UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS

JUDUL: DESIGN AND FABRICATION SMOKE PIPING FOR FLOW OVER IMMERSED BODY EXPERIMENT BENCH

SESI PENGAJIAN: 2012/2013

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SUPERVISOR DECLARATION

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

Signature :

Name of Supervisor : EN MOHD FADHLAN BIN MOHD YUSOF

Position : LECTURER

Date :

STUDENT DECLARATION

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

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Date :

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I sincerely grateful to my parents for they love and sacrifice that they had for me throughout my life and their support for me in all my activities that I have done. I also wanted to thank to other people who have directly or indirectly help in the completion of my Final Year Project. I sincerely appreciate all your help.

ABSTRACT

This report shows the design and fabrication of smoke piping system. The problem from the instrument is the smoke flow is late to fill the air smoke rig. It fills the rig with natural pressure come from smoke generator. It takes a long time to fill it. The objective of the report are to make the smoke go more faster to air flow bench and to control volume enter the air flow bench using toggle switch. Design generation is showed and solid three dimensional structures modeling of the smoke piping system was developed with SolidWorks software. The result from testing the smoke piping system shows that the system able to suck smoke in short duration. Ideas for improvement for the smoke piping system also provided to further improve the smoke piping system.

ABSTRAK

Laporan ini menunjukkan reka bentuk dan fabrikasi sistem paip asap. Masalah dari instrumen adalah aliran asap lewat untuk mengisi pelantar asap udara. Ia mengisi pelantar dengan tekanan semulajadi yang datang dari penjana asap. Ia mengambil masa yang lama untuk mengisinya. Objektif projek ini ialah membantu asap untuk pergi lebih cepat ke bangku aliran udara dan untuk mengawal kelantangan memasuki bangku aliran udara menggunakan suis togel. Generasi reka bentuk menunjukkan dan pepejal tiga struktur dimensi model sistem paip asap telah dibangunkan dengan perisian Solid Works. Hasil dari ujian sistem paip asap menunjukkan bahawa sistem yang dibina mampu untuk menyedut asap dalam tempoh yang singkat. Idea untuk penambahbaikan untuk sistem paip asap juga disediakan untuk meningkatkan lagi operasi sistem paip asap pada masa depan.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Basically, fluids flow over bodies that are immersed in a fluid is known as external flow, which emphasis on the resulting forces-drag and lift. External flow is identified by a freely growing boundary layer surrounded by an outer flow region that embraces small velocity and temperature gradients.

External flows past objects have been studied extensively because of their many practical applications. For example, airfoils are made into streamline shapes in order to increase the lifts, and at the same time, reducing the aerodynamic drags exerted on the wings. On the other hand, flow past a blunt body, such as a circular cylinder, usually experiences boundary layer separation and very strong flow oscillations in the wake region behind the body. In certain Reynolds number range, a periodic flow motion will develop in the wake as a result of boundary layer vortices being shed alternatively from either side of the cylinder.

A very important separation of flow types relates to the velocity of the flowing fluid. Fluid flow at low velocities is smooth with the fluid particles moving in straight lines along the direction of flow. This type of flow is called laminar flow. The majority of flows in practice are turbulent with no uniform motion at the local level but an average velocity in the direction of flow.

The study of flow around immersed bodies has a wide variety of engineering applications but in terms of heat and mass transfer, spheres are the most important. Thus most of this article deals with sphere.

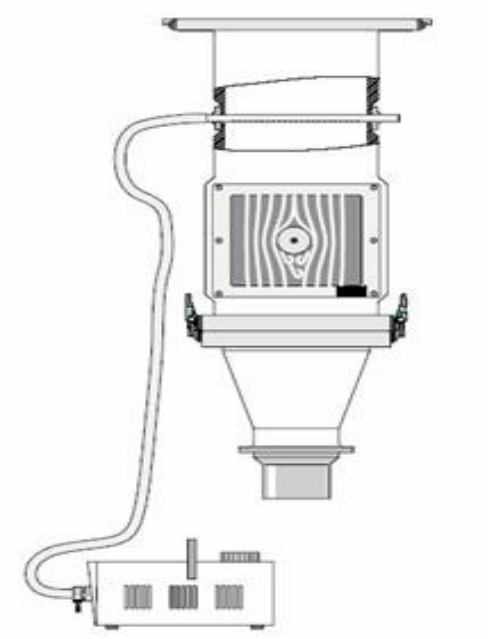

Figure 1.1 : Flow Over Immersed Body Experiment Bench

1.2 PROBLEM STATEMENT

The problem from the instrument is the smoke flow is late to fill the air smoke rig. It fills the rig with natural pressure come from smoke generator. It takes a long duration to fill it.

Therefore, to overcome the problem, the system will be modified to ensure the smoke flow faster than before. For more efficiency, maybe cooler fan will be use at the channel piping before fill in rig. So, the smoke flow will faster than before

1.3 OBJECTIVE

The main objective is design and fabricate the smoke piping system for flow over immersed body. The system will be used by researcher for an experiment of air bench

1.4 PROJECT SCOPES

To archieve the objective, several part have to consider :

1. Blower is used to move air thru the HVAC (heating, ventilation and air conditioning) system.
2. Cooler Fan is use to suck the smoke from tank to the air bench rig
3. Use PVC pipe. PVC pipe is used because it is easily to get in market. Otherwise, it is more cheaper. Maybe shape will be considered. A cylinder will always hold more than a square or triangular prism of the same length and circumference. This is because a circle makes the most efficient use of space of all the shapes, that is to say, it is the maximum size all around. So a round pipe gives you the most space for water to run through it for the amount of material you use to make it.

CHAPTER 2

LITERATURE REVIEW

2.1 THEORY

2.1.1 Flow Over Immersed Body

The shape on an object can differentiate the flow of air moving towards its. Flow over cylinders and spheres are frequently encountered in practice. Generally, surface roughness can increases the drag coefficient in turbulent flow. This case especially for case for streamlined bodies. For dull bodies such as circular cylinder or sphere, an increase in surface roughness may actually decrease the drag coefficient. It's better to illustrate the statement with the figure:

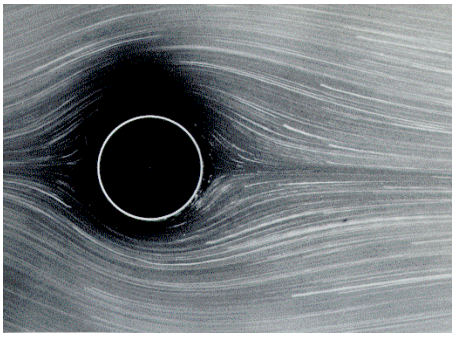

Figure 2.1: Streamline over a cylinder (low Reynolds number)

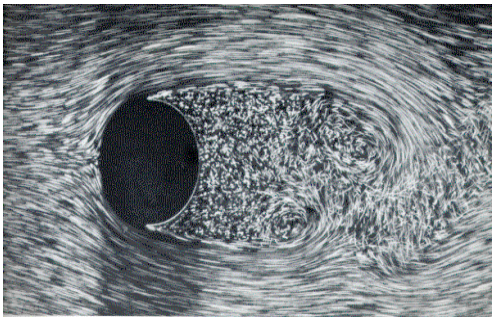

Figure 2.2: Streamline over a cylinder (high Reynolds number)

