smoke that comes in the scrubber can move according to the predetermined route. This concept design also has a water filter to treat dirty water. The structure of this design is very simple.

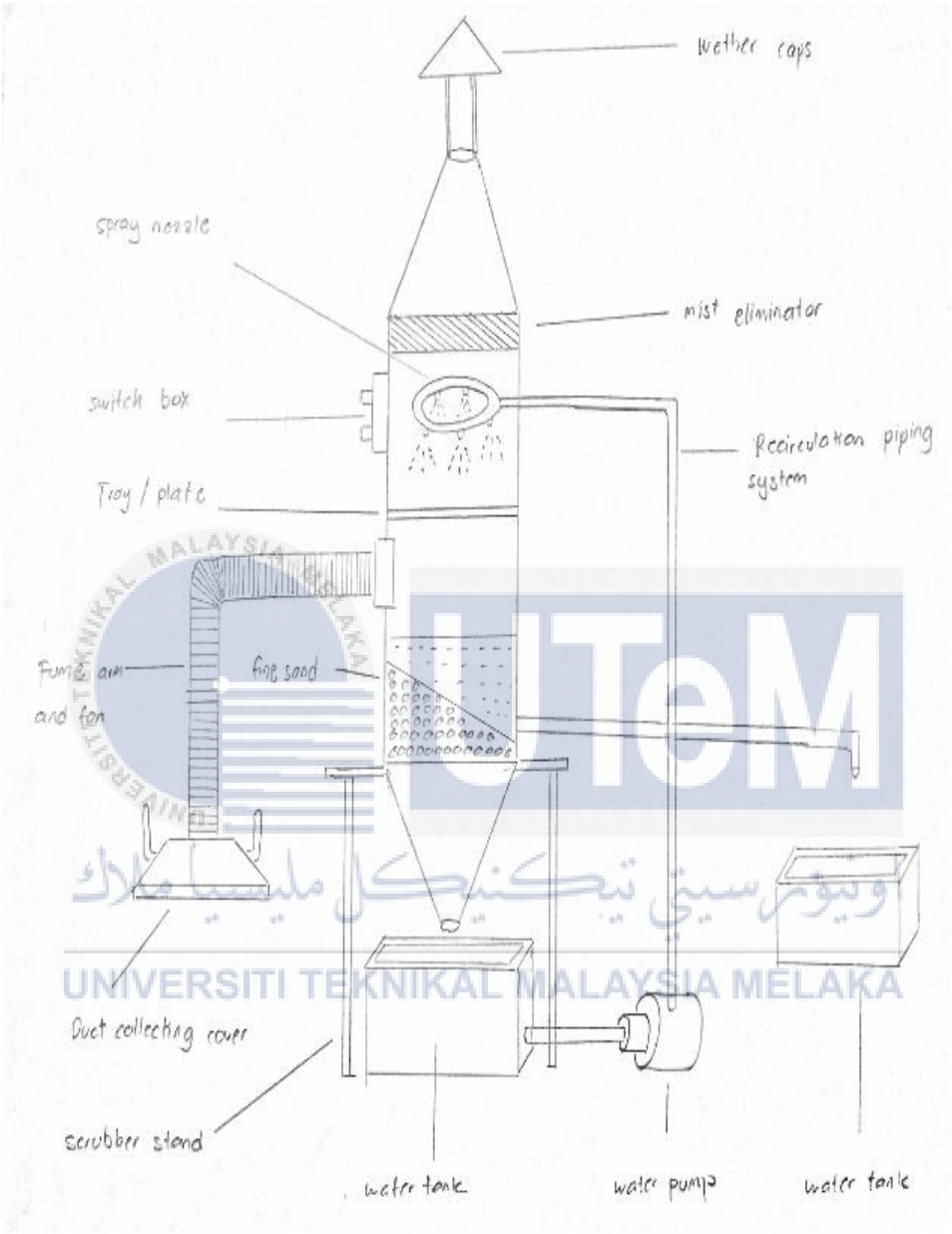


Figure 3.9: Concept Design 1

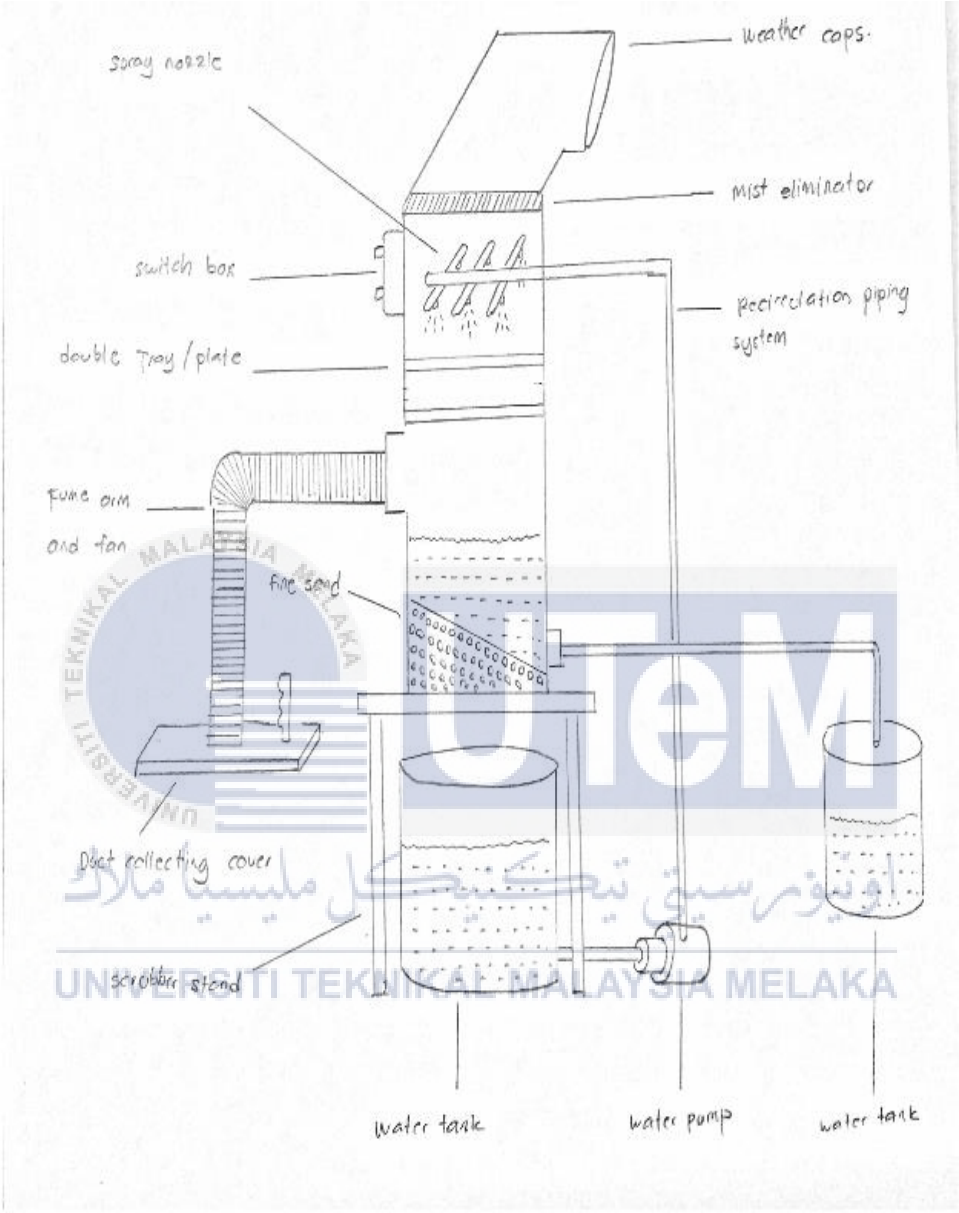


Figure 3.10: Concept Design 2

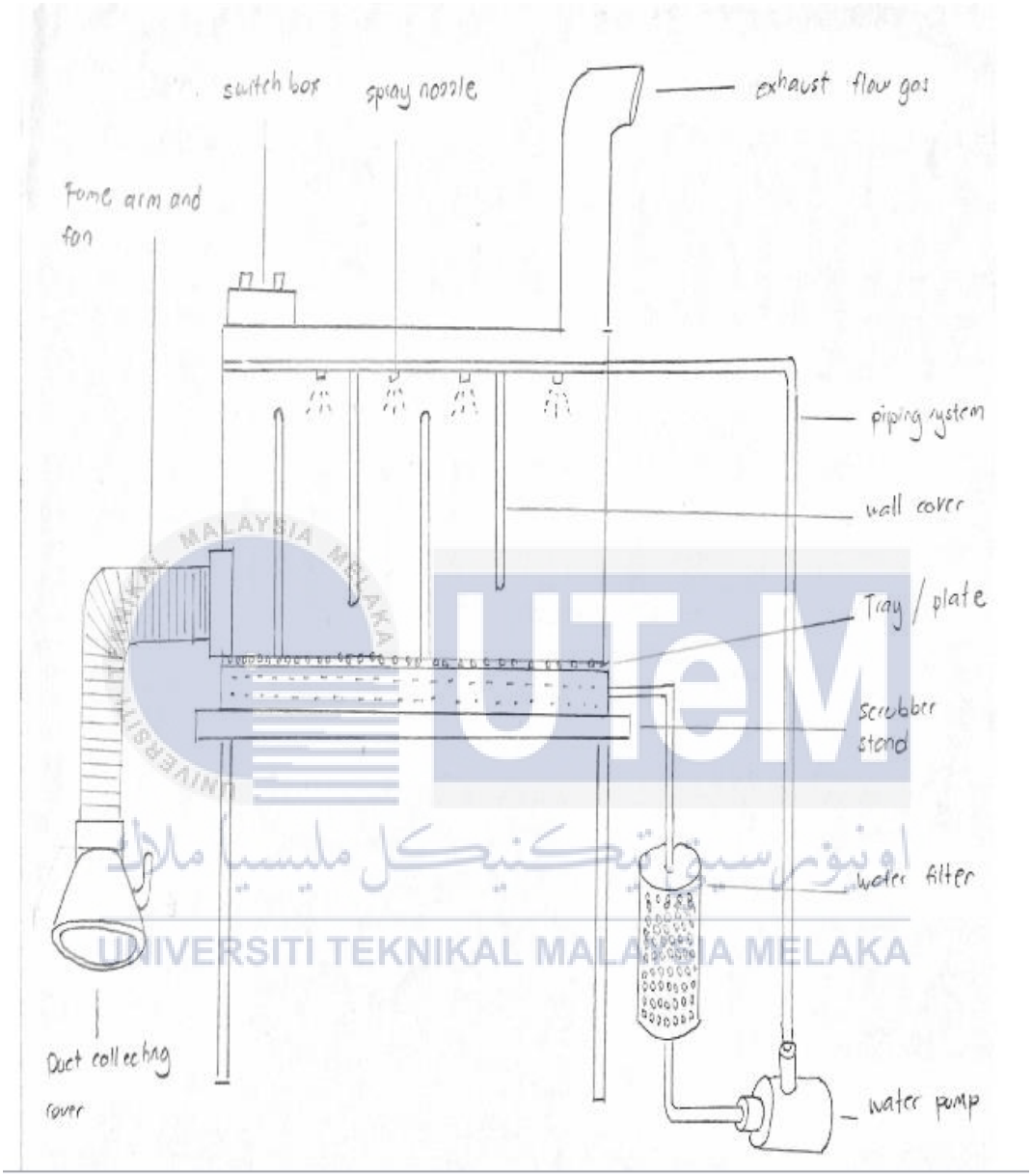


Figure 3.11: Concept Design 3

3.8 CONCEPT SCORING AND SCREENING

3.8.1 CONCEPT SCREENING

Table 3.2: Concept Screening

Selection criteria	Concept		
	1	**2**	**3**
Safety	0	0	+
Easy to maintenance	+	+	+
Easy to handling	+	0	+
Cost effective	0	+	+
Portable capability	-	0	-
Exterior appearance	0	+	+
High pressure water pump	0	+	0
High speed fan	+	+	-
Sum +'s	3	5	5
Sum 0's	4	3	1
Sum –'s	1	0	2
Net score	2	5	3
Rank	3	1	2
Continue?	Revise	Yes	Yes

3.8.2 CONCEPT SCORING

Table 3.3: Concept Scoring

Selection criteria	Weight	Concept					
		1		2		3	
		Rating	Weight	Rating	Weight	Rating	Weight
Safety	10 %	2	0.20	3	0.30	4	0.40
Easy to maintenance	15 %	3	0.45	4	0.60	3	0.45
Easy to handling	20 %	4	0.80	4	0.80	4	0.80
Cost effective	15 %	3	0.45	4	0.60	3	0.45
Portable capability	5 %	3	0.15	5	0.25	4	0.20
Exterior appearance	5 %	4	0.20	5	0.25	3	0.15
High pressure water pump	15 %	4	0.60	4	0.60	4	0.60
High speed fan	15%	4	0.60	5	0.75	4	0.60
Total score		3.45		4.15		3.65	
Rank		3		1		2	
Continue ?		No		Develop		No	

3.9 FINAL DESIGN SELECTION

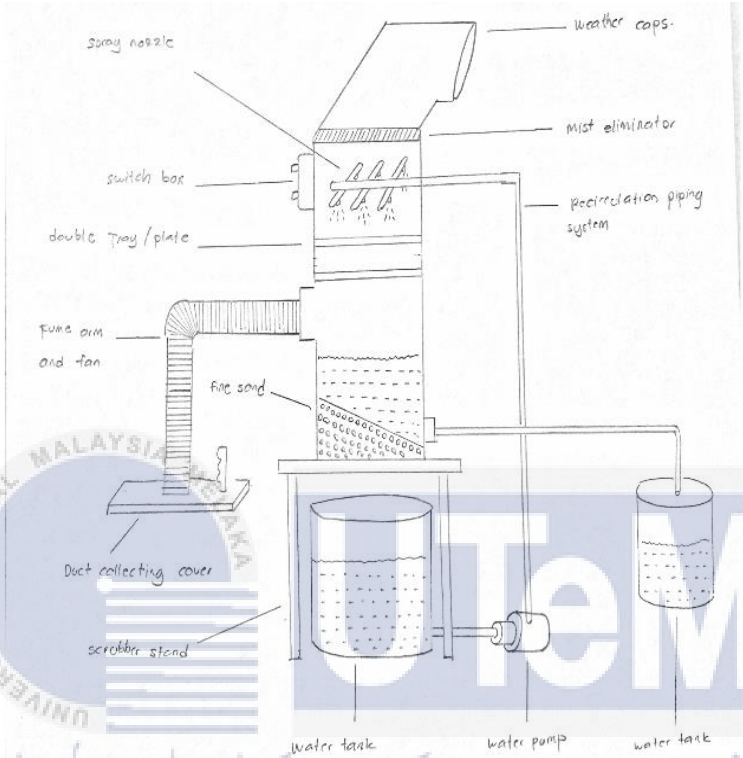


Figure 3.12: Final Design Selection

Based on the screening concept selection method for the evaluation, the best concept design for the scrubber system is Concept Design 2 having the highest final score as shown in the table above. In the process of selecting the final design concept the concept screening and the concept scoring has been used. There are some important criteria that have been suggested to make comparisons between existing design concepts. Comparison of the criteria based on the criterion included safety, easy maintenance, easy to use, affordable, portable, exterior appearance, high pressure water pump, and high speed fan. In the scoring concept design

concept 2 has a higher total score of 4.15 compared to other concept designs. Therefore, concept 2 design is an option to generate. In conclusion, concept design 2 is much promising and reliable to solve the initial problem. Therefore, concept design 2 is chosen as the final design for the further discussion in this final year project.

