POLITEKNIK MALAYSIA
MUKAH

MINI STEAM POWER PLANT

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SESSION: JUNE 2017

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This report is submitted to the Department of Mechanical Engineering in partial full filament of the requirements for graduation Diploma in Mechanical Engineering

PROJECT REPORT VERIFICATION

This report entitled "**MINI STEAM POWER PLANT**" has been submitted and reviewed as to meet the conditions and requirements of project writing.

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We, are the third year Diploma in Mechanical Engineering students, located at KM 7.5 Jalan Oya, 96400 Mukah. (Will be referred to as Polytechnic).

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Therefore, we were and are grateful to many people for the help either direct or indirect in writing this technical report.

Thank you.

ABSTRACT

This Mini Steam Power Plant project is specially designed for Mukah Polytechnic students who take thermodynamic subjects only in Mechanical Engineering only. This project is carried out during experiential activities in learning time as this project can help to improve understanding of the Rankine cycle process. In addition, this project has 4 main component available from the Rankine cycle process. Among the 4 main component are boiler, radiator, pump and turbine. In the boiler section, there are some important things that need to be there such as safety gauge and pressure gauge to prevent any accidents it is not expected during the experiment. The type of boiler used is a water tube boiler because this type is easy to obtain from such things as pressure cooker and water heater. This boiler uses gases to heat the water in it to produce the compact is then discharged to the electric generating part of the turbine. From the turbine spinning due to high pressure punch to each turbine blades then the resulting electric current proves that the bulb can be lit during this process occurs. At the same time, the process of gas switching to water is called as condenser is in progress and from this process the water will be channeled to the radiator to cool the high temperature water. then the water will be discharged to the water storage tank and then sent back to boiler by aquarium pump.This experimental project has dimension 1m x 1m x 1m.In conclusion, this Mini Steam Power Plant project has safety features because the boiler is made of anti-rust stainless steel. Previously, students still do not understand the cycle Rankine because they studied the theory and did not experiment with the lack of materials to experiment.

ABSTRAK

Projek Loji Kuasa Mini Steam ini direka khas untuk pelajar Politeknik Mukah yang mengambil mata pelajaran termodinamika hanya dalam Kejuruteraan Mekanikal sahaja. Projek ini dijalankan semasa aktiviti pembelajaran dalam masa pembelajaran kerana projek ini dapat membantu untuk meningkatkan pemahaman proses kitaran Rankine. Di samping itu, projek ini mempunyai 4 komponen utama yang boleh didapati daripada proses kitaran Rankine. Antara 4 komponen utama ialah dandang, radiator, pam dan turbin. Di dalam bahagian dandang, terdapat beberapa perkara penting yang perlu ada di sana seperti tolok keselamatan dan tolok tekanan untuk mengelakkan sebarang kemalangan yang tidak dijangka semasa eksperimen. Jenis dandang yang digunakan ialah dandang tiub air kerana jenis ini mudah diperolehi dari hal-hal seperti periuk tekanan dan pemanas air. Dandang ini menggunakan gas untuk memanaskan air di dalamnya untuk menghasilkan padat kemudian dilepaskan ke bahagian penjanaan elektrik turbin. Dari turbin berputar kerana punch tekanan tinggi untuk setiap bilah turbin maka arus elektrik yang dihasilkan membuktikan bahawa mentol boleh dinyalakan semasa proses ini berlaku. Pada masa yang sama, proses pemancaran gas ke air dipanggil sebagai kondensor sedang berjalan dan dari proses ini air akan disalurkan ke radiator untuk menyejukkan air suhu tinggi. maka air akan dilepaskan ke tangki simpanan air dan kemudian dikembalikan ke dandang oleh pam akuarium. Projek eksperimen ini mempunyai dimensi 1m x 1m x 1m. Dalam kesimpulannya, projek Loji Kuasa Mini Steam ini mempunyai ciri-ciri keselamatan kerana dandang dibuat keluli tahan karat anti karat. Sebelum ini, pelajar masih tidak memahami peringkat Rankine kerana mereka mempelajari teori dan tidak bereksperimen dengan kekurangan bahan untuk bereksperimen.

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CHAPTER 1

INTRODUCTION

1.1 SYNOPSIS

The project called "Mini Steam Power Plant" because the project is designed to focus on Polytechnic students Mukah, however, it functions as a generator of electricity produced from water vapor.Boilers are the main components that will produce water vapor from the boiling water while the turbine rotates when water vapor through the turbine blades and generate electricity. The boiler also has a pressure gauge which serves as measuring the pressure inside and have a safety valve that serves as security such as when the pressure exceeds a predetermined limit, the safety valve will act promptly. Suitable materials used to make the boiler is stainless steel so that components can be used with a long period of time and does not contribute any danger to users. This project aims to use gases so that the resulting boiling process.

1.2 PROBLEM STATEMENT

Among the problems that is faced by the students who are studying thermodynamics is the difficulties in understanding the Rankine cycle graph. This is due to the fact that the students are not able to understand the graph thoroughly only by theory. The Mini Steam Power Plant is built just for that purpose as they will be able to precisely picture the cycle with this tool.

The next problem faced by the students of thermodynamics is the calculation regarding Rankine cycle. Some of the students were unable to use the existing formula, based on the steam table. It took them quite some time for them to understand and to apply the formula correctly.

Another problem the students faced is the lack of equipment while performing thermodynamics experiments. The experiments regarding thermodynamics are not elaborate enough for the students. While the students can try to find information regarding the cycle through sources like the internet or reference books, it is easier to understand by observing it directly.

1.3 OBJECTIVE

Among the objective are achieved:

a) To improve knowledge in the theory of the Rankine cycle.

b) To create Mini Steam Power Plan.

1.4 SCOPE

Among the scope are achieved:

a) Only used for thermodynamics subject.

b) Only used to conduct experiments only.

c) Use turbine.

CHAPTER 2

LITERATURE REVIEW

2.1 HISTORY OF MINI STEAM POWER PLANT

The initially developed reciprocating steam engine has been used to produce mechanical power since the 18th Century, with notable improvements being made by James Watt. When the first commercially developed central electrical power, stations were established in 1882 at Pearl Street Station in New York and Holborn Viaduct power station in London, reciprocating steam engines were used. The development of the steam turbine in 1884 provided larger and more efficient machine designs for central generating stations. By 1892 the turbine was considered a better alternative to reciprocating engines, turbines offered higher speeds, more compact machinery, and stable speed regulation allowing for parallel synchronous operation of generators on a common bus. After about 1905, turbines entirely replaced reciprocating engines in large central power stations. The largest reciprocating engine-generator sets ever built were completed in 1901 for the Manhattan Elevated Railway. Each of seventeen units weighed about 500 tons and was rated 6000 kilowatts; a contemporary turbine set of similar rating would have weighed about 20% as much.

2.2 INTRODUCTION OF MINI STEAM PLANT

A thermal power station is a power plant in which heat energy is converted to electric power. In most of the places in the world the turbine is steam-driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankine cycle. The greatest variation in the design of thermal power stations is due to the different heat sources, fossil fuel dominates here, although nuclear heat energy and solar heat energy are also used. Some prefer to use the term energy centre because such facilities convert forms of heat energy into electrical energy. Certain thermal power plants also are designed to produce heat energy for industrial purposes of district heating, or desalination of water, in addition to generating electrical power.

2.3 RANKINE CYCLE

The Rankine cycle is a model that is used to predict the performance of steam turbine systems, though the theoretical principle also applies to reciprocating engines such as steam locomotives. The Rankine cycle is an idealized thermodynamic cycle of a heat engine that converts heat into mechanical work. The heat is supplied externally to a closed loop, which usually uses water as the working fluid. It is named after William John Macquorn Rankine, a Scottish polymath and Glasgow University professor.

The Rankine cycle closely describes the process by which steam-operated heat engines commonly found in thermal power generation plants generate power. The heat sources used in these power plants are usually nuclear fission or the combustion of fossil fuels such as coal, natural gas, and oil.

The efficiency of the Rankine cycle is limited by the high heat of vaporization of the working fluid. Also, unless the pressure and temperature reach super critical levels in the steam boiler, the temperature range the cycle can operate over is quite small: steam turbine entry temperatures are typically around 565 °C and steam condenser temperatures are around 30 °C. This gives a theoretical maximum Carnot

Efficiency for the steam turbine alone of about 63.8% compared with an actual overall thermal efficiency of up to 42% for a modern coal-fired power station. This low steam turbine entry temperature (compared to a gas turbine) is why the Rankine (steam) cycle is often used as a bottoming cycle to recover otherwise rejected heat in combined-cycle gas turbine power stations.