To identify the types of flow, whether laminar flow, transitional flow or turbulent flow, the formula of Reynolds Number is used, where symbol D represent the cylinder diameter:

$$\text{Reynolds Number} = \frac{\rho \text{VD}}{\mu} \tag{2.1}$$

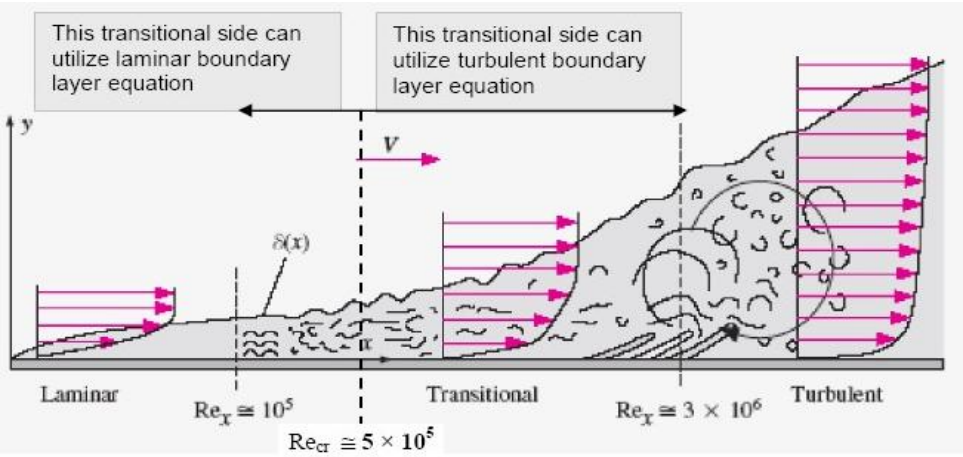

Figure 2.3: Three types of flow

Far upstream of the cylinder, the flow is uniform in all directions (we could call this a zero-dimensional flow). The flow near the cylinder varies in the streamwise and normal directions but not in the spanwise direction. So the flow near the cylinder is two-dimensional. In this region the streamlines come closer together, and the area between them decreases. Since the density is constant, the velocity must increase according to the principle of mass conservation. For constant density flow, wherever the area between streamlines decreases, the velocity increases. This is exactly similar to what happens with constant-density flow through a duct or a pipe - if the area decreases, the velocity increases so that the volume flow rate is maintained constant (volume flow rate out must equal volume flow rate in by continuity). At a reasonable speed for a reasonably sized cylinder (more precisely, at Reynolds numbers that are not too small), the maximum flow velocity in the region where the streamtubes take their minimum area is about 1.74 times the velocity in the far-field.

As the flow passes over the shoulder of the cylinder, it separates. Large eddying motions form in the wake of the cylinder, and the wake flow is unsteady and three-dimensional. Streamlines become very difficult to visualize and interpret in this region

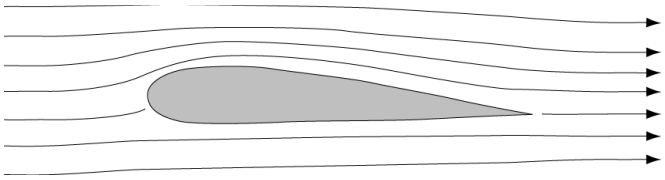

Figure 2.4: Streamline over a wing profile

In a typical external flow such as flow over an airplane wing, the boundary layer in the front portion of the body is subjected to a favourable pressure gradient, while that in the rear position is subjected to an adverse pressure gradient. If the adverse pressure gradient is strong enough, the boundary layer is likely to separate off the wall.

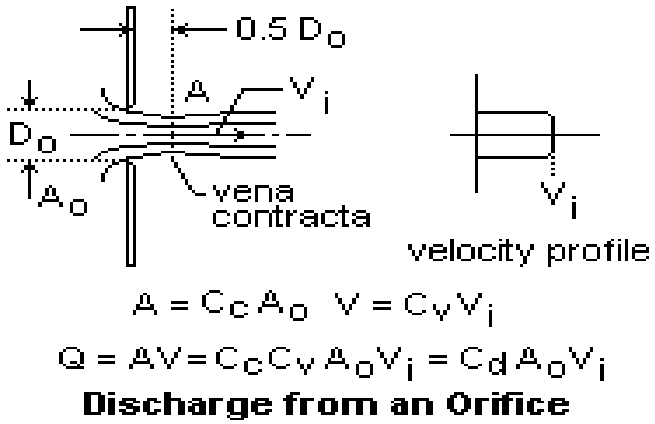

Figure 2.5: Streamline over an orifice

It can be seen that the streamlines are parallel a short distance from the orifice. The convergence of the streamlines approaching the orifice, the cross section of the jet decreases slightly until the pressure is equalized over the cross-section, and the velocity profile is nearly rectangular, after moving into the orifice, friction with the fluid outside the jet (air) slows it down, and the cross section increases perforce. This divergence is usually quite small, and the jet is nearly cylindrical with a constant velocity. The jet is held together by surface tension, of course, which has a stronger effect the smaller the diameter of the jet. The average velocity V is defined so that it gives the correct rate of discharge when it is assumed constant over the smaller area or:

$$Q=VA \tag{2.2}$$

2.1.2 Bernoulli's Theorem

The Bernoulli theorem is an approximate relation between pressure, velocity, and elevation, and is valid in regions of steady, incompressible flow where net frictional forces are negligible. The equation is obtained when the Euler's equation is integrated along the streamline for a constant density (incompressible) fluid. The constant of integration (called the Bernoulli's constant) varies from one streamline to another but remains constant along a streamline in steady, frictionless, incompressible flow. Despite its simplicity, it has been proven to be a very powerful tool for fluid mechanics.

Bernoulli's equation states that the "sum of the kinetic energy (velocity head), the pressure energy (static head) and Potential energy (elevation head) per unit weight of the fluid at any point remains constant" provided the flow is steady, irrotational, and frictionless and the fluid used is incompressible. This is however, on the assumption that energy is neither added to nor taken away by some external agency. The key approximation in the derivation of Bernoulli's equation is that viscous effects are negligibly small compared to inertial, gravitational, and pressure effects. We can write the theorem as;

$$\frac{P}{\rho g} + \frac{v}{2g} + z = \text{streamline} \tag{2.3}$$

Where, P=Pressure

ρ=density

g=gravitational pressure

v=velocity

z=elevation

The Bernoulli's equation forms the basis for solving a wide variety of fluid flow problems such as jets issuing from an orifice, jet trajectory, flow under a gate and over a

weir, flow metering by obstruction meters, flow around submerged objects, flows associated with pumps and turbines etc.

The equipment is designed as a self-sufficient unit it has a sump tank, measuring tank and a pump for water circulation as shown in figure1. The apparatus consists of a supply tank, which is connected to flow channel. The channel gradually contracts for a length and then gradually enlarges for the remaining length.