3.10 MATERIAL COST

Table 3.4: Material Cost

COMPONENTS	UNIT	COST (RM)
Water pump / pump aquarium	1	50.00
Fume extractor fan	1	40.00
Mist eliminator	1	20.00
Water quality tester	1	24.00
Water tank	2	22.00
Cable wire electric (1 meter)	1	5.00
PVC pipe (piping)	2	20.00
Mild steel hollow (stand)	1	35.00
Switch (on/off)	1	15.00
Aluminum plate	1	30.00
Tray /plate (mild steel)	1	25.00
Spray nozzle	5	15.00
Silicone clear	1	7.00
Samurai spray	1	8.00
3 ton steel weld epoxy	1	9.00
Total	1	325

3.11 MANUFACTURING COST

Table 3.5: Manufacturing Cost

Transportation (fuel)	RM 20
Electrode (welding machine)	RM 25
Hot glue gun	RM 10
Screw multi size	RM 10
Wire mesh (fine sand)	RM 5
Grinding Wheel	RM 10
Electric bill	RM 30
total	RM110

CHAPTER 4

FABRICATION PROCESS.

In this chapter, before producing fabrication the concept design that was chosen was made using the CATIA V5R21 software. The actual design is produced using the right dimension and suitable for the scrubber system after completion of the design. In this chapter also contains a fabrication tool, item, and material, component, process fabricate, design parameters, calculation and engineering drawing. The appropriate material for the manufacturer has been selected and listed according to the predefined unit. Results that were obtained from the fabricating of the entire scrubber system.

4.1 FABRICATION TOOL

In order to start fabricating, some tools are required. Several tools are listed in the Table 4.1 as follows:-

Table 4.1: Fabrication Tool

Item	Description
Grinder	The grinder is used to cut the measured mild steel and to clean the surface of the mild steel that has been welded.

Welding	Welding is used to joining both metals that have been cut to produce a scrubber stand.
PVC cutter	A pipe cutter is a type of tool used by plumbers to cut pipe. Besides producing a clean cut, the tool is often a faster, cleaner, and more convenient way of cutting pipe than using a hacksaw, although this depends on the metal of the pipe.
Tape	The tape is used to measurement a tape measure or measuring tape is a flexible ruler and used to measure distance. It consists of a ribbon of cloth, plastic, fiberglass, or metal strip with linear-measurement markings. It is a common measuring tool.

4.2 ITEM AND MATERIAL

Material selection is important to ensure the performance of the product is good and safe to use. In ensuring that a product lasts longer for the use of PVC pipe to avoid corrosion. The materials needed are shown in Table 4.2. Last but not list, to make the real dimension as follows the real size of the steel and other materials to avoid some errors during the fabrication. In order to overcome the errors in fabrication, should more behave during the fabrication process. It is because some of the other products having with such a problem that will be disturbing the final product and will affects the safety factors. So, the best fabrication will be produced as the best real product as follows the compulsory of requirements.

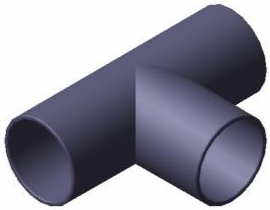
Table 4.2: Item And Material

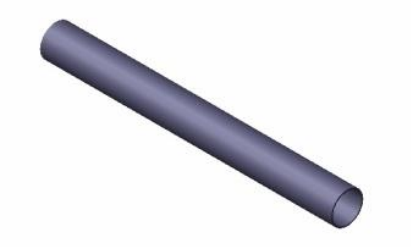
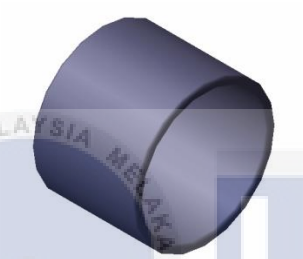
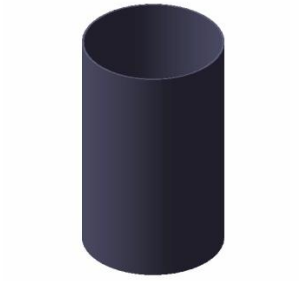
Items.	Measurements/Quantity.
PVC pipe (6 inch).	3.0 meter.
PVC pipe (1 inch).	1.8 meter.
PVC pipe (1 inch).	2.0 meter.
PVC pipe (1 inch).	3.0 meter.
PVC 90 degree elbow (1 inch).	1 unit.
PVC T-joint (1 inch).	3 unit.
PVC cap pipe stopper (1 inch).	4 unit.
PVC Ball Valve	1 unit.

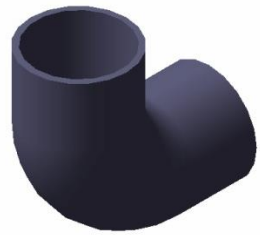
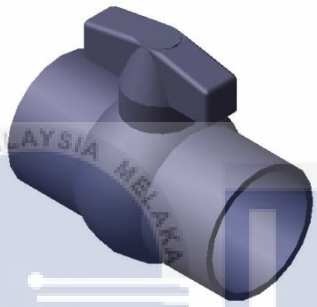
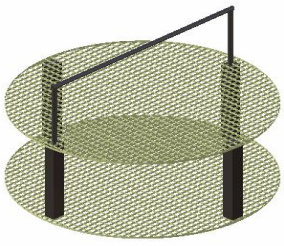
4.3 COMPONENT

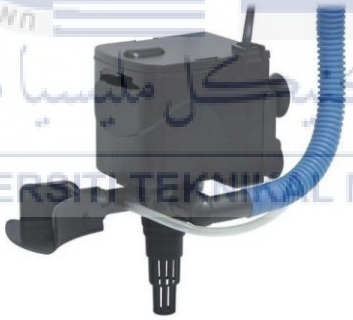
Each part of the scrubber system has its own functionality. In this table 4.3, each section will be described one by one in respect of material, size, shape, length, and weight. Each section has different materials of use to ensure that the scrubber system is easily maintained. There is material that can prevent the occurrence of corrosion, for example, aluminum, plastic, PVC and rubber.

Table 4.3: Component

Name	Component	Description
Assembly view		This is an overview of the scrubber system after produced. The air and welding fumes will enter through the top of the turn will come out through the bottom. The smoke and water mixed in the middle of the scrubber system.
Scrubber tank		The scrubber tank is the main part of the smoke collected. Material scrubber tank is aluminum.
PVC tee join		PVC tees are three-end fitting two in a straight line and one on the side at an angle of 90 degrees. Tees allow a line to be divided into two separate lines with a connection of 90 degrees. Tees can also connect two lines in one main line. They are also frequently used in PVC structures

PVC pipe		In this scrubber system, the PVC pipe is used for the flow of water into the Scrubber tank. High water pressure flow through this PVC pipe. This PVC pipe has a diameter of 22 mm in diameter and 180 mm in length.
PVC cap pipe stopper		Cap pipe stopper used to stop the water flow to flow into the spray nozzle.
Stand and gas outlet		The stand and outlet gases is a bottom that serves to provide a support scrubber tank and also drain dirty water and air. The stand material is mild steel. using a square hollow with a size of 50x25 meters.
PVC pipe 6 inch		PVC pipe 6 inches is used to receiving from welding gases.

PVC elbow		PVC pipes are connected to PVC elbow to change the direction of water flow to different directions for this project scrubber. PVC elbow 90 degrees selected.
PVC ball valve		PVC ball valves are plastic shut-off valves that are widely used. The valve contains a ball with a bore that can rotate. The bore is inline or perpendicular to the piping by rotating the ball a quarter turn and the flow is opened or blocked. PVC valves are long-lasting and cost-effective. This PVC ball valve is used to open and close the water flow from the upper tank (water source).
Inset Filter		Inset filter is the inside of the scrubber tank which can be cleaned after being used by exchanging old sponge. This material filter is wire mesh coated with rubber. The rubber is to avoid being rusted.

Mist nozzle		In the nozzle, the highly pressurized liquid passes through a hollow tube and hits a pin or plate at the tip of the nozzle. A very fine fog of about 25 to 400 μm in diameter is produced from small, uniform-sized droplets. Because the nozzle contains no internal parts, it will not plug as long as a strainer filter out particles larger than the opening. Usually, these nozzles are made of brass or stainless steel.
Water pump		Temperature Range :24-34 degree C Voltage :220-240 V Cable Length :2-3 m Power Watts :15W Frequency :50 Hz
Water flow assembly		Water flow assembly is a part of the scrubber tank where it will be connected with a 5 spray nozzle. This water flow is totally using PVC material to ensure good water flow.

4.4 PROCESS FABRICATE

Figure 4.1: The Stand Outlet Gas

This proses to making the stand outlet gas. Mild steel hollow is used to produce the stand using MIG welding. This stand is made with the right size, thickness, and material so that the stand can support the scrubber system. The process to produce the design of the stand size is determined based on the diameter of the scrubber tank.

Figure 4.2: Stand For Sponge

Produces stand for sponge pairs in scrubber tanks so that static and non-arc sponge conditions are caused by the water weight attached to the sponge. The sponge is combined with weld mesh with 44 mm diameter into the scrubber tank. This sponge can be cleaned and maintained to ensure the effectiveness of this scrubber system. Sponge's stand is made of PVC so it is very light and easy to maintain at any time. Each part connection by using screw and silicon.

Figure 4.3: Installing Nozzle Spray

The process of installing nozzle spray on PVC pipe. In this project, four nozzle spray is connected to PVC pipe using 3 Ton Steel Weld Epoxy Compound. Strong water pressure will ensure the effectiveness of this scrubber system. Make holes in PVC pipe using hand drill make sure four holes are punched.

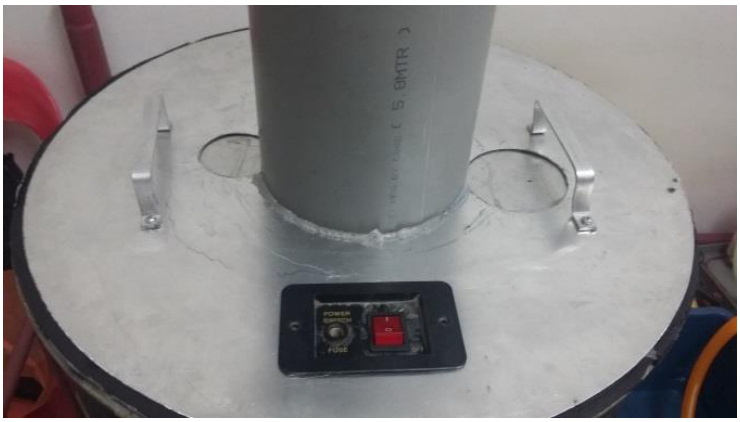


Figure 4.4: The Power Supply

The power supply is used to control the pump. In addition, the pump will work with 240v power supply. The control system provided comes from the power source of alternating current electrical AC, which is 240V/15A, and the control system also includes safety aspects in the event of an unforeseen accident. The switch is a type of tool that can decide on an electric circuit, stop the flow of electric current or divert the flow from one conductor to another conductor. In this case, the switch is used to switch on and off the pump.

Figure 4.5: Centrifugal Fan

The most important part in the process of making the smoke extractor fan is the motor fan. Motor fan is chosen by taking into consideration the speed factor of the blade spinning and the fan's ability to inhale the air more forcefully. This fan has a speed of 220-240v. The current supply the fan is 0.14A. In addition, the stand is produce to facilitate the process of sucking welding smoke. Fans transport (push or pull) exhaust gases through ducts to and from the scrubber, while pumps transport liquids through pipes. Although not part of the scrubber chamber, both fans and pumps are essential to its operation.

Figure 4.6: The Smoke Extractor Fan

Table 4.4: Detail Specific Fume Extractor Fan

Size	**120x120x38mm**
Brand	**SUNON**
Bearing structure	**oil formula**

Voltage	**AC 220 ~ 240V**
Power	**23/21 (W)**
Frequency	**50/60 (Hz)**
Speed	**2650/3050 (R / min)**
Air flow	**90/100 (CFM) / 0.000424752699 m3 / s**
Noise	**44/48 (dB-A)**
Weight	**0.33KG**
Insulation resistance	**500 MΩ minimum**
Withstanding Voltage	**leakage current 0.5mA withstand voltage 1500V / 1 min;.**
Operating voltage	**220V (voltage range: 185V ~ 245V)**
Ambient Temperature (°c)	**: - 20 °c ~ 75°c**

Pumps

The scrubbing liquid and the sludge are transported with a wide variety of pumps. A pump's proper choice depends on the rate of flow, pressure, temperature, and pumped material. The rotating impeller produces a reduction in pressure at the impeller's eye (center) in a centrifugal pump, which causes the liquid to flow from the suction pipe into the impeller's center. Then the liquid is forced out along the blades and generally discharged at an angle of 90 degrees. As with fans, the main maintenance problems associated with pumps in scrubbing

systems are abrasion and corrosion. Potential problems with corrosion and abrasion are the impellers, housing, and seals.