The working fluid in a Rankine cycle follows a closed loop and is reused constantly. The water vapor with condensed droplets often seen billowing from power stations is created by the cooling systems (not directly from the closed-loop Rankine power cycle) and represents the means for (low temperature) waste heat to exit the system, allowing for the addition of (higher temperature) heat that can then be converted to useful work (power). This 'exhaust' heat is represented by the "Q_{out}" flowing out of the lower side of the cycle shown in the T/s diagram below. Cooling towers operate as large heat exchanges by absorbing the latent heat of vaporization of the working fluid and simultaneously evaporating cooling water to the atmosphere. While many substances could be used as the working fluid in the Rankine cycle, water is usually the fluid of choice due to its favorable properties, such as its non-toxic and unattractive chemistry, abundance, and low cost, as well as its thermodynamic properties. By condensing the working steam vapor to a liquid the pressure at the turbine outlet is lowered and the energy required by the feed pump consumes only 1% to 3% of the turbine output power and these factors contribute to a higher efficiency for the cycle. The benefit of this is offset by the low temperatures of steam admitted to the turbine(s). Gas turbines, for instance, have turbine entry temperatures approaching 1500°C. However, the thermal efficiency of actual large steam power stations and large modern gas turbine stations are similar.

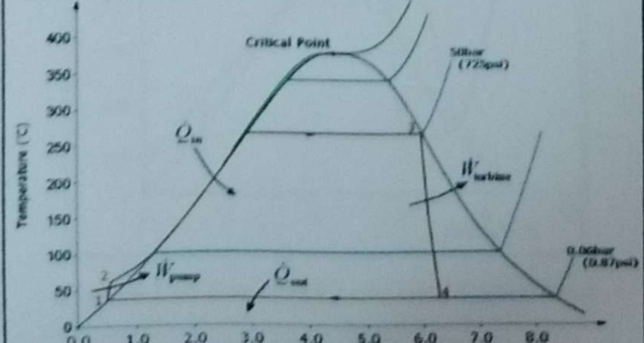

Figure 2.1: Rankine Cycle

T-s diagram of a typical Rankine cycle operating between pressures of 0.06bar and 50bar, there are four processes in the Rankine cycle. These states are identified by numbers (in brown) in the above T-s diagram.

1) Process 1-2: The working fluid is pumped from low to high pressure. As the fluid is a liquid at this stage, the pump requires little input energy.

2) Process 2-3: The high-pressure liquid enters a boiler where it is heated at constant pressure by an external heat source to become a dry saturated vapor. The input energy required can be easily calculated graphically, using an enthalpy-entropy chart (aka h-s chart or Mollier diagram), or numerically, using steam tables.

3) Process 3-4: The dry saturated vapor expands through a turbine, generating power. This decreases the temperature and pressure of the vapor, and some condensation may occur. The output in this process can be easily calculated using the chart or tables noted above.

4) Process 4-1: The wet vapor then enters a condenser where it is condensed at a constant pressure to become a saturated liquid.

2.4 RANKINE CYCLE WITH SUPER HEAT

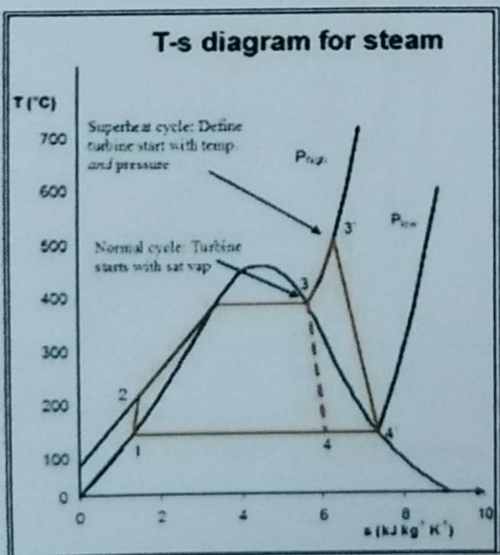

Figure 1.2: Rankine Cycle with Super Heat

In a real power plant cycle (the name 'Rankine' cycle is used only for the ideal cycle), the compression by the pump and the expansion in the turbine are not semitropical. In other words, these processes are non-reversible and entropy is increased during the two processes. This somewhat increases the power required by the pump and decreases the power generated by the turbine.

In particular, the efficiency of the steam turbine will be limited by water droplet formation. As the water condenses, water droplets hit the turbine blades at high speed causing pitting and erosion, gradually decreasing the life of turbine blades and efficiency of the turbine. The easiest way to overcome this problem is by super heating the steam. On the Ts diagram above, state 3 is above a two-phase region of steam and water so after expansion the steam will be very wet. By super heating, state 3 will move to the right of the diagram and hence produce a drier steam after expansion.

2.5 RANKINE CYCLE WITH REHEAT

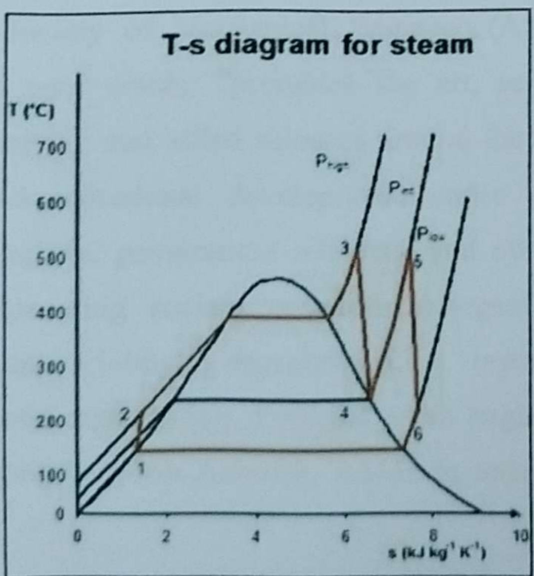

Figure 2.2: Rankine Cycle with Reheat

The purpose of a reheating cycle is to remove the moisture carried by the steam at the final stages of the expansion process. In this variation, two turbines work in series.

The first accepts vapor from the boiler at high pressure. After the vapor has passed through the first turbine, it re-enters the boiler and is reheated before passing through a second, lower-pressure, and turbine. The reheat temperatures are very close or equal to the inlet temperatures, whereas the optimum reheat pressure needed is only one fourth of the original boiler pressure. Among other advantages, this prevents the vapor from condensing during its expansion and thereby damaging the turbine blades, and improves the efficiency of the cycle, because more of the heat flow into the cycle occurs at higher temperature.

The reheat cycle was first introduced in the 1920s, but was not operational for long due to technical difficulties. In the 1940s, it was reintroduced with the increasing manufacture of high-pressure boilers, and eventually double reheating was introduced in the 1950s. The idea behind double reheating is to increase the average temperature

2.6 THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

The American Society of Mechanical Engineers (ASME) is a professional association that, in its own words, "promotes the art, science, and practice of multidisciplinary engineering and allied sciences around the globe" via "continuing education, training and professional development, codes and standards, research, conferences and publications, government relations, and other forms of outreach." ASME is thus an engineering society, a standards organization, a research and development organization, a lobbying organization, a provider of training and education, and a nonprofit organization. Founded as an engineering society focused on mechanical engineering in North America, ASME is today multidisciplinary and global.

2.6.1 Standard of Boiler

Section I – Power Boilers Provides requirements for all methods of construction of power, electric, and miniature boilers; high temperature water boilers, heat recovery steam generators, and certain fired pressure vessels to be used in stationary service; and power boilers used in locomotive, portable, and traction service. Rules pertaining to use of the single ASME certification mark with the V, A, M, PP, S, and E desiccator are also included.

Section VII – Care of Power Boilers Provides guidelines to assist those directly responsible for operating, maintaining, and inspecting power boilers. These boilers include stationary, portable, and traction type boilers, but not locomotive and high-temperature water boilers, nuclear power-plant boilers (see Section XI), heating boilers (see Section VI), pressure vessels, or marine boilers. Guidelines are also provided for operation of auxiliary equipment and appliances that affect the safe and reliable operation of power boilers.

2.7 EXISTING PRODUCT

2.7.1 Boiler

Figure 2.3: Boiler

A boiler is a closed vessel in which water or other fluid is heated. The fluid does not necessarily boil (In North America, the term "furnace" is normally used if the purpose is not to boil the fluid). The heated or vaporized fluid exits the boiler for use in various processes or heating applications, including water heating, central heating, boiled-based power generation, cooking and sanitation.