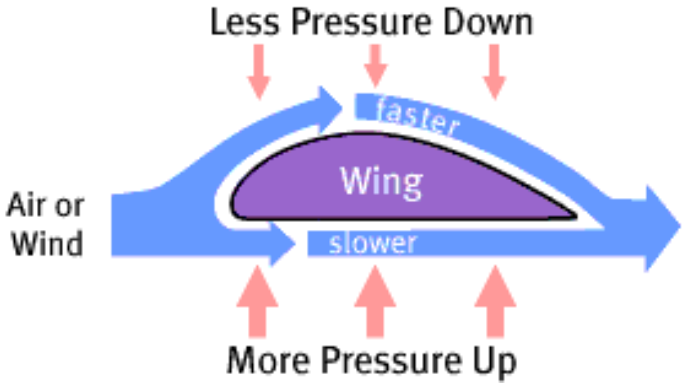

Figure 2.6: Bernoulli concept

2.1.3 Bench Marking

Figure 2.7 Smoke exhaust in restaurant

In order to make a design of smoke piping system, the several bench marking were identified. The same concept used for the project title is smoke exhaust in restaurant. Basically, most of the restaurant will use this system in their kitchen to suck the smoke during cooking process. A restaurant kitchen or commercial kitchen will produce plenty of unwanted smoke, grease, steam, vapors and odors that will need to be removed from the air. The air that is removed will travel through an exhaust system with the help of fans and be released to the outdoors from the ductwork. Without a proper exhaust system, a restaurant or commercial kitchen can have dangerous buildup of fumes and smoke, and the heat would create not only uncomfortable but also hazardous conditions for the kitchen workers.

Smoke, grease, steam and vapors create a sticky mess on commercial vent hoods, filters, fans, ductwork, walls and ceilings. This can lead to the potential development of respiratory hazards for employees, as well as unsanitary cooking conditions. Frequent and

through cleaning of the commercial kitchen ventilation equipment is required to eliminate this possibility. Regular detergents, baking soda and water pastes, and commercial degreasers are used for the proper cleaning of a restaurant hood system.

As the conclusion, the concept of this system will be use in order to complete this project where the desktop fan / silent fan will be use. It will be generate by using 9V battery and will be control by toggle switch.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will briefly describes the process to design and fabrication the smoke piping system. The process was conducted step by step as shown in flow chart beow. The literature review was carried out for further understanding on the flow over immersed body theory before starting the designing and fabrication process. The design was developed in multiple concepts in order to select a best design. These design were implemented by using the SolidWorks software. Finally the fabrication process was conducted which involving several appropriate manufacturing process.

3.2 METHODOLOGY PROCESS FLOW CHART

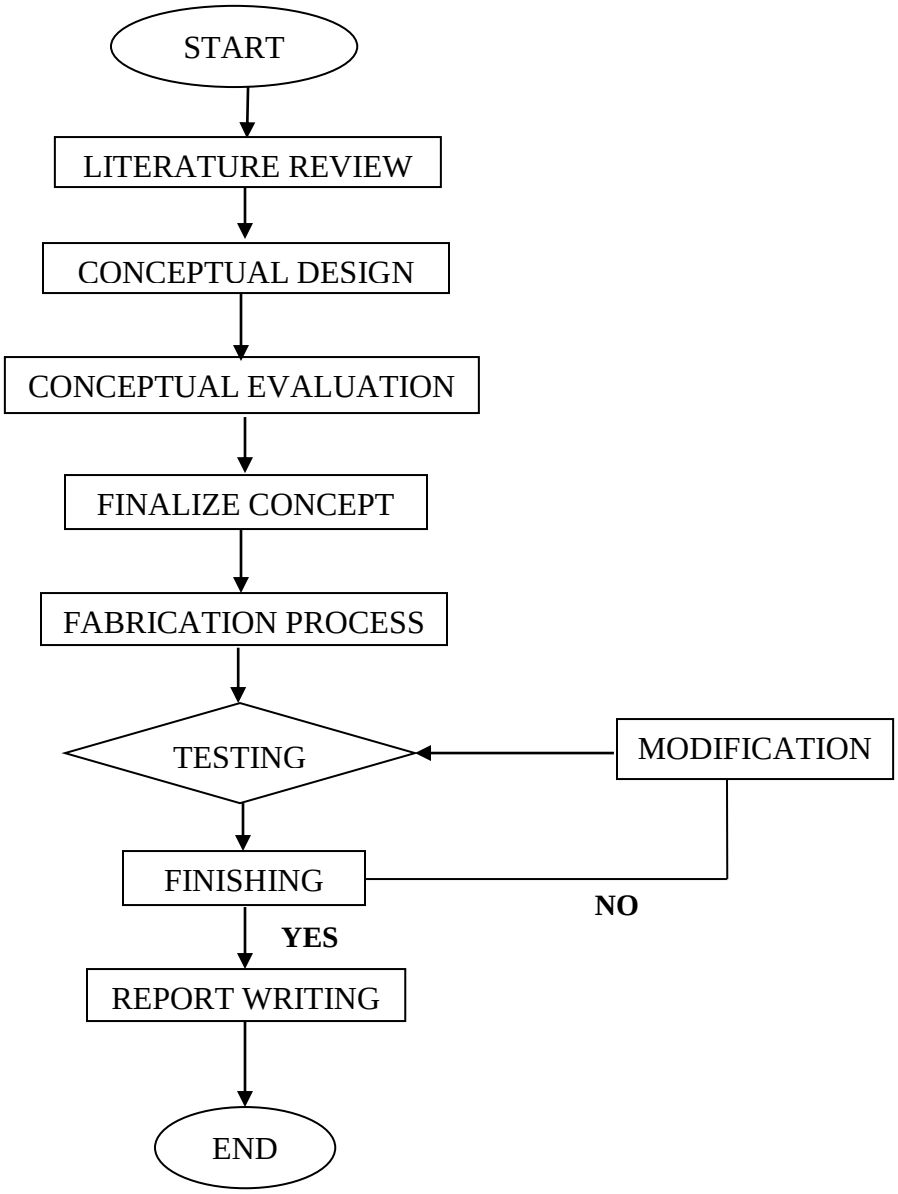

Figure 3.1: Flow Chart

This project is basically beginning with the topic selection and discussion regarding the project topic about the project objectives and project scopes with the supervisor. Then, the literature review process was performed to investigate the existing smoke piping system in term of material used and etc. Other references materials like text books and journals had been studied to get further understanding about this project topic.

After that, the designing process was carried out starting with the design sketching and then improves into proper design into proper design drawing by using SolidWorks software. The design generation and design selection were implemented in order to select a best design among the others design. The selection of the design was carried out by using the concept scoring method base on the some criterions. Next, the necessary material were selected to fabricate the smoke piping system.

Then, the fabrication process of the selected design was conducted by using appropriate fabrication process. After the fabrication process had been done, the testing of the system was performed in order to know whether it can be run or not. Finally, the report of this final project needed to be completed and submit before the due date.