Table 4.5: Detail Specific Pump

Volt	**12V**
Amps	**6A**
Rated power	**70W**
The larges flow	**6.0 liter/min**
Pressure setting	**0.90 Mpa**

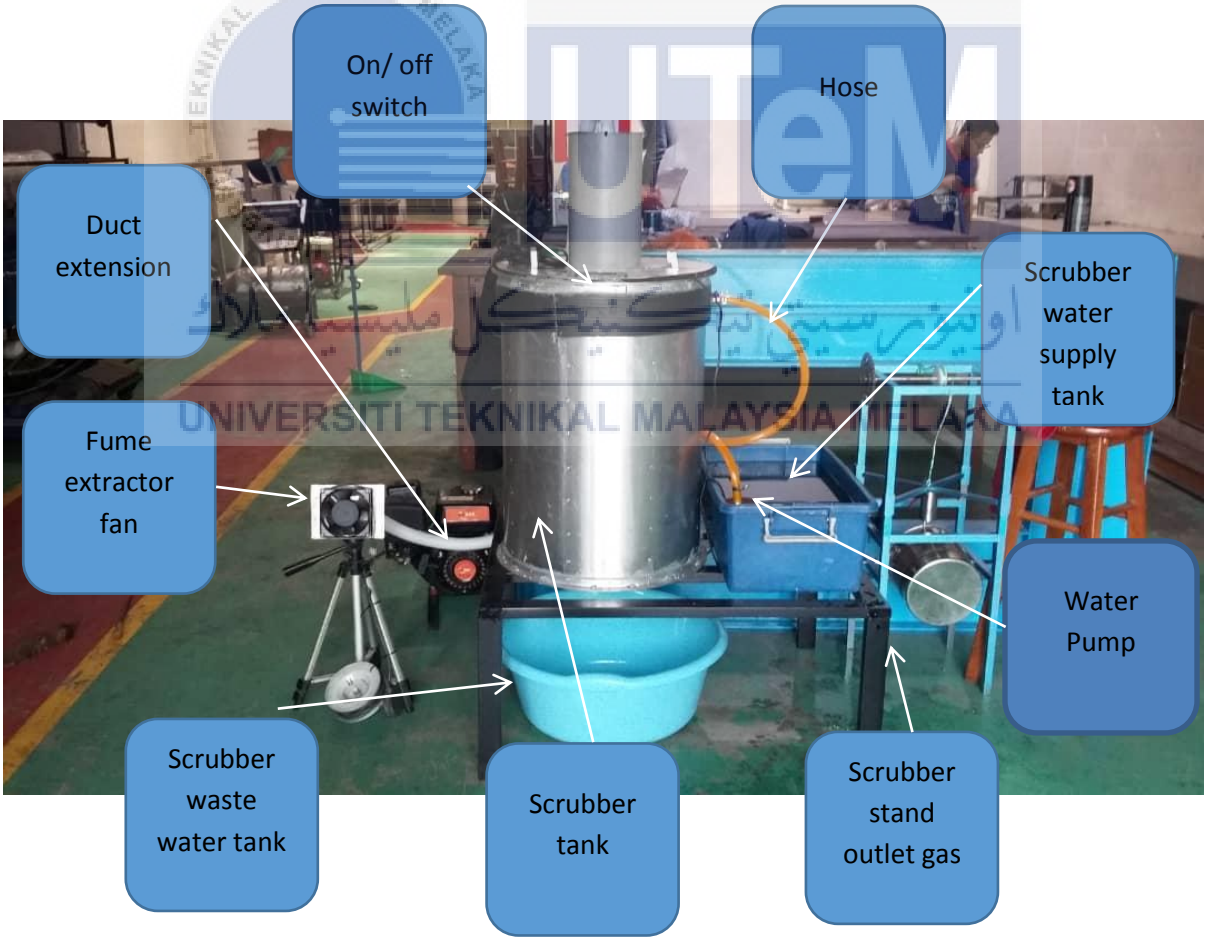


Figure 4.7: Full Overall Image Design Scrubber System (i)

Figure 4.8: Full Overall Image Design Scrubber System (ii)

4.5 DESIGN PARAMETERS

The parameters affecting the overall performance of a wet scrubber are:

- Particle size distribution and loading;
- Waste gas flow rate, temperature and humidity;
- Gas velocity and pressure drop;
- Liquid-to-gas (L/G) ratio;
- Droplet size; and
- Residence time.

Each of these parameters are briefly discussed below.

4.5.1 LIQUID-TO-GAS RATIO

The liquid-to-gas ratio (L/G) is the volume of liquid injected per volume of waste gas treated. In general, a higher L/G ratio increases collection efficiency since the density of droplets across a given cross-section of the venturi is higher. Liquid flow rates between 7 and 10 gal/1000 ft3 give optimum performance. L/G ratios in this range produce fairly constant collection efficiencies given a constant pressure drop. L/G ratios of greater than 10 gal/1000 ft3 do not improve the scrubber performance significantly. While increasing the L/G ratio increases collection efficiency, operating costs are increased as well due to greater scrubbing liquid and pump usage.

4.5.2 GAS ANALYZER

Figure 4.9: Gas Analyzer Devise

Analyzer for emission gas can be used to measure the concentration of CO, CO2, HC, O2 and NO welding machine emission gas. Two beams non-dispersion infrared (NDIR) method is based on the pulsable infrared source and single source, this analyzer is designed with portable and smaller physical dimensions.

Feature

- Simultaneous measuring CO,CO2,NO,HC,O2, Lambda.
- Automatic calculation and display of Lambda and A/F.
- LCD screen and keypad buttons for easier setting and operation.
- Selection of C3-C6 factor.
- Automatic leakage test, blocking test and HC residue test of the sampling line.
- Optional various type RPM sensors.

- Optional oil temperature measurement probe.
- Equipped with RS-232 digital serial interface and PC software.
- Small size, light weight and most convenient for carry.

Table 4.6: General Parameter For Gas Analyzer

General Parameter					
Measurement	CO2, CO, HC, O2, NO gases, Lambda display				
Technology	CO2, CO, HC(NDIR), O2, NO(ECD)				
Measuring range	CO2	CO	HC	O2	NO
	0-20%	0-10%	0-9999pp	0-25%	0-5000ppm
Resolution	0.01%	0.01%	1ppm	0.01%	1ppm
Relative error	±4%	±3%	±5%	±3%	±5%
Absolute error	±0.4%	±0.06%	±12ppm	±0.1%	±25ppm
Warm-up time	10 minutes				
Display	LCD display				
Response time	TD+T90:10 second(NDIR), ECD:30 seconds				
Power	110V-220V±10% 50Hz±1Hz				
Operation temperature	0~40℃				
Dimension	260mm*180mm*360mm				
Net weight	6kg				
Flow rate	0.7-1.2L/min				
Standard accessories	Sampling pipe, sampling probe, RS-232 cable, standby filters, PC software				
Options	Oil temperature option, inbuilt printer, RPM sensor options				

4.5.3 TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids (TDS) are measured in milligrams per unit water volume (mg / L) as well as parts per million (ppm). The maximum level of concentration set by EPA for drinking water is 500 mg / L.

Total Dissolved Solids (TDS) is a measure of the combined dissolved content of all inorganic and organic substances in a suspended molecular, ionized or micro-granular (colloidal sol) liquid. The operational definition is generally that the solids must be small enough to survive filtration through a two-micrometer (nominal or smaller) pores filter. Total dissolved solids are normally only discussed for freshwater systems since salinity includes some of the TDS definition ions. TDS is mainly used in the study of water quality for streams, rivers, and lakes, although TDS is not generally considered to be a primary pollutant (e.g. it is not considered to be associated with health effects) it is used as an indication of drinking water's esthetic characteristics and as an aggregate indicator of the presence of a wide range of chemical contaminants.

Table 4.7: Total Dissolved Solids In Part Per Million (Ppm)

TDS in part per million (ppm) (range)	Description
0	Idea drinking water from reverse osmosis microfiltration
50	Carbon filtration mountain spring or aquifers
100	Hard water (TDS 170)
200	Marginally acceptable
300	Average tap water

400	High TDS water from the tap or mineral springs
500	U.S EPA's Maximum Contamination Lever

Hard water is high mineral water (as opposed to "soft water"). When water percolates through deposits of calcareous and chalk that are largely composed of calcium and magnesium carbonates, hard water is formed.

4.5 CALCULATION

For Fan sizing

Scrubber system developed is shown in Figure 2 and . The airflow rate was calculated using continuity equation. Table 4.1 shown the result of experiment.

Q = A x V

Q = Fume flow rate

A = Area of the duct

V = Fume velocity

V = distance / time

Given:

$$Q = 4.2475 \times 10^{-4}\ m^3/s \quad (4.1)$$

For round duct of d = 0.03m,

$$A = \pi r^2 = \pi \frac{d^2}{4}$$

$$A = \pi \frac{0.03^2}{4}$$

$$A = 7.0686 \times 10^{-4}\ m^2$$

Find velocity of fume :

$$Q = A \times V \quad (4.2)$$

$$V = \frac{4.2475 \times 10^{-4}}{2\ 7.0686 \times 10^{-4}}$$

$$V = 0.6\ m/s$$

Distance for duct extension L = 2 meter,

$$V = d/t = \text{Distance / Time} \quad (4.3)$$

$$T = \frac{2\ m}{0.6\ m/s}$$

$$T = 3.33\ second$$

Table 4.8: Experimental result

Run	Time (second)	Velocity (m/s)	Flow rate (m^3/s)
1	5	0.4	2.83×10^{-4}
2	10	0.2	1.41×10^{-4}
3	15	0.13	9.19×10^{-5}
4	20	0.1	7.07×10^{-5}
5	25	0.08	5.65×10^{-5}
6	30	0.07	4.95×10^{-5}

4.6 ENGINEERING DRAWINGS

Engineering drawing consists of assembly view, exploded view and orthographic view which consist of front view, top view, right view and isometric view. The engineering drawing is necessary in drawing specification and attached to appendices.

CHAPTER 5

RESULT AND DISCUSSION

In this chapter, results that were obtained from the testing are shown and in addition to that, further discussion will be made according to the testing data acquired. The results of testing which mainly consists of adjusting spray nozzle head, test the clarity of the water, and the response will be displayed in graphs for easier understanding and observation.

5.1 TESTING

Experiments were made using an arc welding machine in a mechanical engineering laboratory. Fume from arc welding utilization is used to study the effectiveness of this system. This arc-welding fume contains many chemicals such as carbon monoxide, carbon dioxide, nitrogen oxides, Sulphur dioxide and ozone. To know if this scrubber system works properly or not need to be seen on the sponge changes contained into the scrubber tank and also needs to be seen in the condition of water after the scrubber operation of this system. Welding fume is sucked into the scrubber tank through the exhausted duct hose extension. Once the fume goes into the scrubber tank at a time when the water pump needs to be activated so that the spray nozzle can operate properly. This test is done 5 times to ascertain the percentage of clean air that can be produced.

5.2 ADJUST SPRAY NOZZLE HEAD

The first experiment was performed by adjusting the spray nozzle head with two different conditions is wide spray and straight spray. Sample of water that has been out of both two wide spray and straight spray conditions is taken to see the difference in which one is more polluted. Figure 5.1 shows wide nozzle spray conditions and figure 5.2 shown straight nozzle spray condition. Testing is done 5 times with different time conditions. The time for this spray nozzle experiment has been set for 5 minutes, 10 minute, 15 minutes, 20 minute and 25 minutes. Dirty smoke direct to mix with clean water from the spray nozzle. This test was performed without the use of sponge lead to direct water mixed with smoke and will continue to go out unhindered by a sponge.

Figure 5.1: Wide Nozzle Spray

Figure 5.2: Straight Nozzle Spray

Table 5.1: Testing Adjust Spray Nozzle Head

Run	Time (minute)	Wide spray (0-500 ppm)	Straight spary (0-500 ppm)
1	5	115	108
2	10	127	119
3	15	142	130
4	20	155	142
5	25	170	155

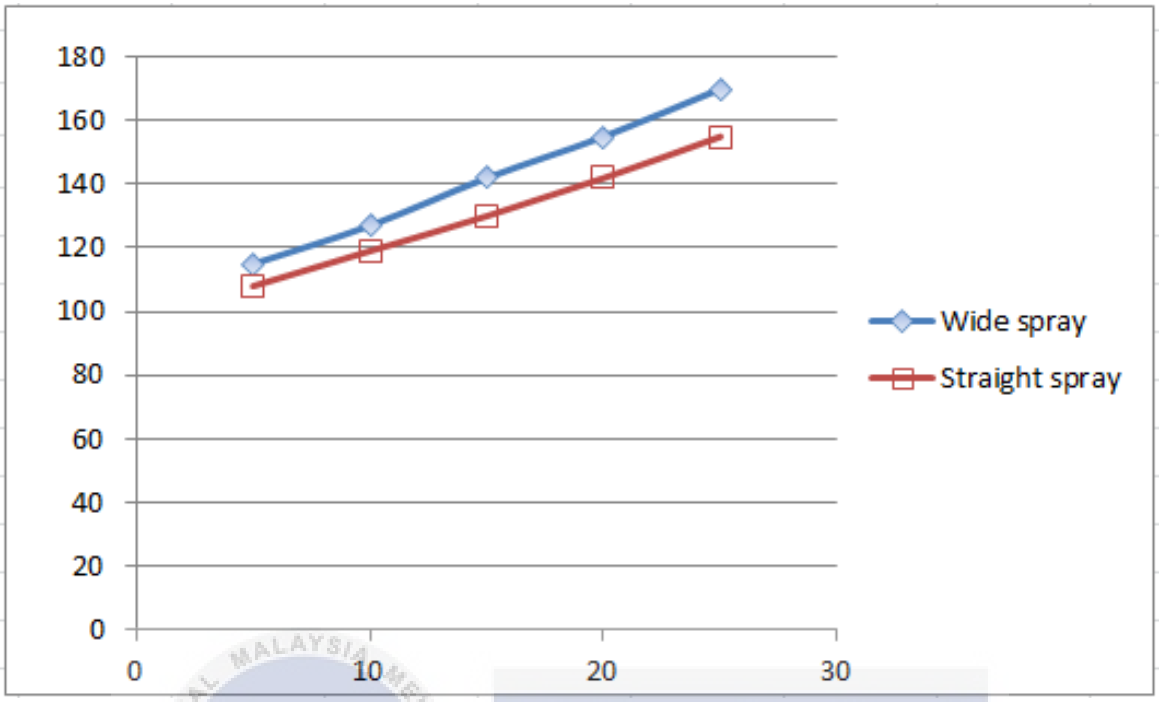


Figure 5.3: Graph Testing Adjust Spray Nozzle Head

Based on the graft shown in figure 5.3 line blue for wide nozzle spray and line red for straight nozzle spray condition. Wide nozzle spray reaches 170 parts per million (ppm) higher than straight nozzle spray that 155 ppm after 25 minute. This suggests the wide nozzle spray is more effective than straight nozzle spray in the process and methods for treating contaminated gases. In addition, there are several factors to achieve a good level of the spray nozzle to speak of contaminated smoke. Firstly, pressure pump pressure also becomes an important role to ensure that the spray nozzle works well. The straight nozzle spray cannot trap the smoke thoroughly because the water spray does not trap the smoke zones elsewhere.