2.7.2 Fire Tube Boiler and Water Tube Boiler

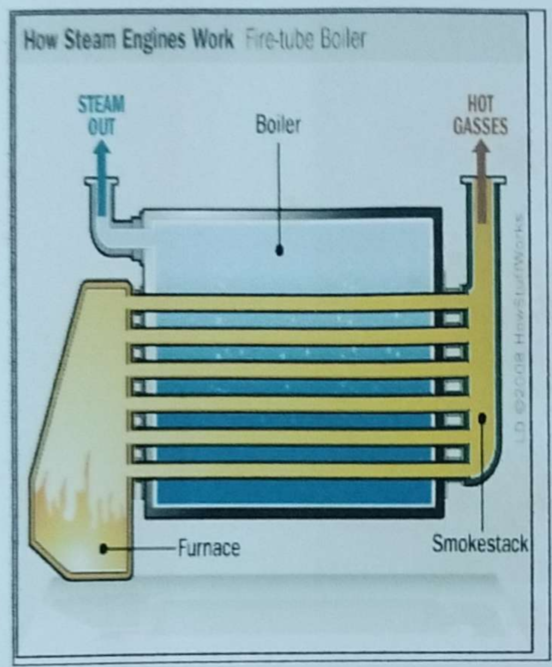

Figure 2.5: Fire Tube Boiler

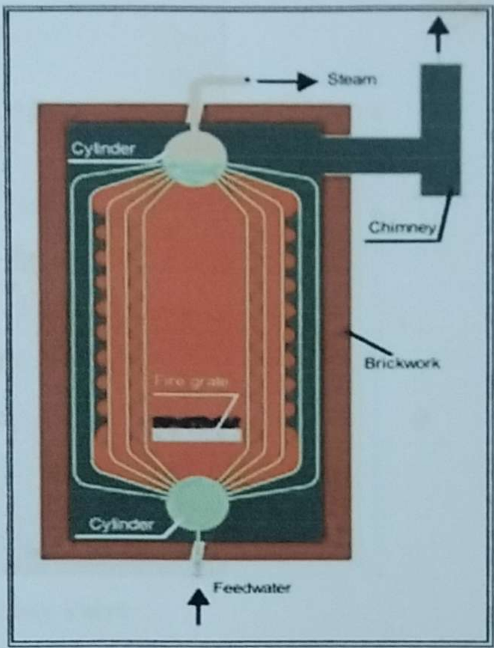

Figure 2.6: Water Tube Boiler

There are two general types of boilers: "fire-tube" and "water-tube". Boilers are classified as "high-pressure" or "low-pressure" and "steam boiler" or "hot water boiler." Boilers that operate higher than 15 psi are called "high-pressure" boilers.

A hot water boiler, strictly speaking, is not a boiler. It is a fuel-fired hot water heater. Because of its similarities in many ways to a steam boiler, the term "hot water boiler" is used.

1) Hot water boilers that have temperatures above 250° Fahrenheit or pressures higher than 160 psig are called "high temperature hot water boilers".

2) Hot water boilers that have temperatures not exceeding 250° Fahrenheit or pressures not exceeding 160 psig are called "low temperature hot water boiler's.

2.7.3 Safety Valve

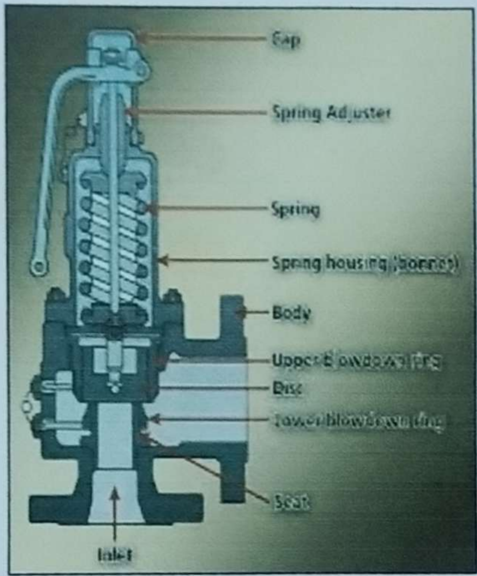

Figure 2.7: Safety Valve

A safety valve is a valve that acts as a fail-safe in a thermal-hydraulic plant. An example of safety valve is a pressure relief valve (PRV), which automatically releases a substance from a boiler, pressure vessel, or other system, when the pressure or temperature exceeds preset limits. Pilot-operated relief valves are a specialized type of pressure safety valve.

Safety valves were first developed for use on steam boilers during the Industrial Revolution. Early boilers operating without them were prone to explosion.

Vacuum safety valves (or combined pressure/vacuum safety valves) are used to prevent a tank from collapsing while it is being emptied, or when cold rinse water is used after hot CIP (clean-in-place) or SIP (sterilization-in-place) procedures. When sizing a vacuum safety valve, the calculation method is not defined in any norm, particularly in the hot CIP / cold water scenario, but some manufacturers have developed sizing simulations.

2.7.4 Dynamo

Figure 2.8: Dynamo

A dynamo is an electrical generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based including the electric motor, the alternating current alternator and the rotary converter. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (vacuum tube or more recently solid state) is effective and usually economical.

The electric dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. Due to Faraday's law of induction the motion of the wire within the magnetic fields creates an electromotive force which pushes on electrons in the metal, creating an electric current in the wire. On small machines the constant magnetic field may be provide by one or more permanent magnets.

2.7.5 Radiator

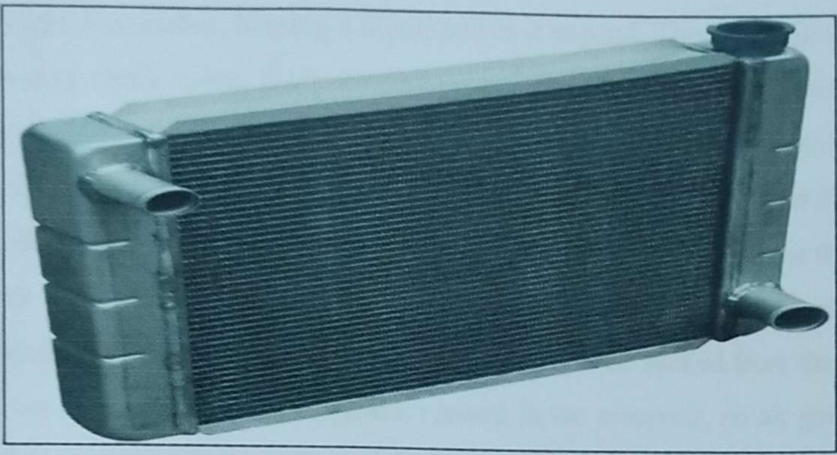

Figure 2.9: Radiator

Radiators are heat exchanges used to transfer thermal energy from one medium to another for the purpose of cooling and heating. The majority of radiators are constructed to function in automobiles, buildings, and electronics. The radiator is always a source of heat to its environment, although this may be for either the purpose of heating this environment, or for cooling the fluid or coolant supplied to it, as for engine cooling. Despite the name, most radiators transfer the bulk of their heat via convection instead of thermal radiation though the term "convector" is used more narrowly; see radiation and convection.

I) FUNCTION OF RADIATOR.

When liquids are heated sufficiently, they boil and vaporize, changing to a gas. Water boils at 212 degrees Fahrenheit. A pan of boiling water on the stove will boil away, with the vapor going into the surrounding air. Pressurizing the liquid raises its boiling point. The radiator cap maintains system pressure to 16 pounds per square inch (psi) on most vehicles. This allows the coolant to reach much higher temperatures without boiling away. If the pressure is not maintained, the coolant may boil out of the system. If the pressure is allowed to go too high hoses could burst, the radiator could rupture or worse. If the coolant temperature gets too high, the radiator cap lets some coolant escape. Remember, heating a liquid makes it expand. This is the first function of the two-way check valve. It allows coolant to escape as necessary. When the hot, expanding coolant leaves the radiator, a small hose transfers it into a reservoir. If there were no radiator cap, air would be drawn into the engine. That is bad. Air in the cooling system leads to corrosion and poor engine cooling. As the vacuum builds in the cooling system, the second function of the two-way check valve comes into play. At a predetermined vacuum, the radiator cap allows coolant to be sucked from the reservoir back into the engine. If there is sufficient coolant in the reservoir, no air gets into the engine. Most reservoirs are translucent and have minimum and maximum level marks on them. Make sure yours has at least the minimum level. Check it when you check your oil. If necessary add a 50/50 mixture of water and antifreeze. Premixed coolant is being sold in many stores. Technicians have testers and can check your cap out in less than five minutes. Caps are cheap and easily replaced--as long as the engine is cold. Never uncap a hot engine because a geyser of super-hot liquid may seriously scald you.