3.3 SMOKE PIPING SYSTEM

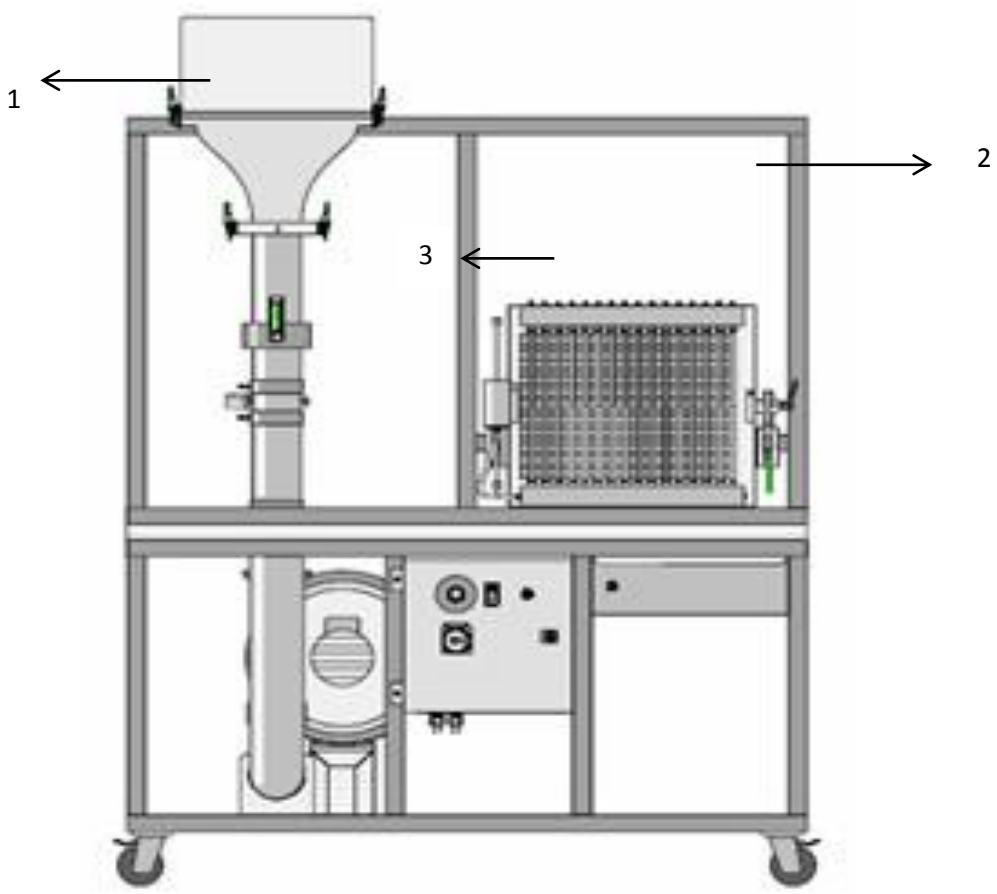

Figure 3.2 Front view of Flow Bench

1. Air Bench Rig
    - It use to trap the smoke from the smoke generator
2. Metering Element
    - There are several possible types of metering element in use. Flow benches ordinarily use three types: orifice plate, venturi meter and pitot/static tube, all of which deliver similar accuracy. Most commercial machines use orifice plates due to their simple construction and the ease of providing multiple flow ranges. Although the venturi offers substantial improvements in efficiency, its cost is higher.
3. Test Pressure Manometer

3.4 DESIGN GENERATION

1ST DESIGN

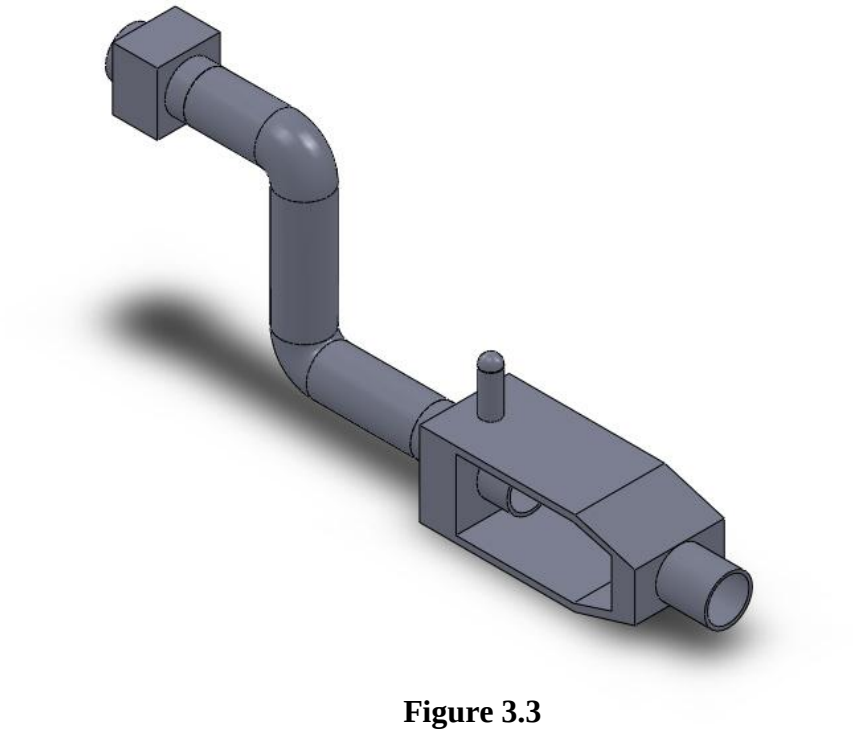

Figure 3.3

The advantages of this design are it trap smoke first. The smoke level also easy to know because the smoke level is use in order to know the level of smoke. The disadvantages of this design is the distance between fan and tank too far. It maybe difficult the suction happen. Other than that, it's complicated because use control system which the PLC has to apply to this system.

2ND DESIGN

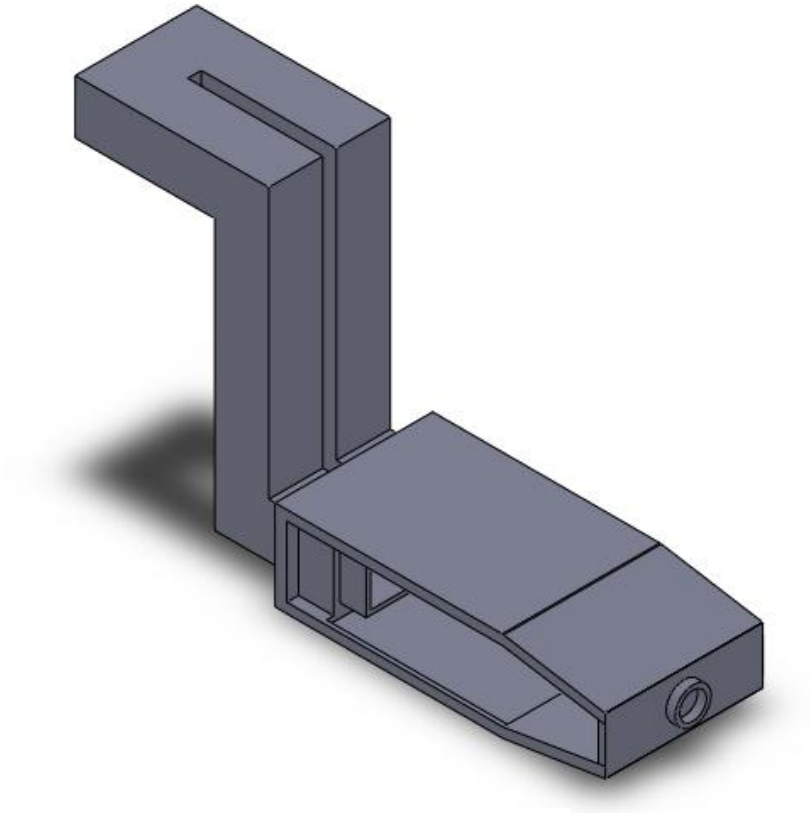

Figure 3.4

The advantages of this design are it trap smoke first. Other than that, the flow of smoke more faster because using 2 silent fan at the door of air bench rig. The disadvantage of this design is the length between fan and tank is far each other. So, the efficiency of suction is decrease.