5.3 TEST THE CLARITY OF THE WATER

The second experiment was performed by looking at the clarity of the water coming out through the scrubber tank. The clarity of the water coming out through the scrubber tank affects the efficiency of this system scrubber. This experiment is conducted to see the effectiveness of the sponge inside this scrubber. In this experiment, we take note of the sponge dirty stage. The sponge works to filter contaminated water as a result of a welding gas mixture in the scrubber tank. The sponge impurities can be described by 4 conditions.

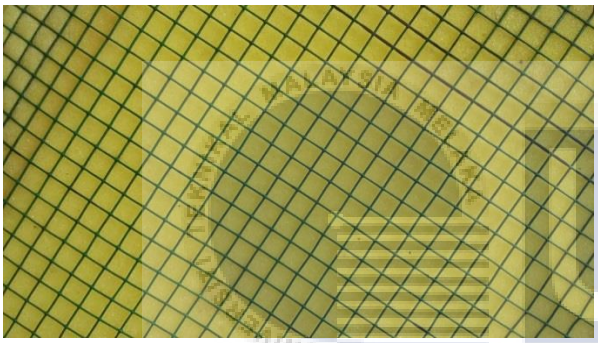


Figure 5.4: Condition 1

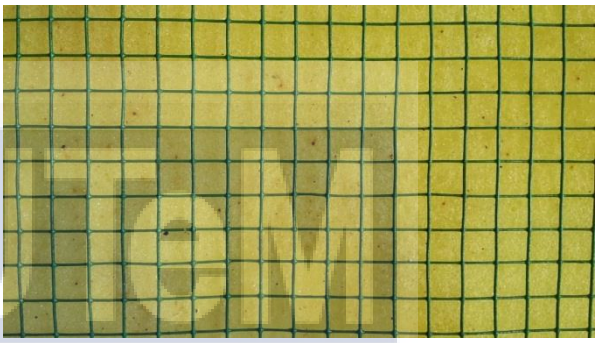


Figure 5.5: Condition 2

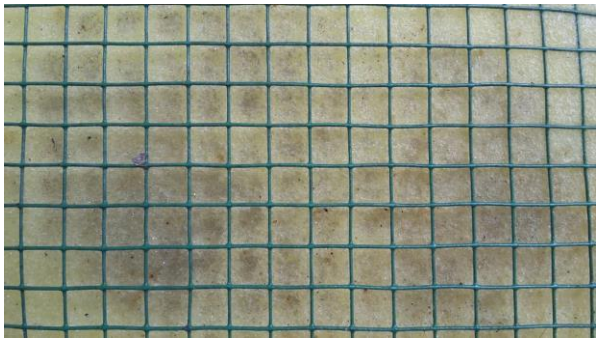


Figure 5.6: Condition 3

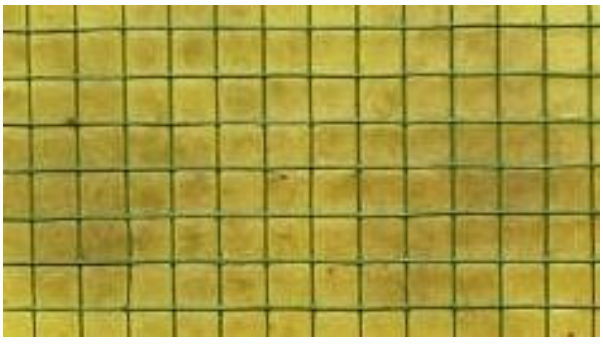


Figure 5.7: Condition 4

Table 5.2: Testing Sponge Condition

Run	Time (minute)	Condition sponge (range)
1	5	10%
2	10	30%
3	15	60%
4	20	80%
5	25	100%

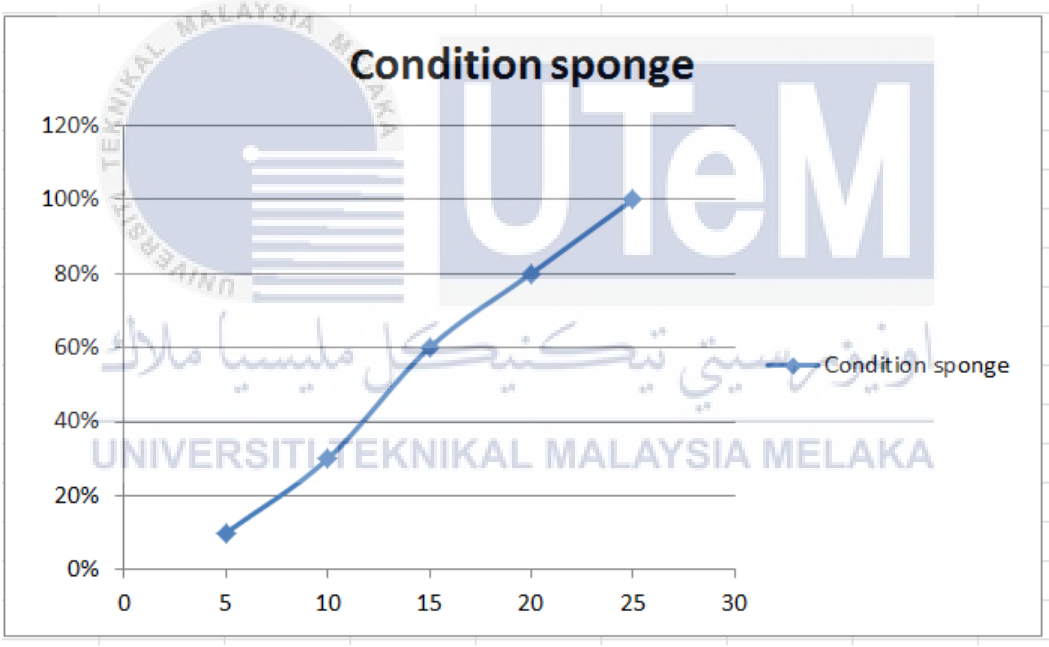


Figure 5.8: Graph Condition Sponge After Testing

Based on the graph shown in figure 5.8 the sponge gross state increases at 20 minutes the graph indicates a sponge 80 percant dirty state caused by chemical zones attached to the sponge.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION OF RESEARCH

After going through some researches, completing experiment, collecting data and discussing the results, there are several conclusions can be made. Below are the conclusions that summarize all the data:

a) Once the inlet gas stream has been characterized, it is necessary to select the best scrubber components to obtain maximum performance.
b) Horizontal mist eliminators have greater capacities than vertical types, but space requirements are also greater.
c) Water pressure is an important element for the scrubber system because it can give the performance to nozzle spray for filter the welding gases.
d) Each material necessary to be selected first according to the suitability of the material itself. The durability of a product depends on the material used. In this case, material selection is very important to ensure the scrubber works properly.

This scrubber system is design to treatment of the welding gases from the industry and workshop. The design of the machine is based on the spray tower scrubber system at the construction site, the house of quality is generated to decide the important rating for every

criteria based on the research. After generation of engineering characteristics, certain criteria highlighted to proceed as element of morphological chart.

Few concept were generated from the concept design but second concept were selected based on concept scoring and screening selection method. The second concepts able to fulfill the requirements of the spray tower scrubber system. It do have better maintenance and durability compared to others concept.

Configuration of the design have been made after the selection concept so that the machine would able to operate smoothly and in the optimize condition. Before starting the fabrication we have assumed that the total cost might be come to RM 425 but fortunately the cost is more cheaper which is only RM 300.

6.2 RECOMMENDATIONS

a) Need to choose the best design for various scrubber components based on operating experience and research studies.

b) The most common construction material for scrubbers is 316 stainless steel. At points of high abrasion, wear plates, brick linings, or high-grade nickel alloys are recommended. The higher grade alloys are also recommended in areas subject to chloride attack.

c) More drainage spray nozzles in the scrubber are getting better for treatment welding gases.

d) Make sure the exhaust hose duct extension diameter is greater because it ensures that the quantity of smoke is more inhaled.