2.7.6 Turbine

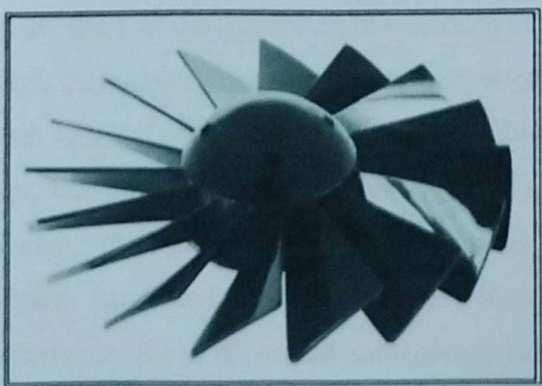

Figure 2.10: Turbine

Gas, steam, and water turbines have a casing around the blades that contains and controls the working fluid. Credit for invention of the steam turbine is given both to

British engineer Sir Charles Parsons (1854–1931) for invention of the reaction turbine, and to Swedish engineer Gustaf de Laval (1845–1913) for invention of the impulse turbine. Modern steam turbines frequently employ both reaction and impulse in the same unit, typically varying the degree of reaction and impulse from the blade root to its periphery.

I) Types Of Turbines.

Figure 2.11: Steam Turbine

Steam turbines are used for the generation of electricity in thermal power plants, such as plants using coal, fuel oil or nuclear fuel. They were once used to directly drive mechanical devices such as ships' propellers (for example the Turbine, the first turbine-powered steam launch, but most such applications now use reduction gears or an intermediate electrical step, where the turbine is used to generate electricity, which then powers an electric motor connected to the mechanical load. Turbo electric ship machinery was particularly popular in the period immediately before and during World War II, primarily due to a lack of sufficient gear-cutting facilities in US and UK shipyards.Gas turbines are sometimes referred to as turbine engines. Such engines usually feature an inlet, fan, compressor, combustion and nozzle (possibly other assemblies) in addition to one or more turbines.

Figure 2.12: Transonic turbine

Transonic turbine. The gas flow in most turbines employed in gas turbine engines remains subsonic throughout the expansion process. In a transonic turbine the gas flow becomes supersonic as it exits the nozzle guide vanes, although the downstream velocities normally become subsonic. Transonic turbines operate at a higher pressure ratio than normal but are usually less efficient and uncommon.

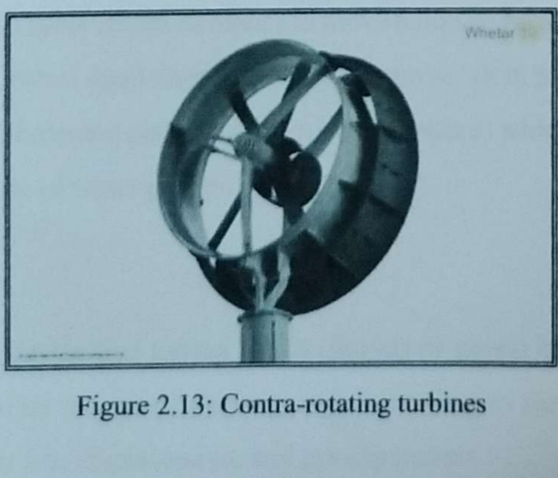

Figure 2.13: Contra-rotating turbines

Contra-rotating turbines. With axial turbines, some efficiency advantage can be obtained if a downstream turbine rotates in the opposite direction to an upstream unit. However, the complication can be counter-productive. A contra-rotating steam turbine, usually known as the Ljungström turbine, was originally invented by Swedish Engineer Fredrik Ljungström (1875–1964) in Stockholm, and in partnership with his brother Birger Ljungström he obtained a patent in 1894. The design is essentially a multi-stage radial turbine (or pair of 'nested' turbine rotors) offering great efficiency, four times as large heat drop per stage as in the reaction (Parsons) turbine, extremely compact design and the type met particular success in back pressure power plants. However, contrary to other designs, large steam volumes are handled with difficulty and only a combination with axial flow turbines (DUREX) admits the turbine to be built for power greater than ca 50 MW. In marine applications only about 50 turbo-electric units were ordered (of which a considerable amount were finally sold to land plants) during 1917-19, and during 1920-22 a few turbo-mechanic not very successful units were sold.[6] Only a few turbo-electric marine plants were still in use in the late 1960s (ss Ragne, ss Regin) while most land plants remain in use 2010.

2.7.7 Pump

Working Principle

All pumps use basic forces of nature to move a liquid. As the moving pump part (impeller, vane, and piston diaphragmed.) begins to move, air is pushed out of the way. The movement of air creates a partial vacuum (low pressure) which can be filled up by more air, or in the case of water pumps, water.

Function/Usage

A pump is a device that moves fluids (liquids or gases) by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis.

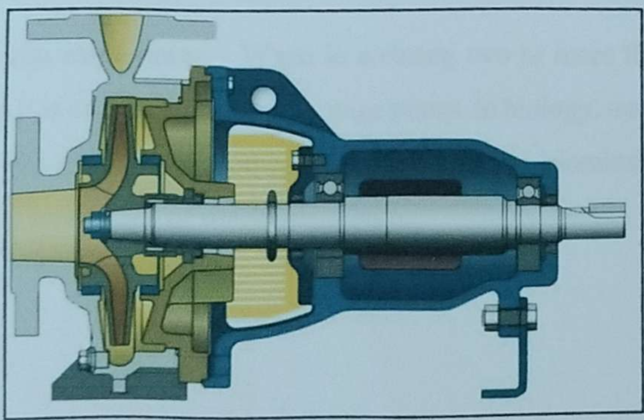

Figure 2.14: Single Stage Pump

Single stage pump - When in a casing only one impeller is revolving then it is called single stage pump.

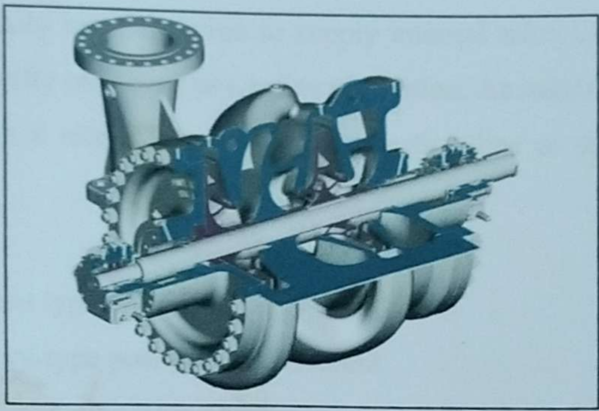

Figure 2.15: Double/multi Stage Pump

Double/Multi stage pump - When in a casing two or more than two impellers are revolving then it is called double/ multi stage pump. In biology, many different types of chemical and bio-mechanical pumps have evolved, and biomimicry is sometimes used in developing new types of mechanical pum.

2.7.8 Types of Pump

Positive displacement pump behavior and safety

Positive displacement pumps, unlike centrifugal or roto-dynamic pumps, theoretically can produce the same flow at a given speed (RPM) no matter what the discharge pressure. Thus, positive displacement pumps are *constant flow machines*. However, a slight increase in internal leakage as the pressure increases prevents a truly constant flow rate.

A positive displacement pump must not operate against a closed valve on the discharge side of the pump, because it has no shutoff head like centrifugal pumps. A positive displacement pump operating against a closed discharge valve continues to produce flow and the pressure in the discharge line increases until the line bursts, the pump is severely damaged, or both.

A relief or safety valve on the discharge side of the positive displacement pump is therefore necessary. The relief valve can be internal or external. The pump manufacturer normally has the option to supply internal relief or safety valves. The internal valve is usually only used as a safety precaution. An external relief valve in the discharge line, with a return line back to the suction line or supply tank provides increased safety.

Positive displacement types

i. Rotary-type positive displacement
ii. Reciprocating-type positive displacement
iii. Linear-type positive displacement

i) Rotary Positive Displacement Pumps

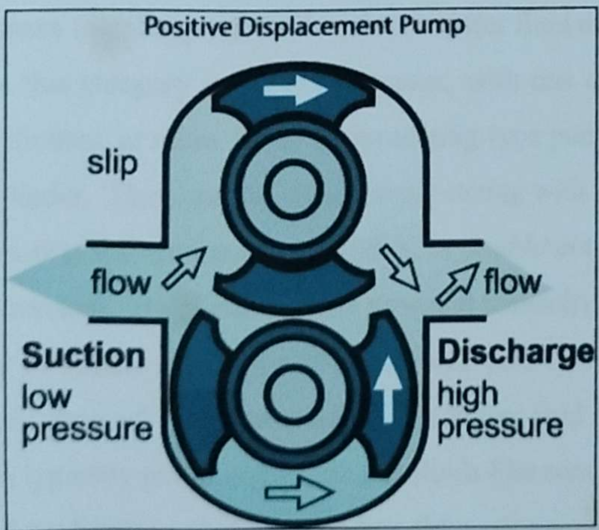

Figure 2.16: Rotary Positives Replacement Pump

These pumps move fluid using a rotating mechanism that creates a vacuum that captures and draws in the liquid.

Advantages: Rotary pumps are very efficient because they naturally remove air from the lines, eliminating the need to bleed the air from the lines manually.