3RD DESIGN

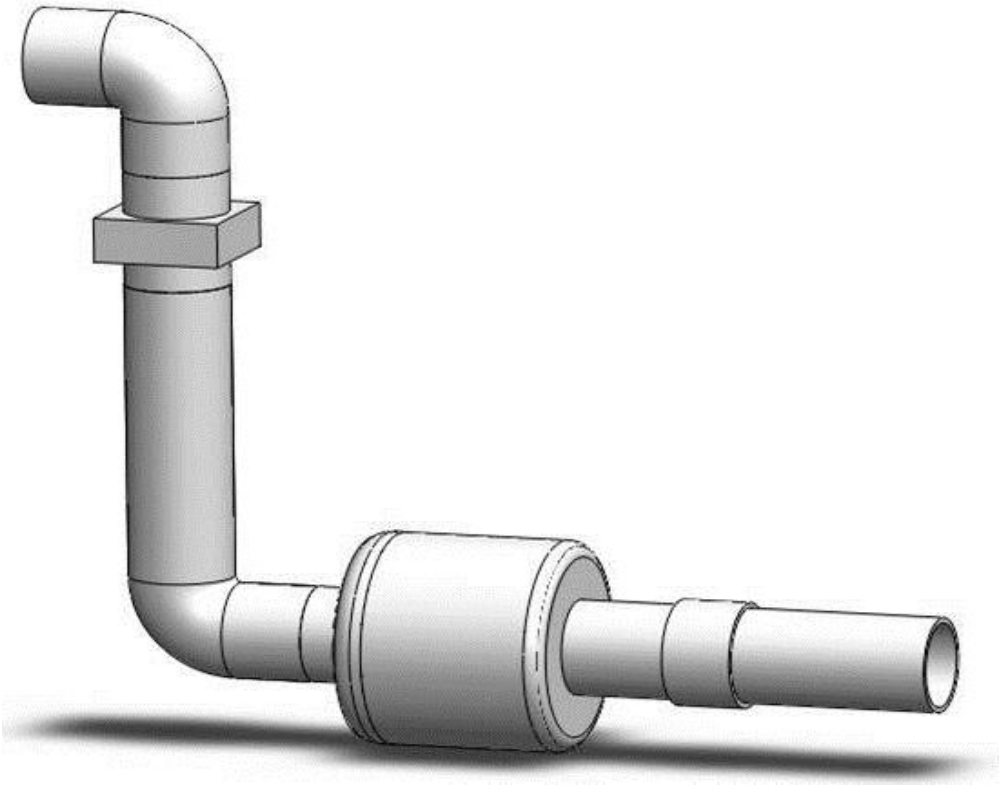

Figure 3.5

The advantages of this design are it trap smoke first. Otherwise, the fan is more closer to smoke tank that make it easily to suck. The disadvantage of this design is the tank is too small. So, it can trap smoke in a few quantity

3.5 FINALIZE DESIGN

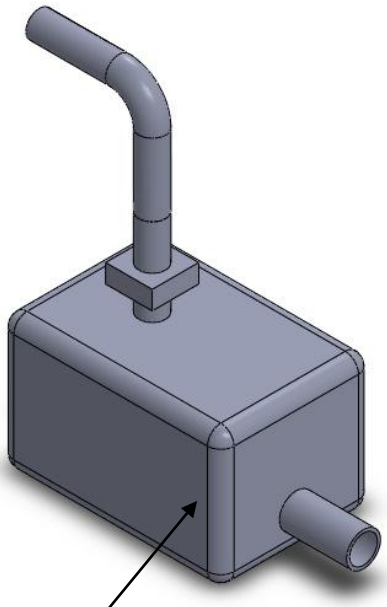

Figure 3.6 Complete Design of Smoke Piping System

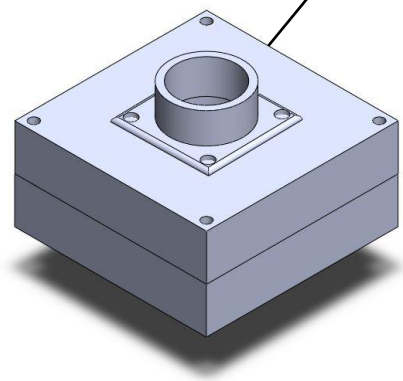

Figure 3.7 Fan Housing

The complete design is shown above which the fan housing is place between tank and air bench rig. The upper PVC pipe will connect to the flunge at air bench rig while the below pipe is connected to the smoke generator.

3.6 DESIGN SELECTION

Design selection is very important in order to select a best design. In this topic some desired criteria was listed which to be rated by each of design concept. Table below shows the concept selection process.

Table 3.1: Concept selection

Criteria	**1st Design**	**2nd Design**	**3rd Design**
1. Easy to use	0	0	0
2. Easy for maintenance	+	-	+
3. Cost production	0	-	+
4. Easy to keep	0	0	0
5.Performance	0	0	+
6. Work area	0	0	0
Plus	1	0	3
Same	5	5	3
Minus	0	2	0
Net	1	-2	0
Rank	2	3	1
Proceed?	Yes	No	Yes

3.7 BILL OF MATERIALS

Table 3.2 Bill of Materials

PARTS	MATERIAL	DIMENSIONS	QUANTITY
FAN HOUSING	ALUMINIUM SQUARE	100X100X25	2
FLUNGE	ALUMINIUM ROD	70mm	2
PIPE PVC	PIPE	3”/2”	2m

The aluminum square is use because want to place the ‘silent fan’ inside it. The shape of ‘silent fan’ is square considered with its cover, so the aluminium square is use. For flunge, the aluminium rod is use because the shape of pipe is round, so it is easily to attach. For pipe, the PVC pipe is used because the shape have in market and it is cheaper than GI pipe.

3.8 FABRICATION

In order to make the design comes to reality, fabrication process need to be done forst. The fabrication process starts from dimensioning the material until it finish as desired product. The process that involved in this project is:

3.8.1 Measuring process

All the raw materials that will be used in this project is measuring. It is important in order to get accurate dimension like in design.

3.8.2 Lathe Process

This is second process involve in this fabrication. The parts of flunge at smoke generator and air bench rig is make using lathe machine. The rotation speed use is 650 rpm for aluminium which have diameter 70mm.

Figure 3.8: Lathe process to making flunge

3.8.3 CNC Milling Process

This process is used to make a square pocket and circular pocket on the aluminium square. The is shown in the Appendix B. Then, the cutting process start after the workpiece is clamped and the coding is transfer to the controller. The cutting tool use for this process is end mill 8.

3.8.4 Drilling Process

This is last process involve. The parts need to drill are fan housing that will be join through bolt and nut and the flunge also need to drill so that it will be attached with air bench rig.

Figure 3.9: Drilling process to making holes on flunge

3.9 THE DESCIPTION OF COOLER CIRCUIT

The problem faced is the smoke flow is late to fill the air smoke rig. It fills the rig with natural pressure come from smoke generator. It takes a long time to fill it. Therefore, to overcome the problem, the system will be modified to ensure the smoke flow faster than before. For more efficiency, maybe cooler fan will be use at the channel piping before fill in rig. So, the smoke flow will faster than before.

The simple cooler circuit has 3 main components, a battery, a switch and a cooler that are connected by wires. The battery that used is battery 9V with the negative terminal and the positive terminal located aside. This battery ideal for the following applications; cameras, digital cameras, GPS units, discmans/MP3 Players, children's toys, pocket flashlights, remote controls, radios and etc.

3.9.1 Battery

Energizer 9 Volt batteries deliver outstanding performance and reliability. Some major advantages of Energizer 9 Volt batteries includes:

- Dependable
- Long lasting power

Figure 3.10: 9V Battery

3.9.2 Switch

The next component is switch. The switch used is switch toggles. It used to connect and disconnect the current flow in the circuit. Current flow when the switch button is pressed or pushed towards the direction contrary, the current stops flowing. It have 3 legs which are COM (common), NO (normally open) dan NC (normally close).