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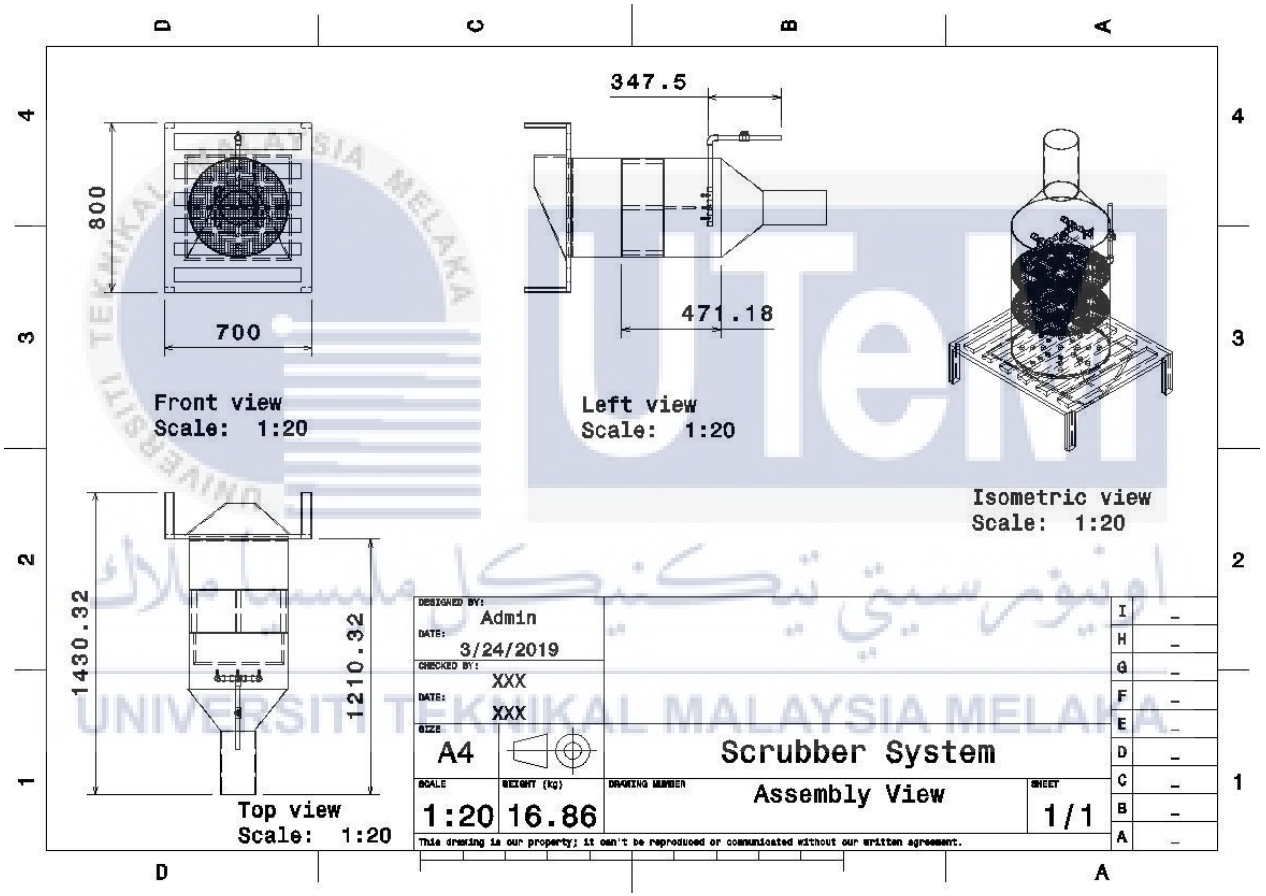
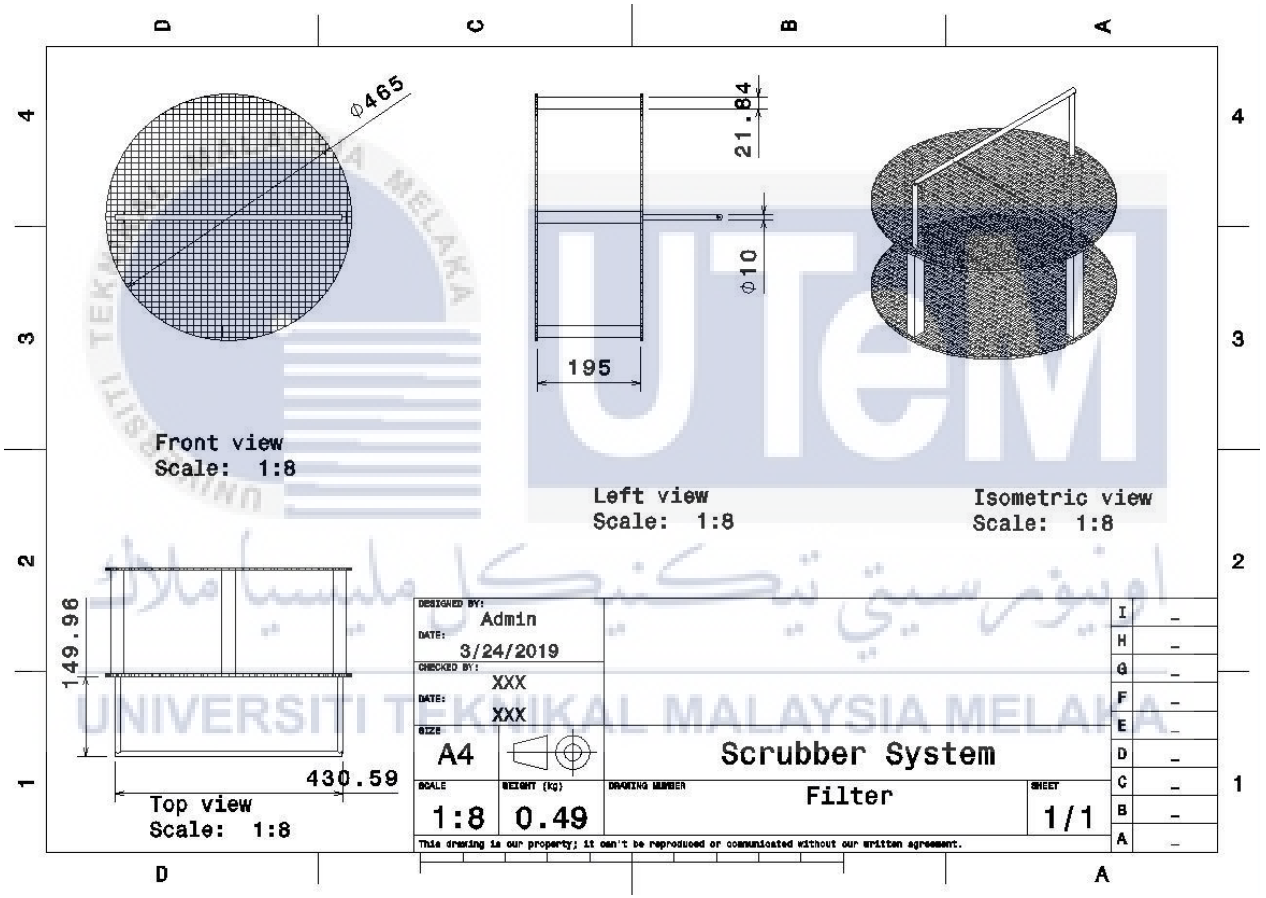
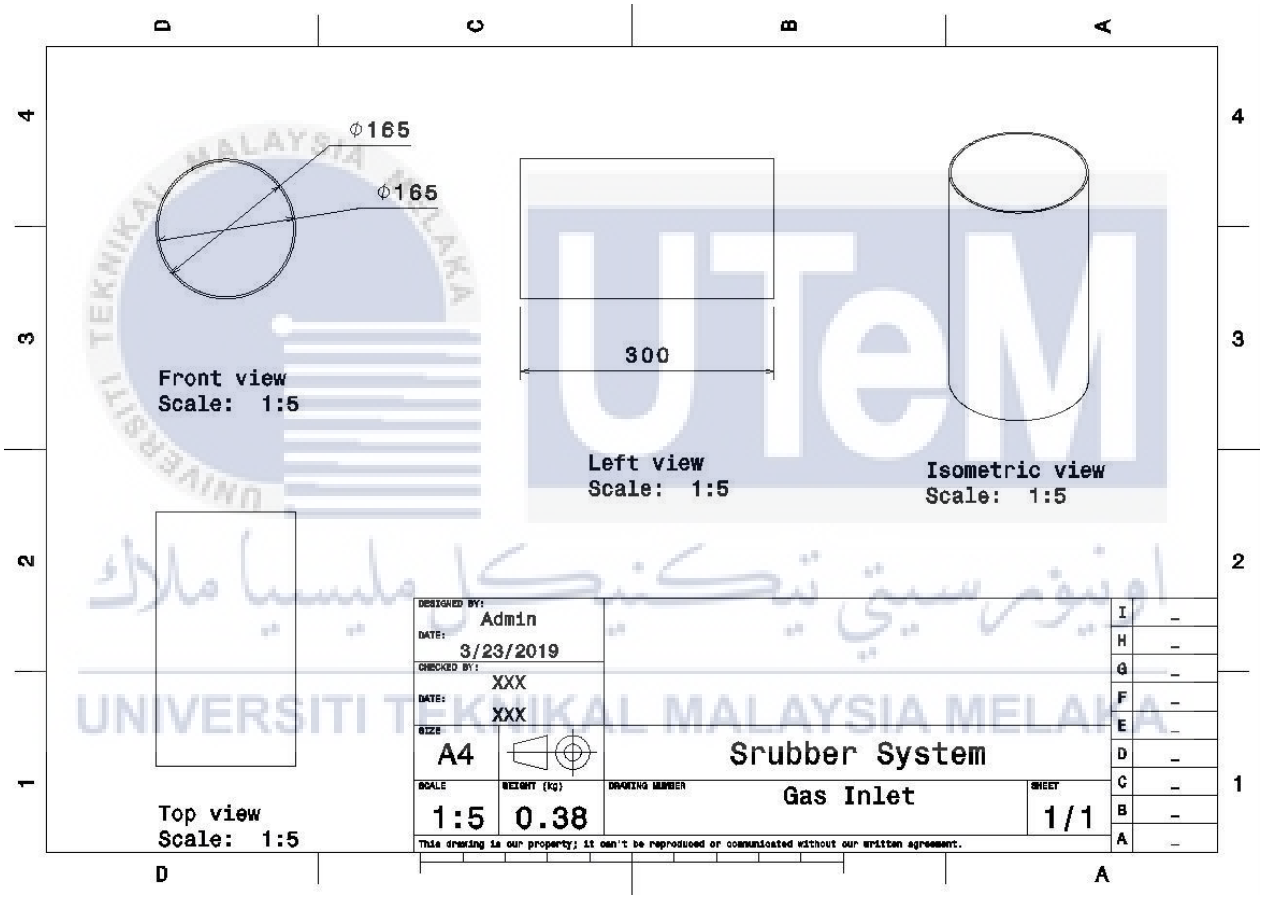
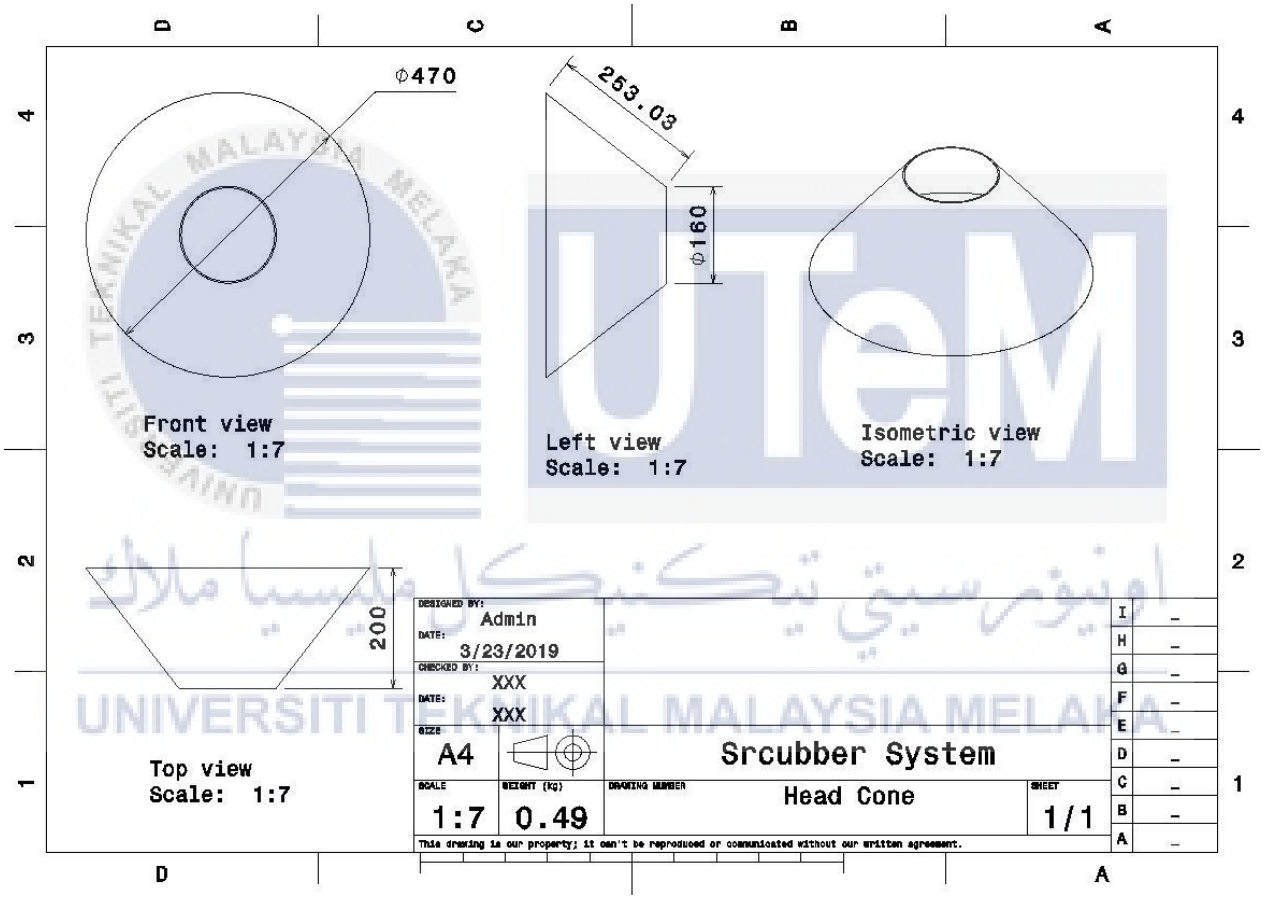
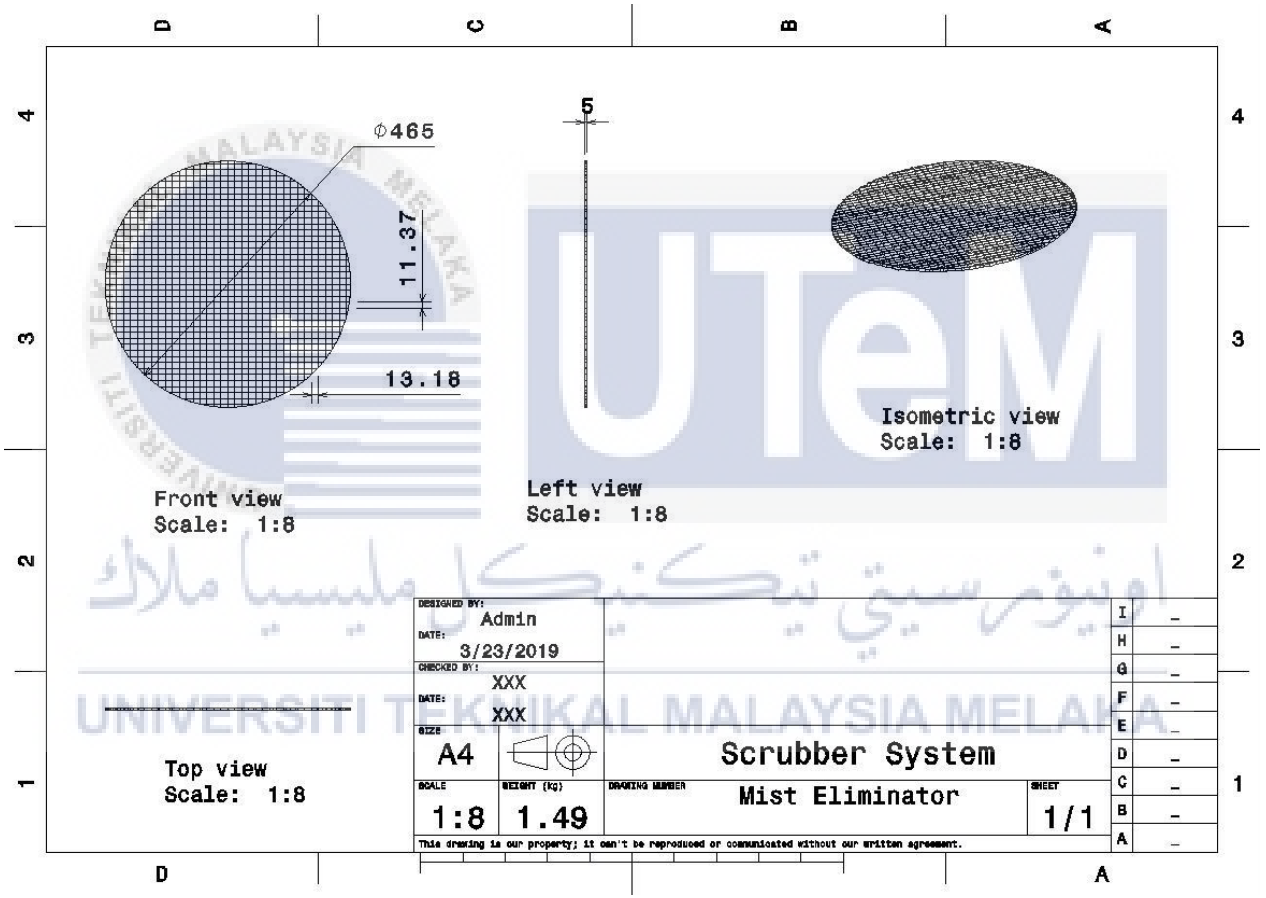
APPENDICES A