Drawbacks: The nature of the pump requires very close clearances between the rotating pump and the outer edge, making it rotate at a slow, steady speed. If rotary pumps are operated at high speeds, the fluids because erosion, which eventually causes enlarged clearances that liquid can pass through, which reduces efficiency.

Rotary positive displacement pumps fall into three main types:

a) Gear pumps - a simple type of rotary pump where the liquid is pushed between two gears

b) Screw pumps - the shape of the internals of this pump is usually two screws turning against each other to pump the liquid.

ii) Reciprocating Positive Displacement Pumps

Reciprocating pumps move the fluid using one or more oscillating pistons, plungers, or membranes (diaphragms), while valves restrict fluid motion to the desired direction. Pumps in this category range from *simplex*, with one cylinder, to in some cases *quad* (four) cylinders, or more. Many reciprocating-type pumps are *duplex* (two) or *triplex* (three) cylinder. They can be either *single-acting* with suction during one direction of piston motion and discharge on the other, or *double-acting* with suction and discharge in both directions. The pumps can be powered manually, by air or steam, or by a belt driven by an engine. This type of pump was used extensively in the 19th century—in the early days of steam propulsion—as boiler feed water pumps. Now reciprocating pumps typically pump highly viscous fluids like concrete and heavy oils, and serve in special applications that demand low flow rates against high resistance. Reciprocating hand pumps were widely used to pump water from wells. Common bicycle pumps and foot pumps for inflation use reciprocating action. These positive displacement pumps have an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pumps as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses. The volume is constant given each cycle of operation.

a) Typical Reciprocating Pumps Are:

- Plunger pumps - a reciprocating plunger pushes the fluid through one or two open valves, closed by suction on the way back.
- Diaphragm pumps - similar to plunger pumps, where the plunger pressurizes hydraulic oil which is used to flex a diaphragm in the pumping cylinder. Diaphragm valves are used to pump hazardous and toxic fluids.
- Piston Pumps displacement pumps - usually simple devices for pumping small amounts of liquid or gel manually. The common hand soap dispenser is such a pump.

iii) Various Positive Displacement Pumps

The positive displacement principle applies in these pumps:

- Rotary lobe pump
- Progressive cavity pump
- Rotary gear pump
- Piston pump
- Diaphragm pump
- Screw pump
- Gear pump
- Hydraulic pump
- Rotary vane pump
- Peristaltic pump
- Rope pump
- Flexible impeller pump

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is the systematic, theoretical analysis of the methods applied to a field of study, or the theoretical analysis of the body of methods and principles associated with a branch of knowledge. It typically, encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.

A Methodology does not set out to provide solutions but offers the theoretical underpinning for understanding which method, set of methods or so called "best practices" can be applied to a specific case. In other word, methodology can be defined as the process used to collect information and data for the purpose of making business decisions. The Methodology may include publication research, interview, survey and other research techniques, and could include both present and historical information.

The method of studies can be divided into several levels. First of all, a first meeting were carried out to identify topic as been told by other lecturer and the topic have been informed earlier.

3.2 PROJECT FLOW

This section will explain on how this project flow or the steps involved in finalizing the project.

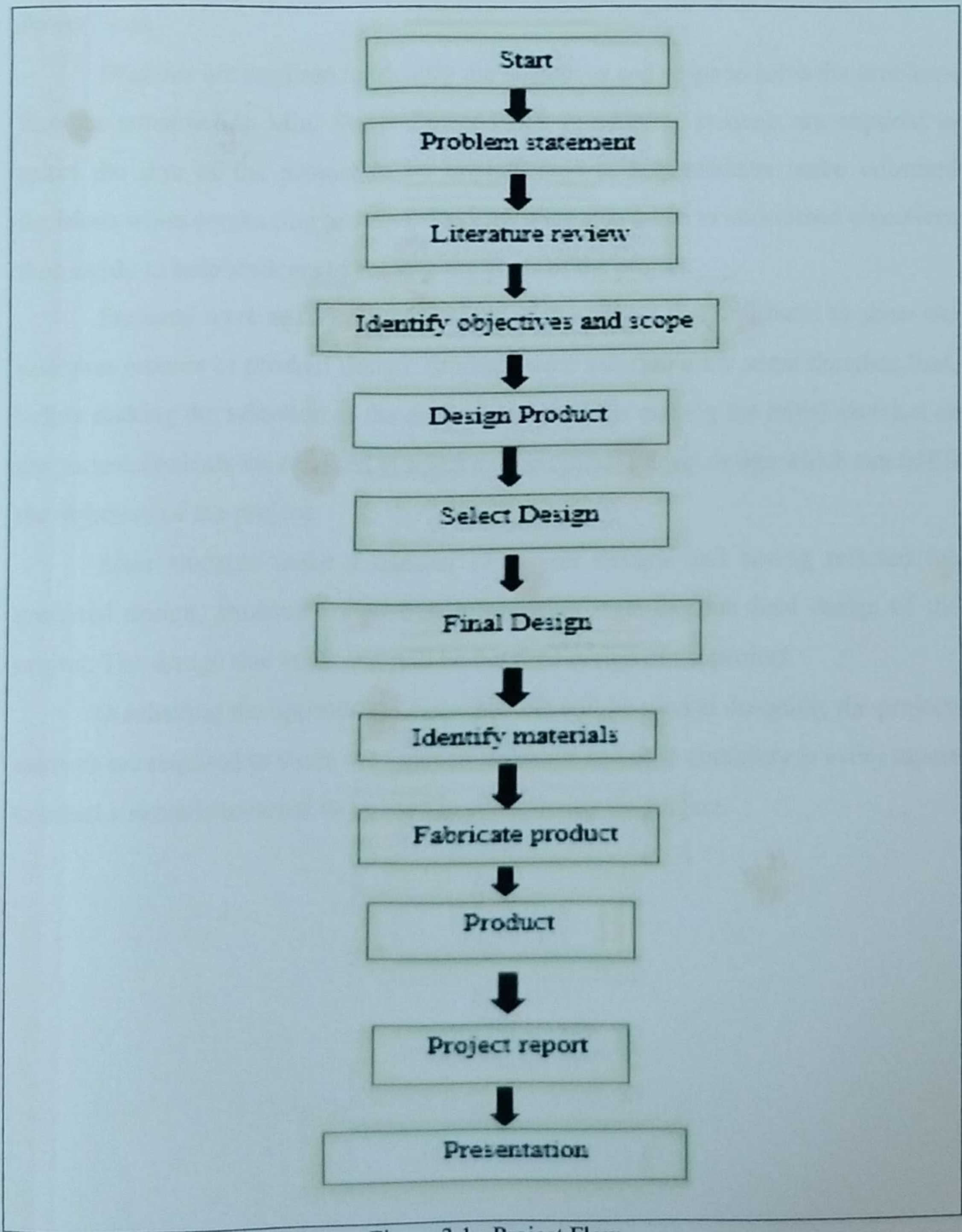

Figure 3.1 : Project Flow

In the literature review, students explained about the history and background of the original project, which is already available in the market currently. Students have been studying the type of Mini Steam Power Plant available in the market and at the same time students can also learn about the parts that are important on the Mini Steam Power Plant already existing and making comparisons between types of Mini Steam Power Plant.

Students are required to identify the objectives and scope to solve the problems faced in constructing Mini Steam Power Plant. In addition, students are required to select the size of the project to be implemented to help students make informed decisions when conducting projects. Students were also asked to understand objectives thoroughly to help students to achieve the goals of the project.

Students were to choose the designs of the project that will build to show the selection process of product design. Students were asked to draw some sketches first, before making the selection of the desired design. After making the initial sketches of the project, students are required to select an appropriate project design which can fulfill the objective of the project.

After students make a number of project designs and having selected the preferred design, students are to find information regarding the final design of the project. The design that is chosen will be the final design of the project.

In selecting the appropriate materials that will be used in designing the project, students are required to study the types of materials and their durability in every aspect to select a suitable material to be used in constructing the project.

3.3 DESIGN CONCEPT PLAN.

3.3.1 Functional Analysis.

Figure 3.2: Functional Analysis

Based on the figure 2 above, we wanted to build a Mini Steam Power Plant that can help students in improving their knowledge in the theory of Rankine cycle. In order to construct one, students have to be knowledgeable about the components that exist in the actual steam power plant. As to know whether we succeeded our aim in trying to make the students know better about the theory, 5 students from a certain class will be asked to do a small test,(consisted of several thermodynamics questions) in which they are using the Mini Steam Power Plant. After that they are asked to do the same test again, this time, without the power plant. We are to make comparison between the marks of the students from when they are using the power plant to do the questions and without. To achieve this we ought to make the components of the Mini Steam Power Plant to be working as they are supposed to be.