Figure 3.11: Toggle Switch

3.9.3 Fan

The next component is “Silent Fan” which is compatible with all system and CPU coolers. It used because it long life, low noise and low pollution.

Specifications:

Table 3.3

Fan Dimension	80 x 80 x 10 mm
Rated Voltag	12 VDC
Rated Speed	3000 10% RPM
Noise level	<27.3 dBa
Beraing Type	Ever Lubricate bearing
Life Time	Over 30000 hr

The “Silent Fan” will located after smoke tank and air flow bench where it will compact by fan housing that makes using aluminium material. It will be place with fan housing and the switch toggles and battery will be locate near the housing to make it easy control.

Figure 3.12: Silent Fan

3.9.4 Wire

The black wire connects to the negative terminal of the cell battery while the red wire connects to the switch. While the positive terminal connects with switch through connection wire. The wires were classified by certain colour :

1.Red Wire / BrownWire – LifeWire
2.Blue Wire / Black Wire – Neutral Wire
3. Green Wire/ Green Yellow Stripe – Earth Wire

Figure 3.13 Type of Wire

3.9.5 Technical Circuit

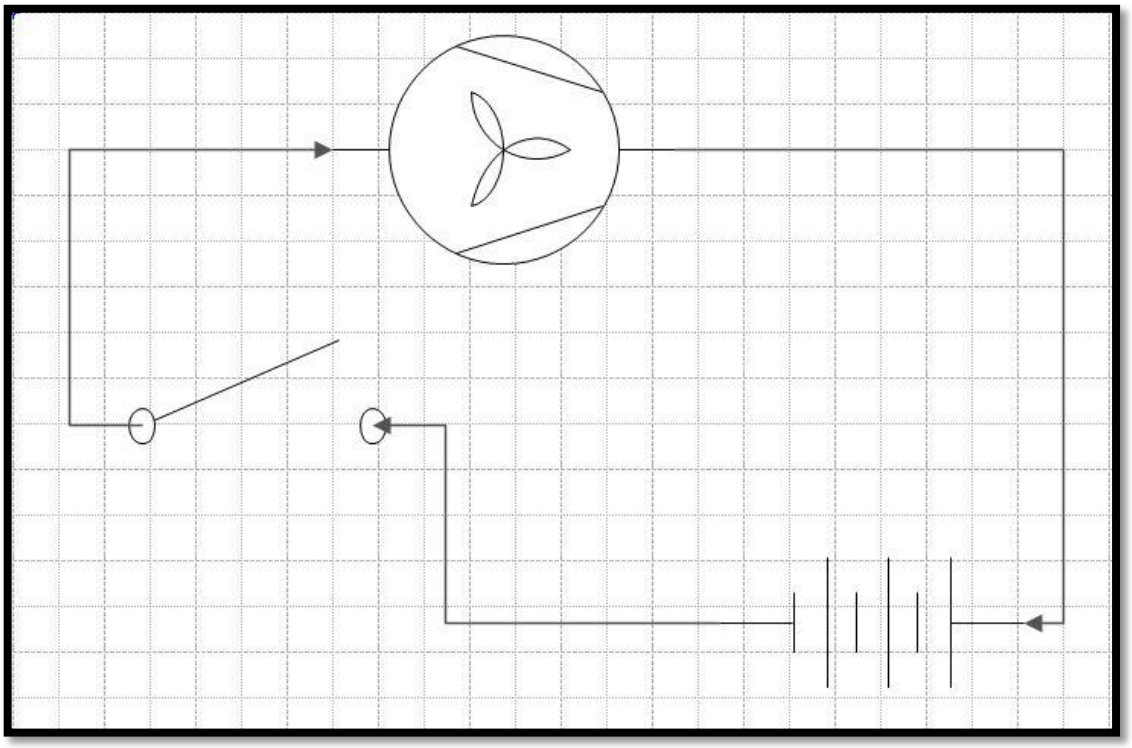

Figure 3.14: Technical Circuit

Electrons flow out of the negative end of the battery and through the cooler, causing it to spin and back into the positive terminal of the terminal. Electron flow from negative terminal to positive terminal while current flow from positive terminal to negative terminal.

CHAPTER 4

RESULT AND DISCUSSION

4.1 RESULT AND DISCUSSION

There is the result after the fabrication process was complete. The project is completely finish after all the part of material is combined together. The experiment can be carried out by researcher after all part have completely assemble

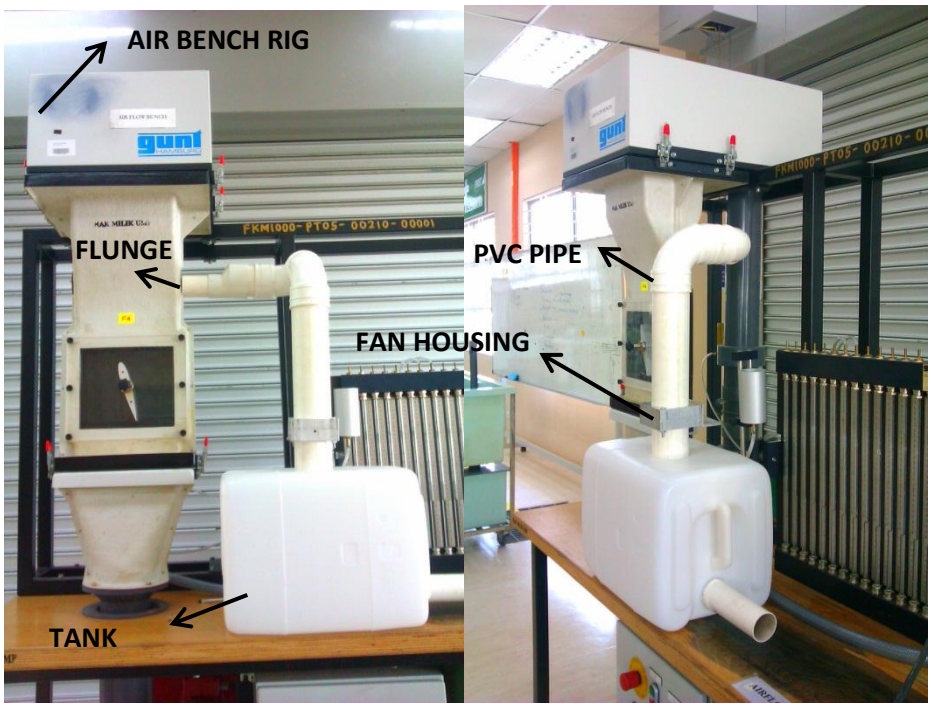

Figure 4.1: Complete Assemble

The final product in several view are shown in the Figure 4.1. The pipe has been attach at the air bench rig through aluminium flunge. The fan housing also has been attached with PVC pipe and tank.

4.2 PART OF SMOKE PIPING SYSTEM

4.2.1 Fan Housing

The fan housing was mainly made of aluminium square which size is 100x100x25. The fan housing is making by using CNC Milling Machine. The coding to make the square pocket and circular pocket can see in the Appendix B. The fan housing was used to place the ‘Silent Fan’.