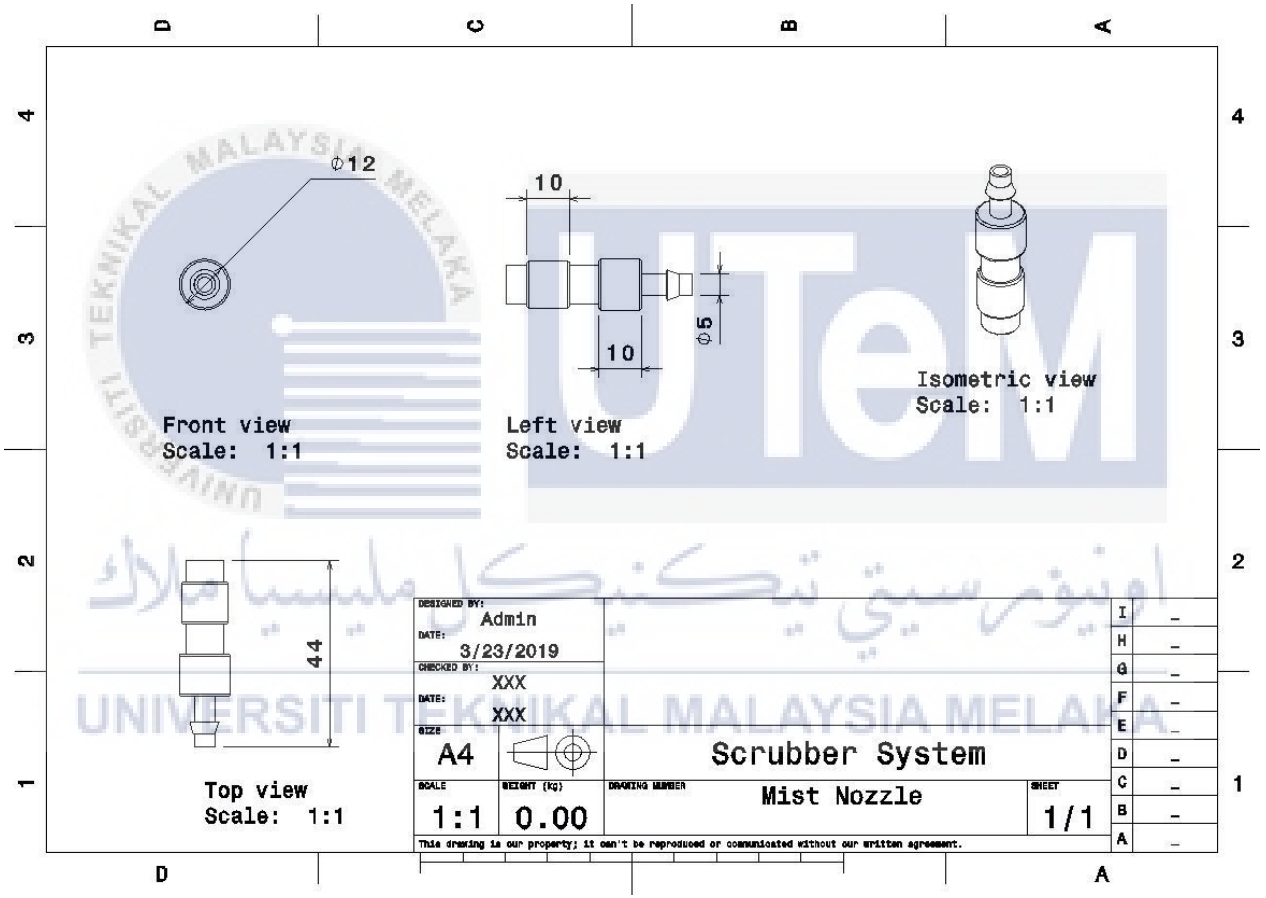


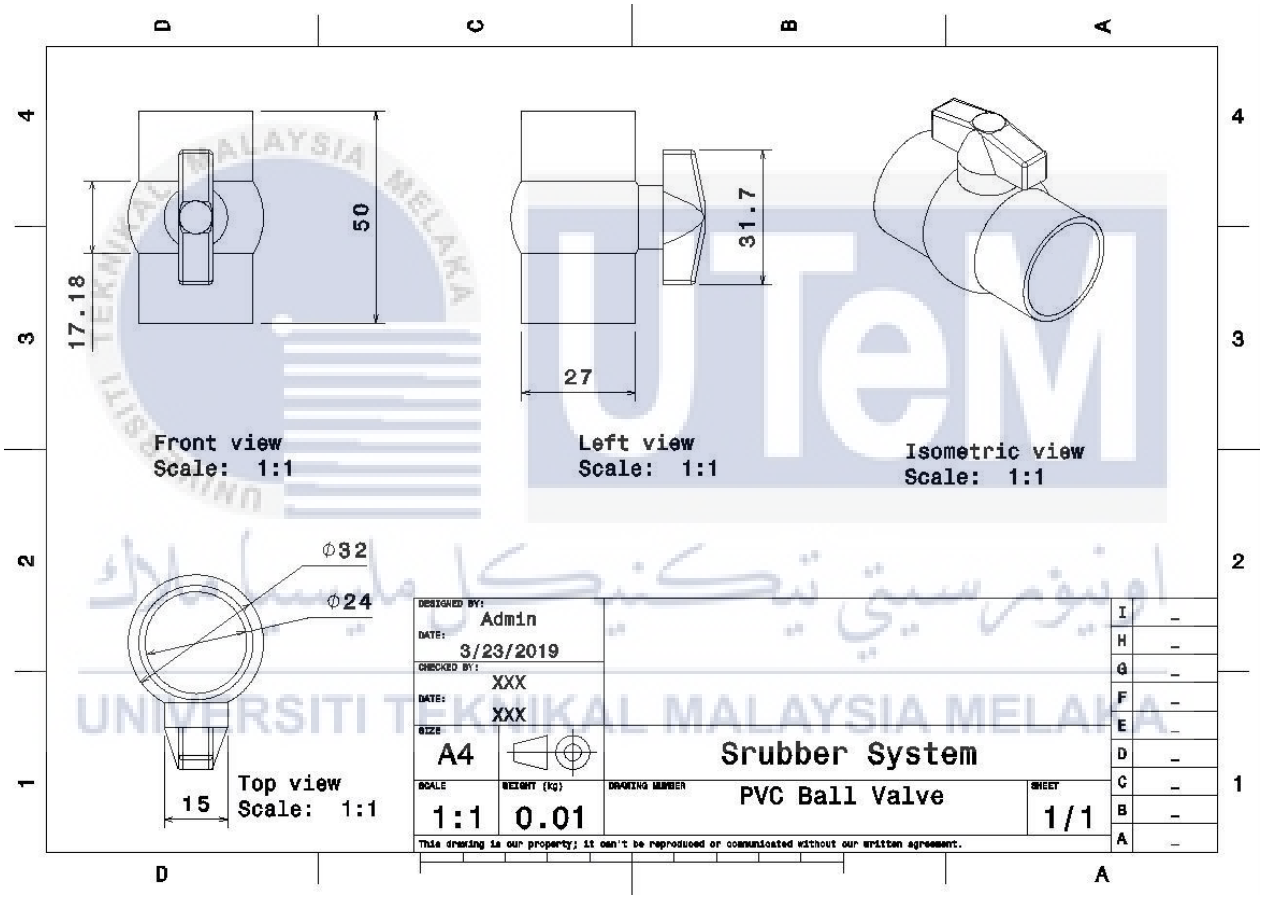


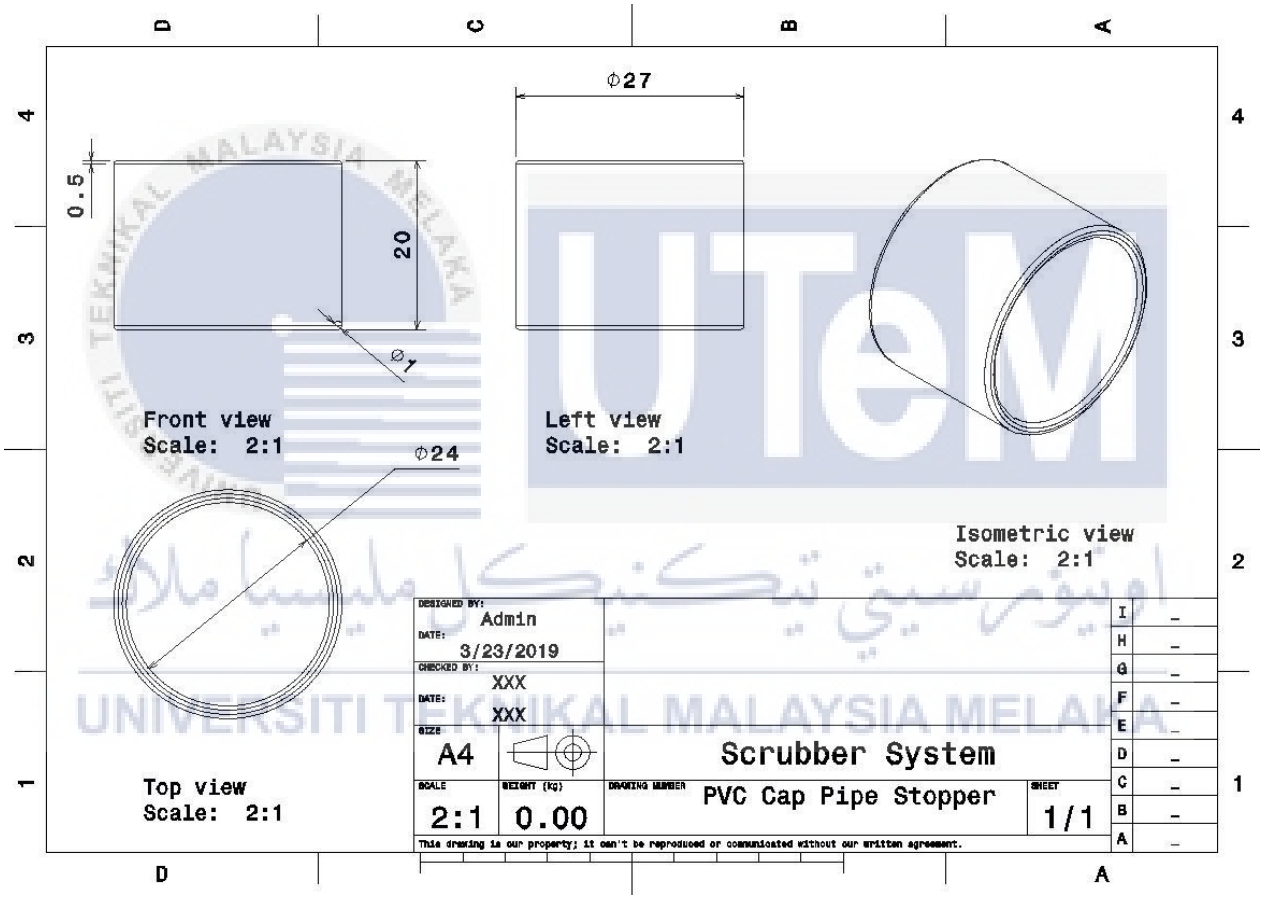


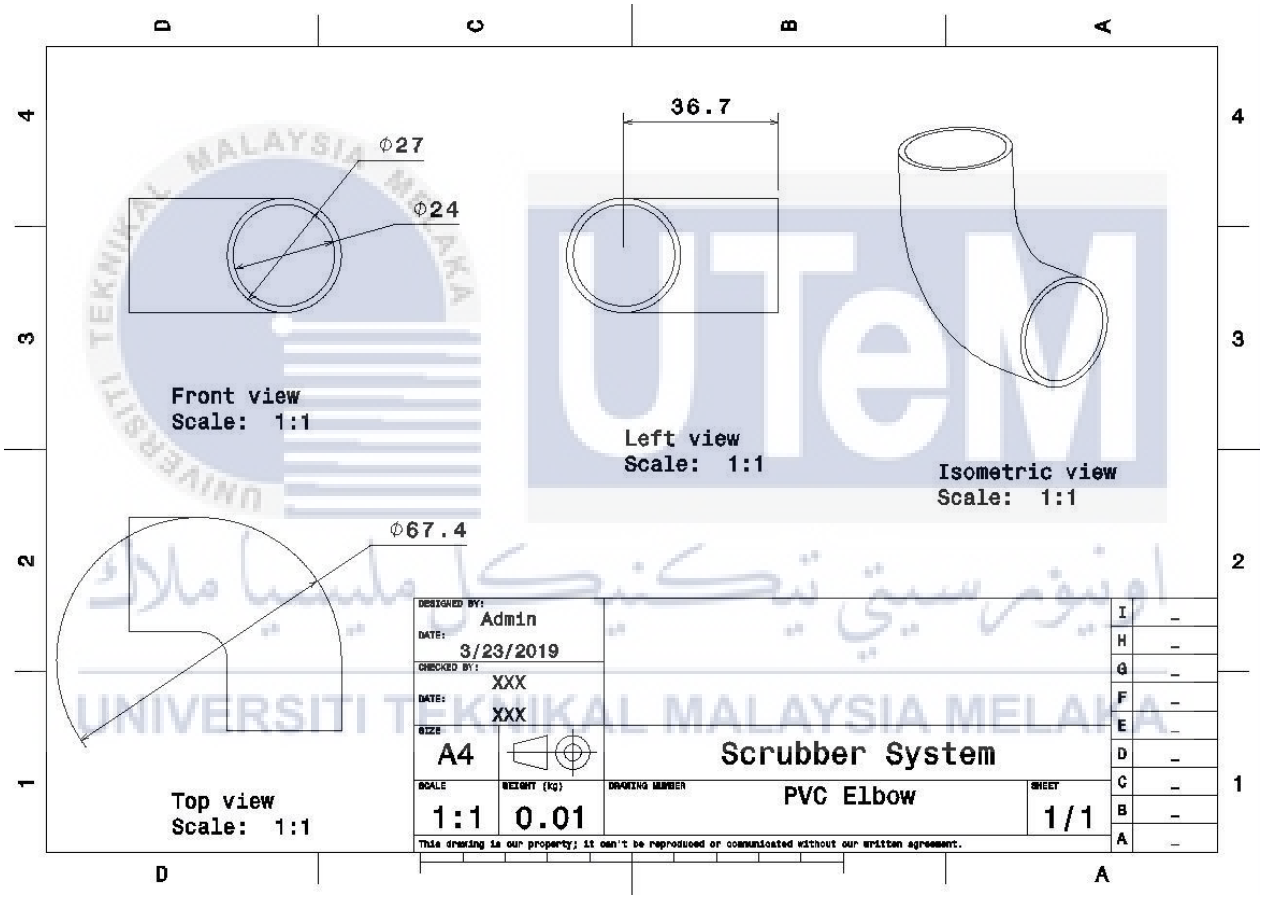


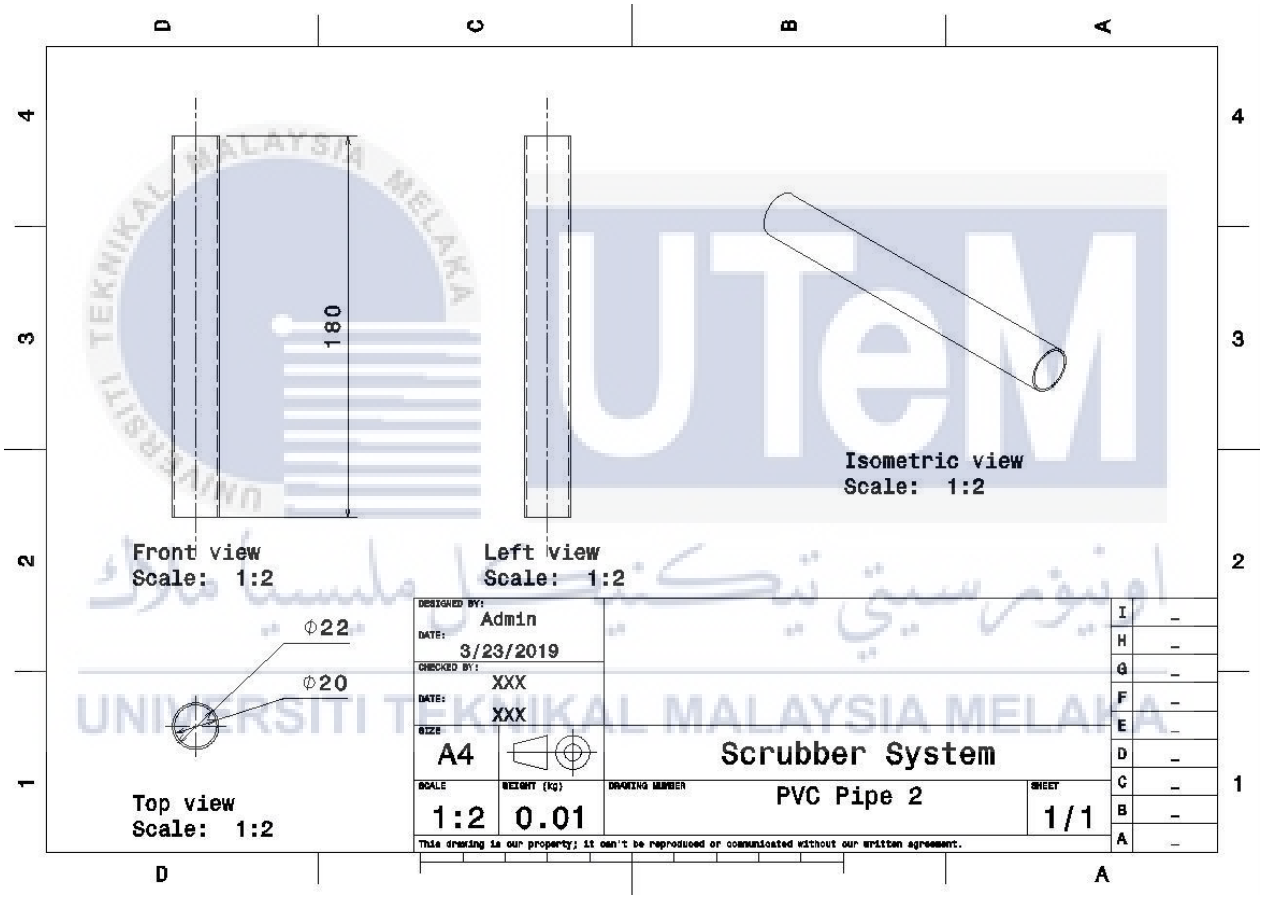


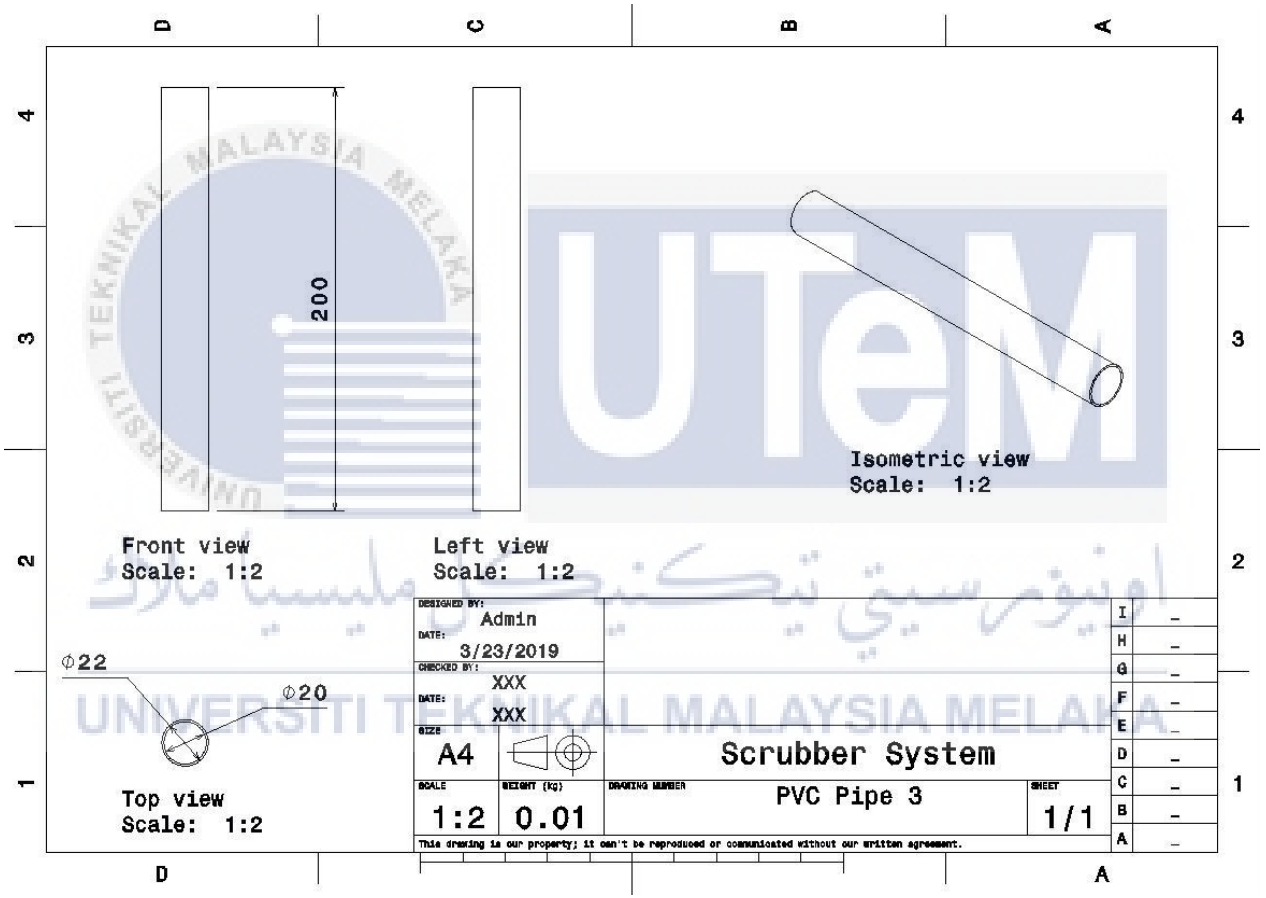


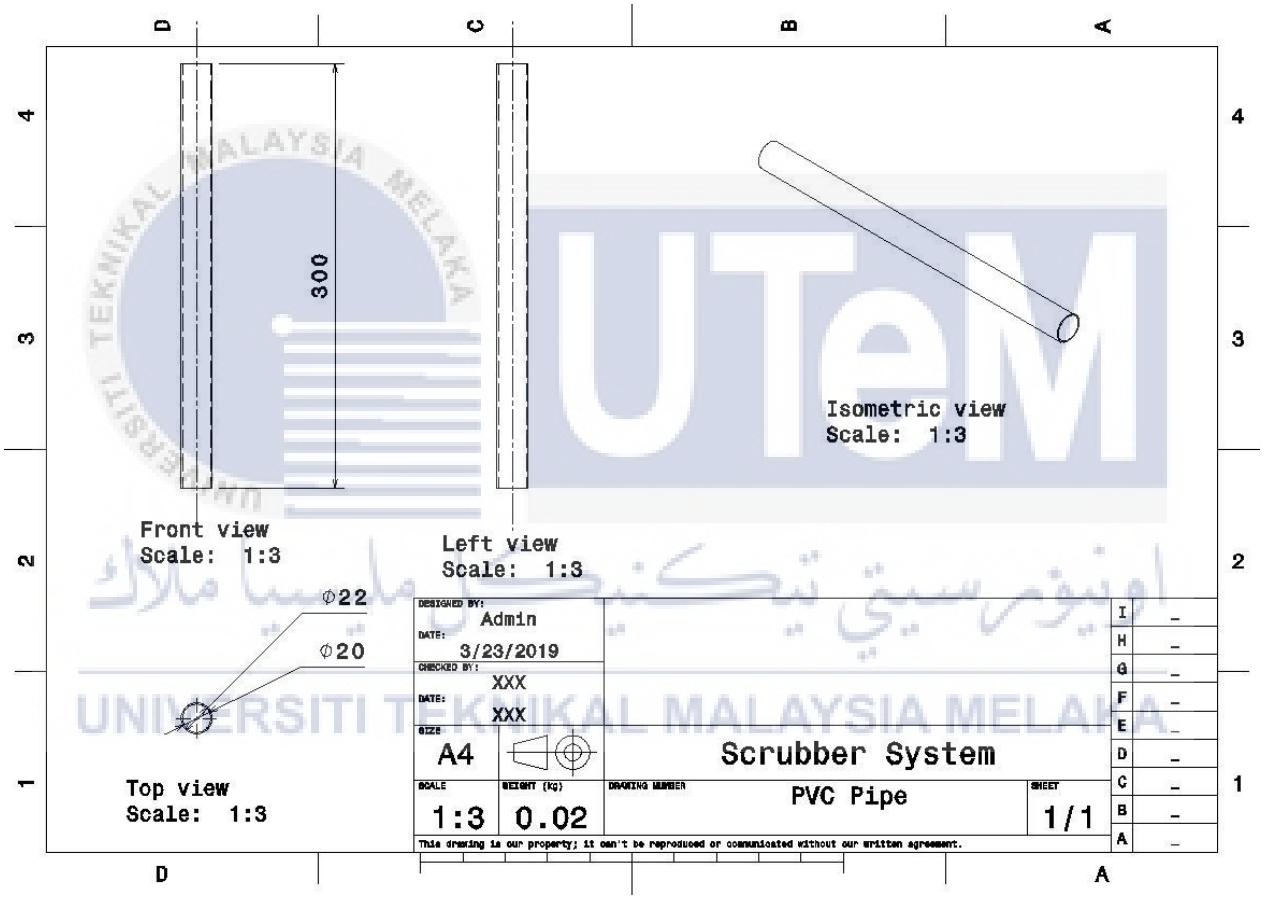


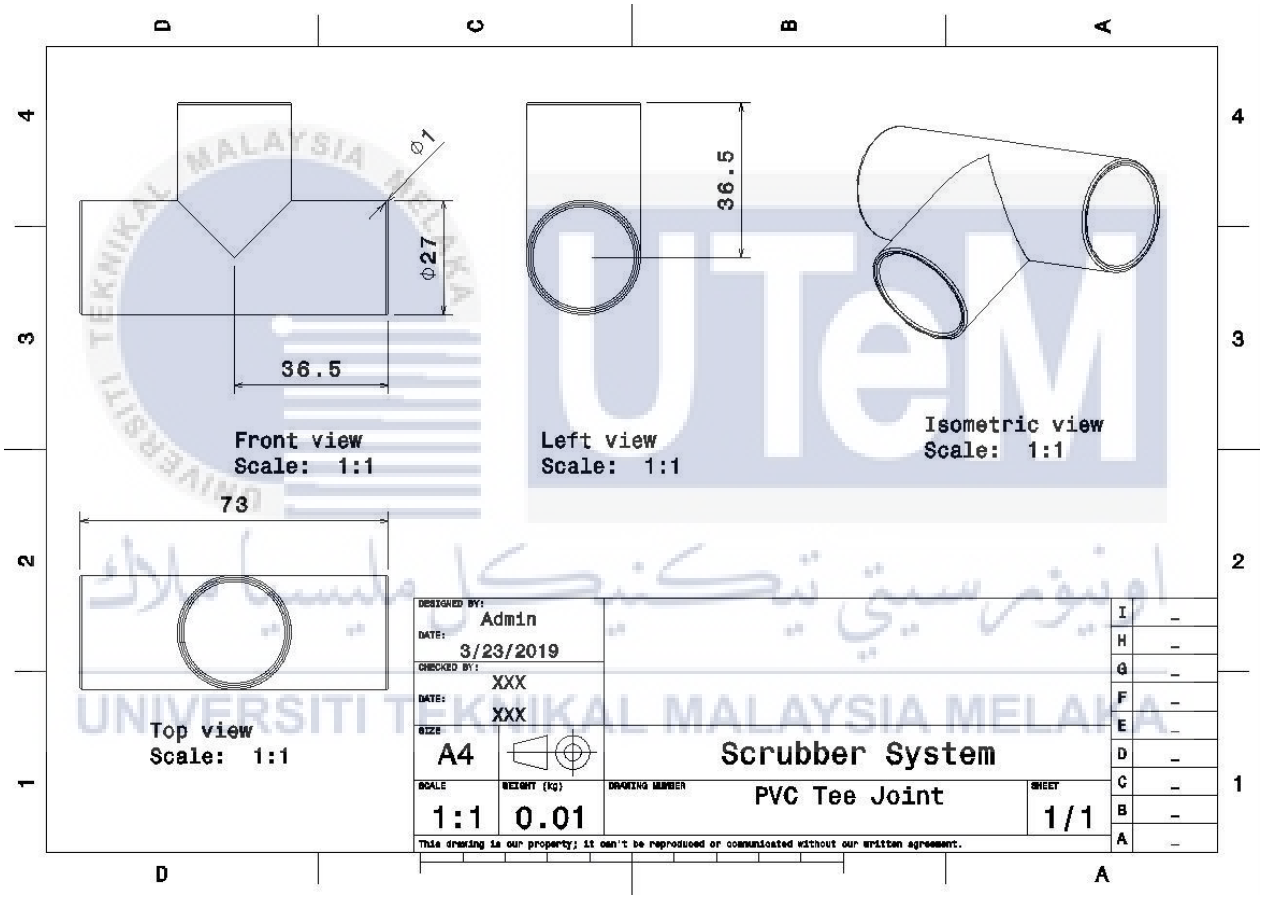


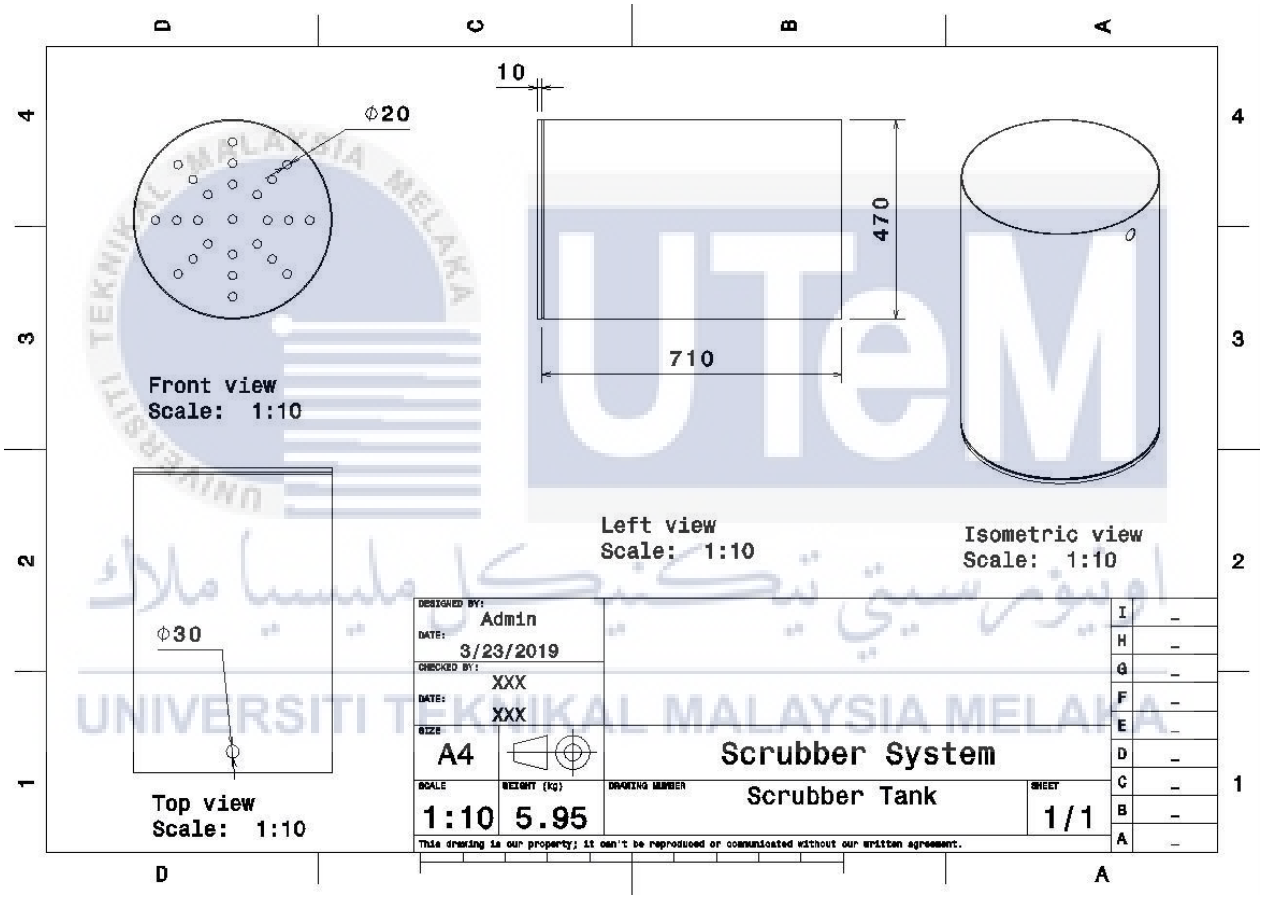


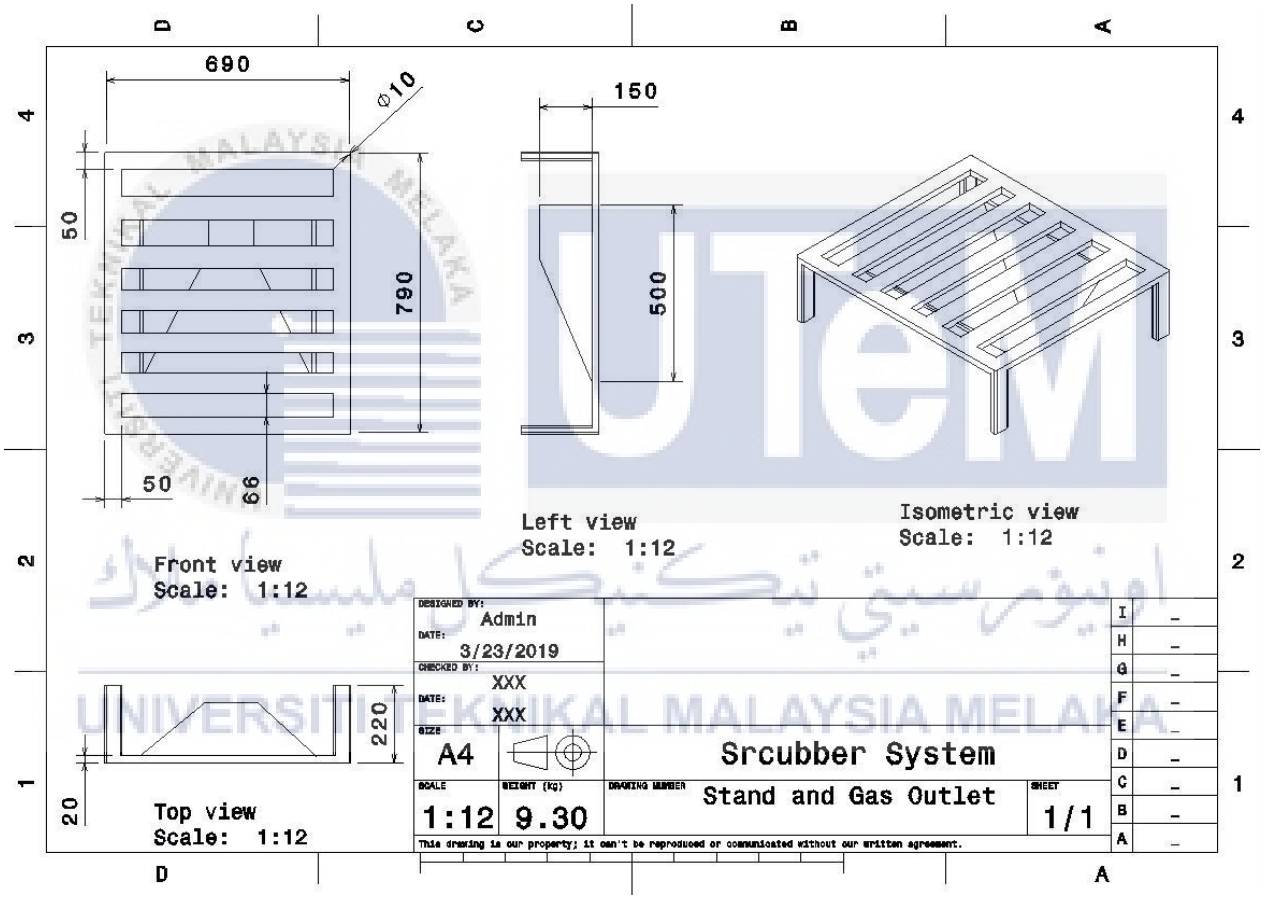


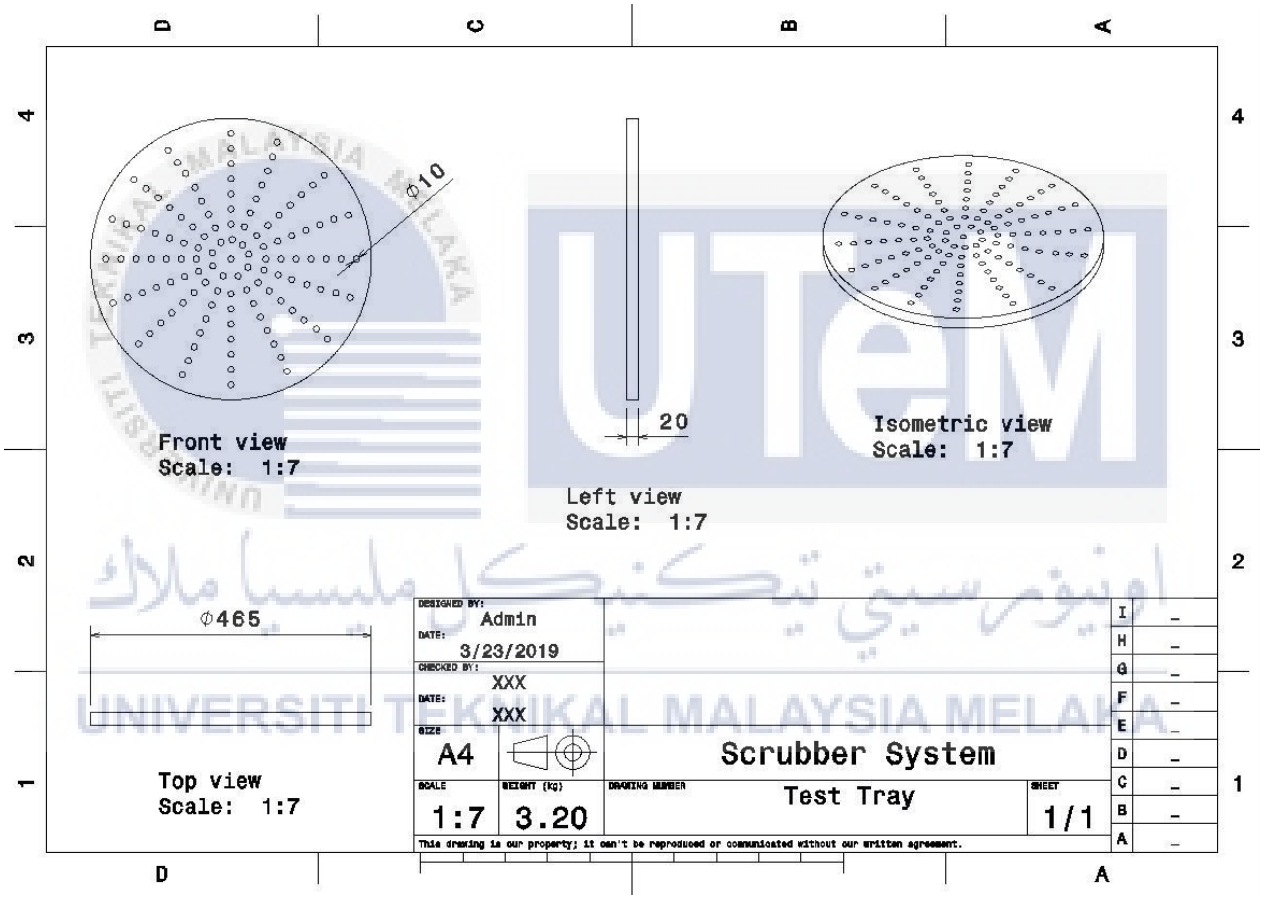


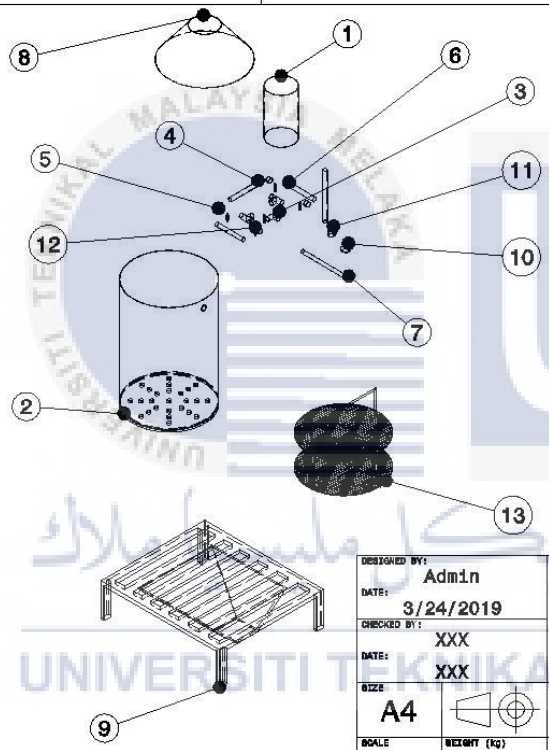












Bill of Material: Product1

Number	Component Description	Quantity
1	PVC Pipe 6 in	1
2	Scrubber Tank	1
3	PVC Tee Joint	3
4	PVC Pipe 4	1
5	PVC Cap Pipe Stopper	4
6	PVC Pipe 3	2
7	PVC Pipe 2	2
8	Head Cone	1
9	Stand and Gas Outlet	1
10	PVC Elbow	1
11	PVC Ball Valve	1
12	Mist Nozzle	5
		1
13	Filter	1

DESIGNED BY: Admin
DATE: 3/24/2019
CHECKED BY: XXX
DATE: XXX
SIZE: A4
SCALE: 1:20
WEIGHT (kg): XXX
DRAWING NUMBER: XXX
SHEET: 1/1

XXX

DASSAULT SYSTEMES

APPENDICES B

GANTT CHART PSM II

Activities	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Briefing about PSM II															
Meeting with supervisor															
Detail design using software															
Detail drawing															
Fabrication and testing															
Chapter 4: Result analysis and discussion															
Chapter 5: Conclusions and Recommendations															
Reference and formatting															
Submission of general conduct form and logbook to supervisor															
Presentation PSM II															
Submission of reports to supervisor and examiners															