3.4 DESIGN PROCESS.

Based on figure 3.3 below, the Mini Steam Power Plant are to improve the students understanding about Rankine cycle. To achieve this, the steam power plant have to be working as intended. The power plant have to be consisted of four main component. The first being the boiler, second is the turbine, followed by radiator and lastly pump. The Mini Steam Power Plant will help the students by mimicking the

3.3 DESIGN CONCEPT PLAN.

3.3.1 Functional Analysis.

Figure 3.2: Functional Analysis

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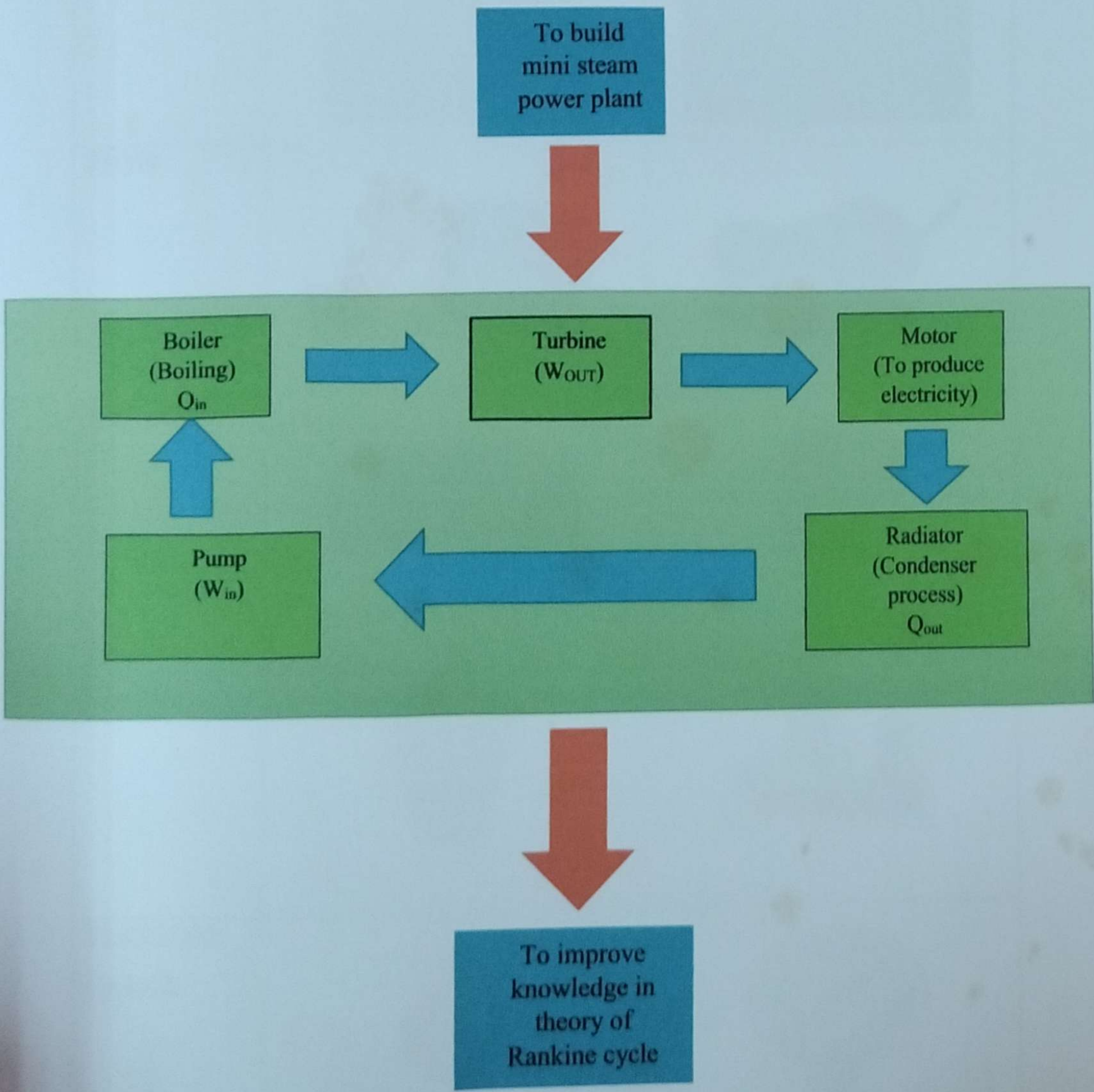
...SIGN PROC...

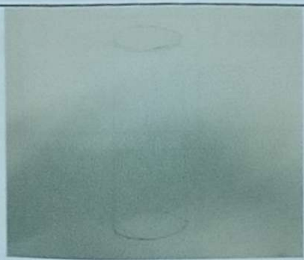
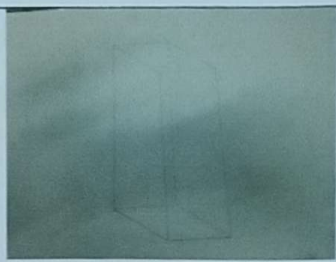
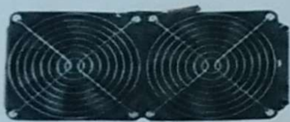
Based ...

processes that are occurring in the actual power plant. As this kind of power plant uses the Rankine cycle theory is it easy to relate the apparatus when learning the theory. To function, the boiler has to be able to exert enough pressure which is produced by steam in order for the turbine to spin.



3.5 Concept Generation

Table 3.1: Concept Generation

	Design 1	**Design 2**
BOILER		
PUMP		
RADIATOR		
SAFETY VALVE		
PRESSURE GAUGE		

3.6 CONCEPT EVALUATION

Table 3.2: Project Evaluation for Boiler

BOILER	Weighing	Reusability	Durability	Energy Require	safety	Cost	Total
DESIGN 1	3	4	4	1	4	4	20
DESIGN 2	3	3	2	1	2	3	14

Table 3.3: Project Evaluation for Pump

PUMP	Weighing	Reusability	Durability	Energy Require	safety	Cost	Total
DESIGN 1	2	2	2	3	4	4	17
DESIGN 2	3	4	4	4	4	2	21

Table 3.4: Project Evaluation for Radiator

RADIATOR	Weighing	Reusability	Durability	Energy Require	safety	Cost	Total
DESIGN 1	2	3	3	3	4	4	19
DESIGN 2	4	3	4	3	4	2	20

Table 3.5: Project Evaluation for Safety Valve

SAFETY VALVE	Weighing	Reusability	Durability	Energy Require	safety	Cost	Total
DESIGN 1	2	4	3	1	4	4	18
DESIGN 2	2	1	1	1	4	2	11

Table 3.6: Project Evaluation for Pressure Gauge

PRESSURE GAUGE	Weighing	Reusability	Durability	Energy Require	safety	Cost	Total
DESIGN 1	3	1	2	1	4	4	11
DESIGN 2	2	4	4	1	4	3	18

Table 3.7: Project Evaluation Remark

4	3	2	1
Best			Worst

3.7 SELECTING PROJECT DESIGN

The next stage after selecting the right material is selecting the right design use for this project. Before we start this project, we already select design from various design that we create to choose which one is better. The factor that we use for the project design is the safety for the user, cost that is not too expensive and referring to our project. Design that we use is the design that referring this factor and will finish within the time period.

3.8 BUDGET ESTIMATION.

3.8.1 Budget Item

Table 3.8: Budget Item

No.	Material	Quantity	Unit Price (RM)	Total (RM)
1	Cylinder Stainless Steel	1	50-80 Per unit	70
2	Safety valve	1	5-25	20
3	Pressure gauge	1	10-20	40
4	Pump Aquarium	1	8-25	20
5	dynamo	1	7-20	15
6	CPU Fan	1	33	33
7	Mini Wheel	4	14 Per unit	56
8	Pipe(5mm)	5	10 Per unit	50
9	Plat Stainless Steel	2	25 Per feet	50
10	Plat Ship Zinc	1	15 Per feet	15
11	Gas Tank	1	6	6
12	Mini Gas Kitchen	1	80	80
13	Electric Wire	1	5Per meter	5
14	L.E.D	1	2	2
15	Container	1	15 Per unit	15
			TOTAL	477

3.8.2 Budget for Materials Used

Table 3.9: Budget for Material Used

No	Material	Quantity	Unit Price (RM)	Total (RM)
1	**Stainless steel**	1	RM50-80 Per feet	70
2	**Copper**	1	RM10-30 Per meter	15
			TOTAL	85

3.9 FABRICATION PROCESS.

Mini Steam Power Plant is a Rankine cycle process for students to make their experiment for Thermodynamic subject. Mini steam power plant consists of boiler, pump, radiator, turbine and dynamo for electric supply of the experiment. The steam produced will reach pressure level not more than 15 psi. For main and major parts, there are boiler which can produce steam and spin around the turbine so that dynamo motor can supply electric to light up the bulb.