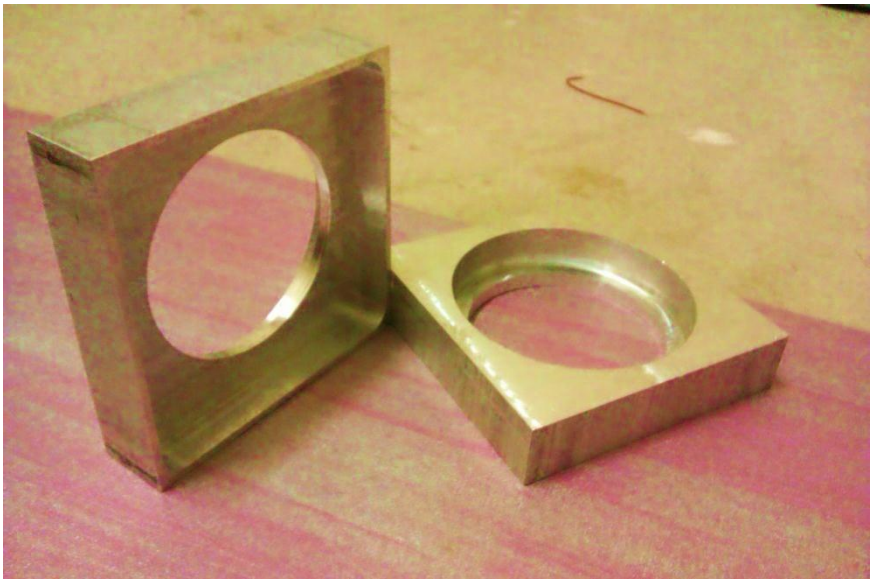

Figure 4.2: Fan Housing

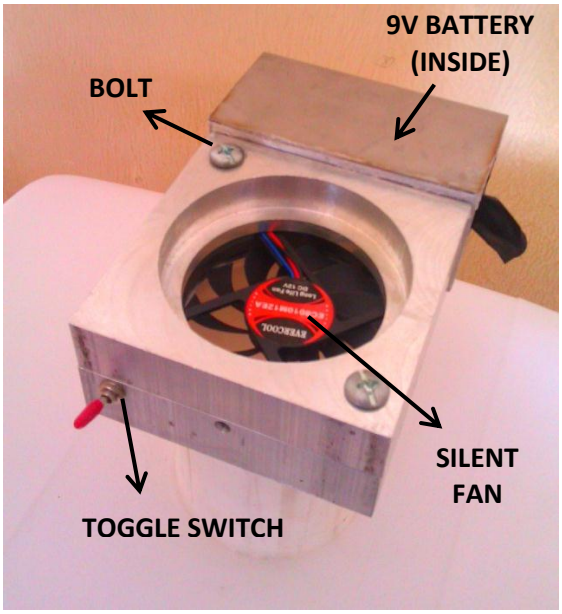

Figure 4.3: Assembly Fan Housing and Fan

The fan housing completely assemble using bolt and nut. The bolt used is 60mm the length which at the end, it attach with nut. The 'Silent Fan' already place inside the fan housing with use the electric and electronic connection. The 'Silent Fan' will be spin or start when the toggle switch is push to the other side. Actually the toggle switch use is toggle switch 3 legs. . It have 3 legs which are COM (common), NO (normally open) dan NC (normally close). But in the connection, just two wire are connected to the leg which is leg NC and leg NO. The 9V battery is placed at the back of the fan housing.

4.2.2 Bolt and Nut

In this project, 2 bolt and 2 nut only used because just two hole were drilled. Its function on the fan housing because the fan housing had 2 part (upper and lower), so the bolt and nut were used to assemble it.

Figure 4.4: Bolt and Nut

4.2.3 Flunge

The Figure 4.4 (a) show the flunge that placed on the air bench rig. It will place on air bench rig using screw. It function as connector with PVC pipe 2". While flunge in Figure 4.4 (b) was placed at the smoke generator. It's because when the smoke generator is on, the flunge can absorb heat because the aluminium is good resistance.

(a) (b)

Figure 4.5: Flunge

CHAPTER 5

CONCLUSION AND RECOMMEDATIONS

5.1 INTRODUCTION

The purpose of this chapter is give conclusion and recommendation for this project. It will also include the objective of this project it is fulfilled, the flow of the project and gives suggestion to improve the project.

5.2 CONCLUSION

The project is finish and the smoke piping system is able to suck the smoke in the short duration to air bench rig. The objective of the project is archieved at the end of design and fabrication. The design of the smoke piping system had developed by using SolidWorks software.

The smoke piping system was produced by conducting several fabrication processes such as measuring, milling, lathe and drilling. The fan housing, flunge was made from aluminium. Thus, it is light weight and easy to move from one place to another place. Besides, it is long lasting because the aluminium had the properties of corrosion resistance and high strength. The fan housing also easy to assemble and disassemble since it was combined by using bolt and nut.

At the end, the concept of flow over immersed body was understood. The flow of smoke can conclude whether it is turbulent or laminar. Then, by performing the fabrication process it will develop the skills to handle the machines in laboratory. Furthermore, the fundamental of manufacturing knowledge also can be enhanced. Throughout this project, the critical thinking and problem solving were fostered in order to overcome the problems occurred.

5.3 RECOMMENDATIONS

There are a few recommendations to improve the smoke piping system for future use :

1. Use an adapter. It will replace the 9V battery. It will connect directly from the source from electricity. Thus, the wire should have change to the thick wire because if the adapter is use, the heat is more because the current move is higher.

2. Use a controller to control the speed of smoke. So, the amount of smoke enter air bench rig can be know as what researcher want.

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APPENDICES

Appendix A

Gantt Chart

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
DISCUSSION REGARDING THE PROJECT	PLAN														
	ACTUAL														
MEETING WITH SUPERVISOR	PLAN														
	ACTUAL														
DESIGN	PLAN														
	ACTUAL														
FINALIZE DESIGN	PLAN														
	ACTUAL														
SLIDE FOR FIRST PRESENTATION	PLAN														
	ACTUAL														
MID PRESENTATION	PLAN														
	ACTUAL														
FABRICATION	PLAN														
	ACTUAL														
MAKING FINAL SLIDE	PLAN														
	ACTUAL														
FINAL PRESENTATION	PLAN														
	ACTUAL														
FINAL REPORT	PLAN														
	ACTUAL														

Appendix B

CNC Coding

1.Pocket Mill

N100 T1 MO6

N102 G90 G54 G00 X0. Y0.

N104 S2000 M03

N106 G43 H01 Z0.1 M08

N108 G1 Z0.01 F30

N110 G150 P511 Z-12 Q0.5 R5 J8. K0.3 G41 D01 F10

N112 G40 G01 X0 Y0

N114 G00 Z1. M09

N116 G28 G91 Y0 Z0

N118 M30

%

Subroutine

O00511

G01 Y40

X-40

Y-40

X40

Y40

X0

M99

%

2. Circular Pocket

N100 T1 M06

N102 G00 G90 654 X0 Y0

N104 S400 M03

N106 G43 H01 Z2. M08

N108 G01 Z-8 F80.