3.9.1 Introduction.

Project fabrication is a working step or working flow while doing the work in order to finish one project where the working flow must have the following step depends on the characteristic of the project. The work steps that needed for this project are:

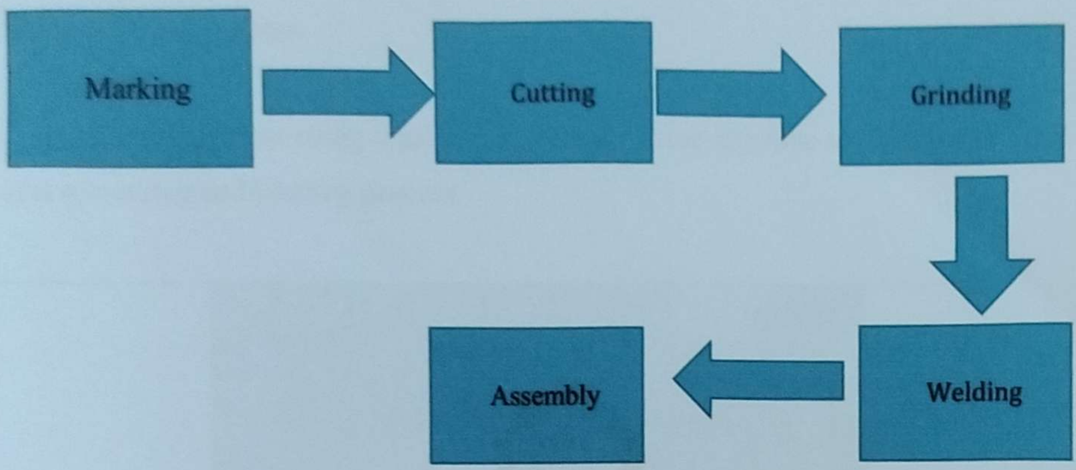


Figure 3.3: Project Fabrication Flow

To ensure that the quality of our project has reached or not, we created a system such as strategic planning and quality control for each stage of work. With the strategic flow system, project will achieve the desired quality

.

3.9.2. Marking and Labelling Process

The first step of fabrication is measuring process. Process of measuring is where the correct measurements required marked on to the material before cutting it to a desired length. After done measuring, labelling process must be done before proceed to the next step.

Figure 3.4: Marking process

3.9.3 Cutting Process

Cutting process using a grinder and power shear machine to cut the iron steel after measuring and labeling process.

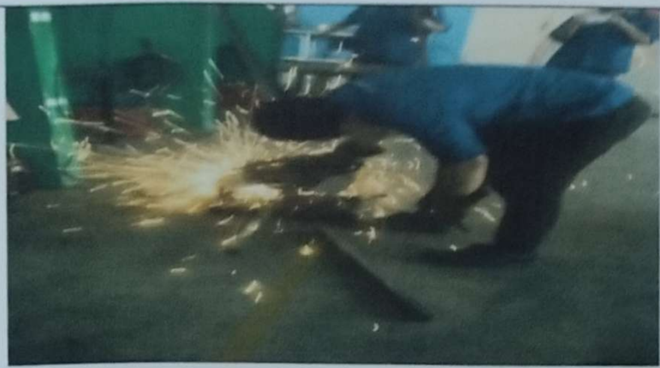


Figure 3.5: Cutting Process

3.9.4 Grinding Process.

The use of grinding machine is to make the surface of the iron steel smooth.

Figure 3.6: Grinding Process

3.9.5 Welding Process

Welding is a fabrication that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal joining technique.

Figure 3.7: Welding Process

3.9.6 Finished Main Component

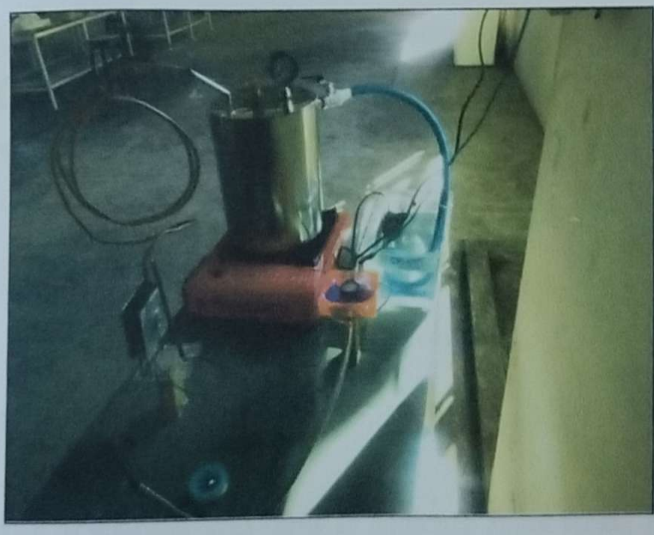


Figure 3.8: Finished Main Component.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter discusses the results of analysis and finding of the investigate. The investigation was conducted to learn about this project that was "Mini Steam Power Plant'. In the first stage, heat up the boiler until the steam vapour coming out after boiler are heated. Second stage, high pressure steam, which is generated in the boilers is passed through turbines which in turn is coupled to generators, thereby generating electricity. The water steam creates after the boiler heated, a steam turbine with condenser, low pressure heaters, high pressure heaters and connecting pipelines. Close water system is used for cooling the condenser. Water vapour punch the turbine blade then the turbine blade will spin around the blade with the shaft and the shaft spin can produce electricity through dynamo with the presence of the small bulb.

4.2 PURPOSE OF ANALYSIS

The purpose of analysis is to show to audience about recent findings obtained from research. When trying to collect data, the first step will always be to clearly understand the purpose of conducting analysis. This is really important as knowing the purpose will help to make decisions. Keeping in mind when conducting analysis to get the best results in order for decisions to be made as it is a crucial process and to ensure desirable results. Important matter that needs to be studied in this project getting the best design for the boiler. Boiler is the component that release steam as its function. Deciding for the design will have to factor the ability of the boiler to produce adequate amount of steam to turn turbine. Material used to build one had to be able to resist rust. In addition, it also need to be heat resistant.

4.3 CONDUCTING REFERENCE

Conducting reference checks can be the one of the most important steps in the selection process. It is done through research, reading resources, via Wikipedia and web. This process important to ensure the project can be done and successfully as the targets.

4.4. PROCEDURES

1. The gas were lit up safety at first.
2. The aquarium pump and the cpu radiator were switched on shortly after.
3. The boiler was made sure to be safe to use during the heating of the water to ensure no damage occurred.
4. The data of the pressure inside the boiler was taken.
5. After the experiment was finished, the gas and the pump were turned off.
6. It was made sure that there is no excess pressure located inside the boiler and everything was safe after being used.

4.5. ANALYSIS DATA

4.5.1. Result from Test Run

Table 4.1: Result from test run

Test Run	Result and Finding
Test Run 1	1.the turbine cannot rotate 2.damaged turbine cover 3.the radiator did not work properly
Test Run 2	1.The turbine can rotate 2.Electricity generated from turbine

4.5.2. Problem Faced

For the first problem we encountered is we are quite difficult to weld the project table legs and project table wheels during the installation process. This is because, the table iron we use is hollow type iron.

For the next problem we encountered was we were having trouble finding the main part to make a boiler. In addition, the turbine blade failed to rotate because the type was not suitable.

For the last problem we encountered was during the test run, there was damage to the turbine cover and leakage on certain pipes.

4.5.4. Advantage and Weakness of Project

Table 4.2. : Advantages and Disadvantages of Mini Steam Power Plant

Advantages	Disadvantages
Making it easier for student to experiment	Less security
Easy to use	Water is always filled
Easy to heat	

4.6. DISCUSSION

Based on the group discussion to carry out a project that was planned. The project starts by discussing the measures required to construct our project which is Mini Steam Power Plant and the designs need to carry out project.

After deciding the designs and the measures of the project, we started to carry out the measures using the material that was being used in the project. Furthermore, we go for materials that do not rust.

Other than that, we also decide the designs of the project whether we are going to use open or closed system. Besides that, we fixated on using stainless steel on construction of the boiler because it does not rust.

Finally, we are discussing of the ways to generate electricity using steam emitted and the usage of motor for this project. Steam will turn the turbine and this generates electricity by the rotation of the turbine will be proven once bulb us lit.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, the studies to achieve the objective is shown. The discussion is to compare the results and the objective of the hypothesis. Through discussion, conclusion about the studies and obtained through number of proposal can be developed for management action in mechanical department and recommendation the study will come especially in related field.

5.2. CONCLUSION

The conclusion, our project was finished thoroughly by our group as planned. There were 2 objective in the planning of our project that was able to be carried out smoothly in our project Mini Steam Power Plant project.