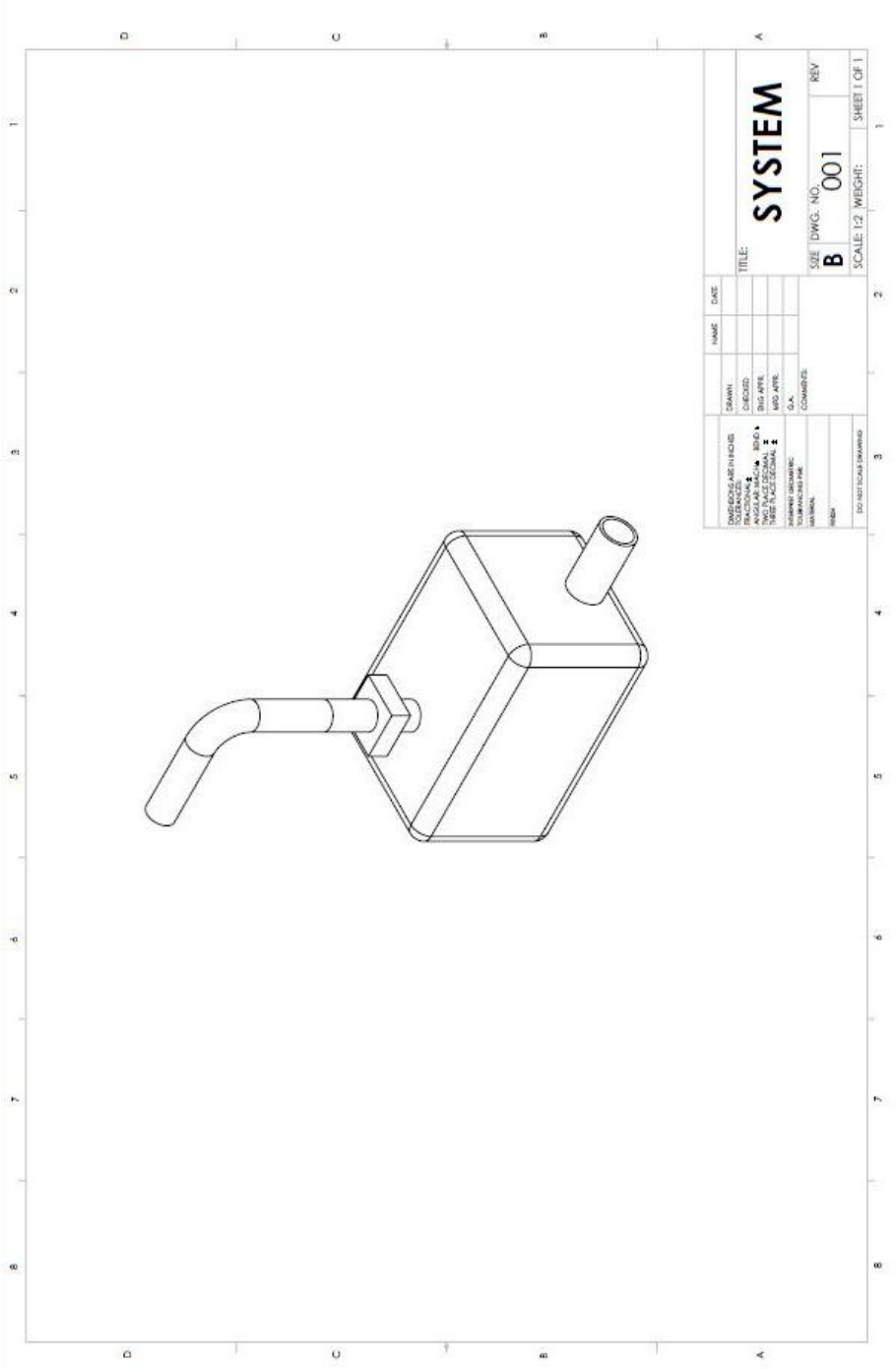
N110 G13 G91 Z-4. I15. K41.5 Q15. L2 D01 F30

N112 G00 G90 Z5 M09

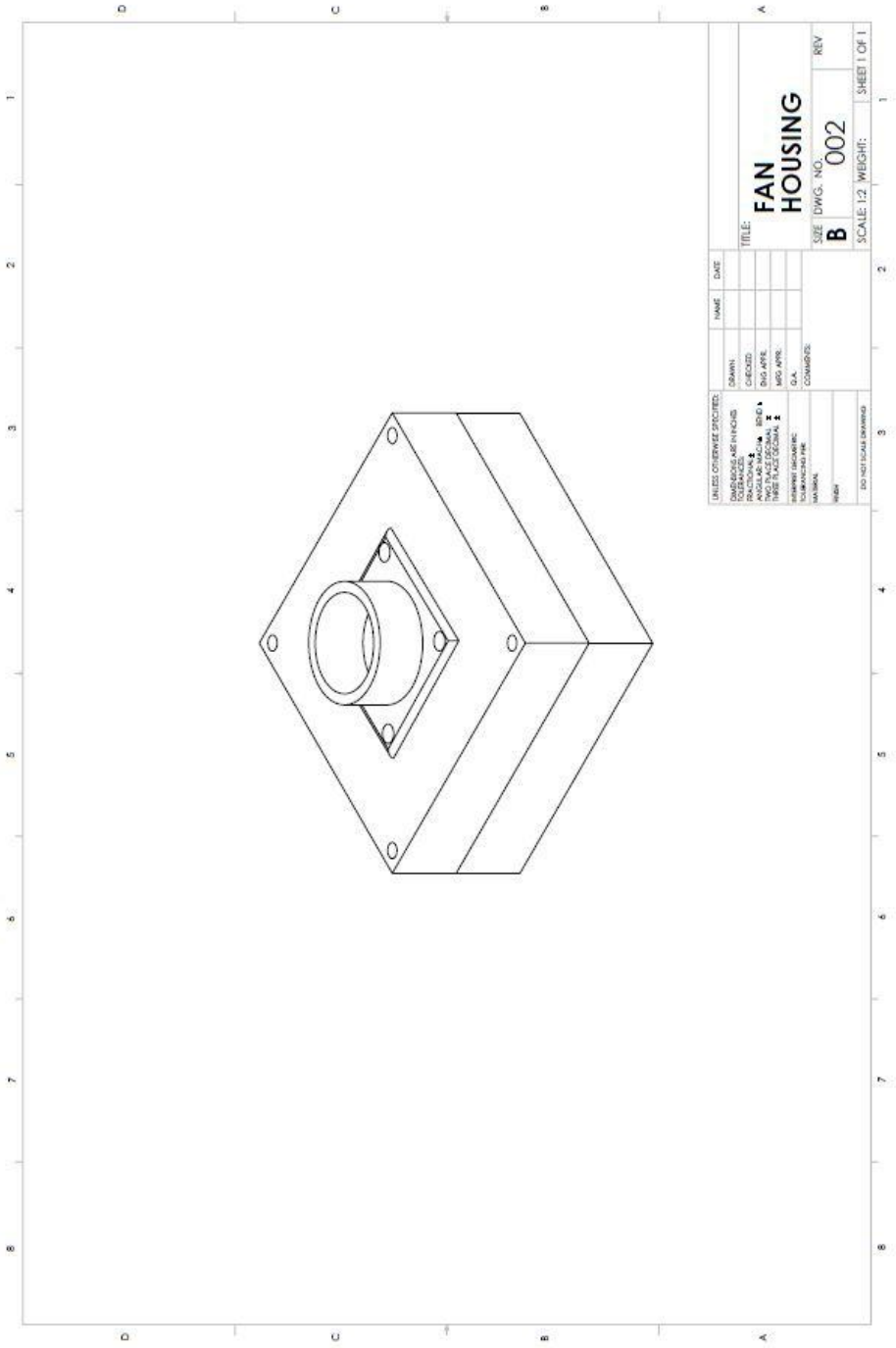
N114 G28 G91 Y0 Z0

N116 M30

Appendix C


SYSTEM
SIZE
B
DWG. NO.
001
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
NAME
DATE
TITLE:

Appendix D



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Report submitted in partial fulfillment of requirements for the award of

Diploma in Mechanical Engineering

Faculty of Mechanical Engineering

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