Firstly, our group was able to finish the Mini Steam Power Plant in design that was decided. We plan the designs by illustrating it, and by the usage of inventor software, showing the design in 3D.

Secondly, we successfully made the Mini Steam Power Plant to have a boiler that is able to be heated up using gas and thus, and steam is released. Our project has shown that electricity is generated. In the design that we created, it can show generation of electricity by the steam that is turning the turbine. We also generate electricity to light up the bulb.

Thirdly, we are using closed system to mimic the processes that is occurring in the actual of Mini Steam Power Plant. We also use radiator to cool down the heated steam that being released by the boiler after spinning the turbine, turning it to water. Besides that, our project uses pump to transfer water that is cooled off from radiator into the boiler.

Lastly, Mini Steam Power Plant that was designed by us, can be made by the materials decided in the making of the project. Electricity can be generated in the closed system of our project. We are using closed system as it is needed to show the application of Rankine cycle.

5.3. RECOMMENDATIONS

Our project which is the Mini Steam Power Plant was aimed to improve the understanding of students who are studying Thermodynamics. Therefore, each components plays an important role to resemble the processes in Rankine cycle. The way we portray our project will be crucial to help the student.

The advantage when using the Mini Steam Power Plant to study Rankine cycle is that students will be able to observe directly how each components work in the cycle. The students who are just learning theories will otherwise have to imagine the processes occurring in said cycle. Just being able to see it directly will boost their interest in learning Rankine cycle.

There are number of familiar apparatus available in the market. While this is true, it is hard to get a hold of such tool here. Getting one would be quite pricey as compared to making it our own though that itself, bring its own risk. The components like the turbine fan, radiator and the pump be found at reasonable price at nearby stores and perhaps reusing some equipment.

Finally, as our boiler is being heated by gas, the fuel needs to be replaced once it runs out. Next, dust might pile up on the fan of the radiator which have to be cleaned after some time.

5.4 SUMMARY

The Mini Steam Power Plant is designed to boost students understanding of Rankine cycle. Each component depict the same process in the cycle. The crucial components that are found in any large scale steam power plant, can be seen in our project which is the boiler, turbine, radiator and the pump. Such as components are important as steam power plants uses Rankine cycle to function. Our project uses exactly the same principle only with a reduced size which is within the size of a student desk, designed to make it easier and simpler for a student to observe the Rankine cycle.

Besides that, as the size of our project considerably small, it does not cause a problem for limited space issue. It also equipped with wheels to ensure the task of arranging it is hustle-free and takes less time.

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POLITEKNIK MALAYSIA MUKAH

MECHANICAL ENGINEERING DEPARTMENT

GANTT CHART

CODE : DJJ5141
COURSE : PROJECT 1

SEMESTER: DIS 2016

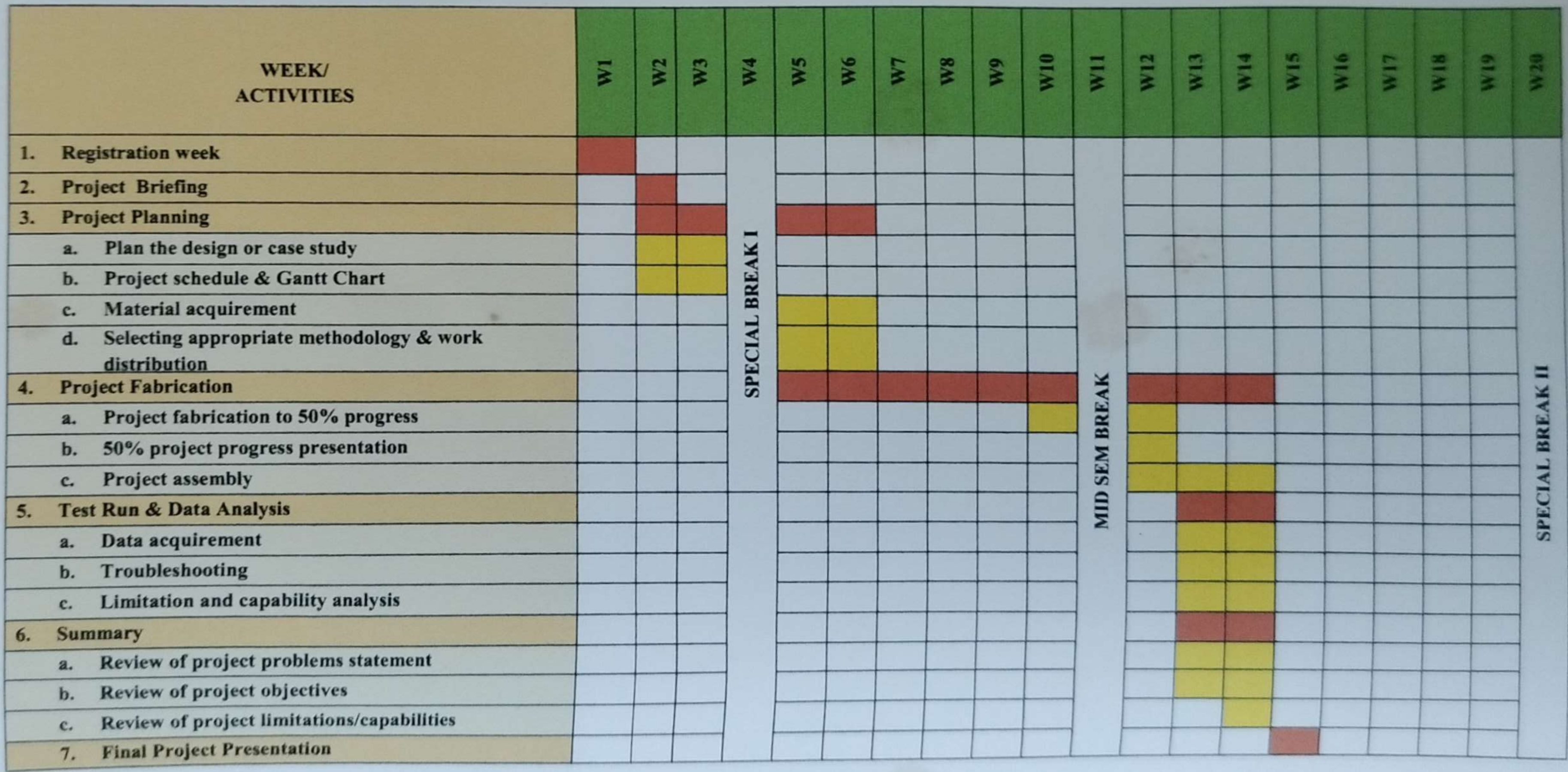
Nos	TASKS/ACTIVITIES		REG	W1	W2	W3	W4		W5	W6	W7	W8		W9	W10	W11	W12	W13	14	W15	W16	
			NOV		DIS					JANUARY						FEBRUARY				MARCH		
		M	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27	6	13	20	27	3
		T	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	7	14	21	28	4
		W	23	30	7	14	21	28	4	11	18	25	1	8	15	22	1	8	15	22	29	5
		T	24	1	8	15	22	29	5	12	19	26	2	9	16	23	2	9	16	23	30	6
		F	25	2	9	16	23	30	6	13	20	27	3	10	17	24	3	10	17	24	31	7
		S	26	3	10	17	24	31	7	14	21	28	4	11	18	25	4	11	18	25	1	8
		S	27	4	11	18	25	1	8	15	22	29	5	12	19	26	5	12	19	26	2	9
1	Course Registration							SPECIAL BREAK					SEMESTER BREAK									FINAL EXAMINATION FOR DIS 2016 SESSION
2	Project 1 Briefing (M)																					
	Project Classification (M)																					
	i) Identify the design or case study																					
	ii) Select the design or case study to be carried out																					
3	Preparing Proposal (M)																					
	i) Development of problem statement																					
	ii) Development of objectives																					
4	Literature Review (M)																					
	i) Define market strategy studies																					
	ii) Search information from book, jurnal & internet																					
5	Research Methodology (M)																					
	i) Identify respondents																					
	ii) Identify market survey																					
	iii) Development of design method																					
	iv) Identify type of product testing/analysis																					
6	Writing Proposal (M)																					
	i) Draft Final Project Design & Assembly																					
	ii) Cost estimation																					
	iii) Expected outcome from project design																					
	iv) Estimation of capabilities/limitation of project																					
	v) Development of prototype (where applicable)																					
7	Final Proposal Presentation (M)																					
	i) Preparing Presentation																					
8	Review Report																					

: Milestone
: Tasks/Activities

Appendix 1: Project 1 Gant Chart

Prepared by: Validated by:

PROJECT 2 GANTT CHART
SESSION : JUNE 2017
DEPARTMENT : KEJURUTERAAN MEKANIKAL
COURSE : DJJ6143 PROJECT 2

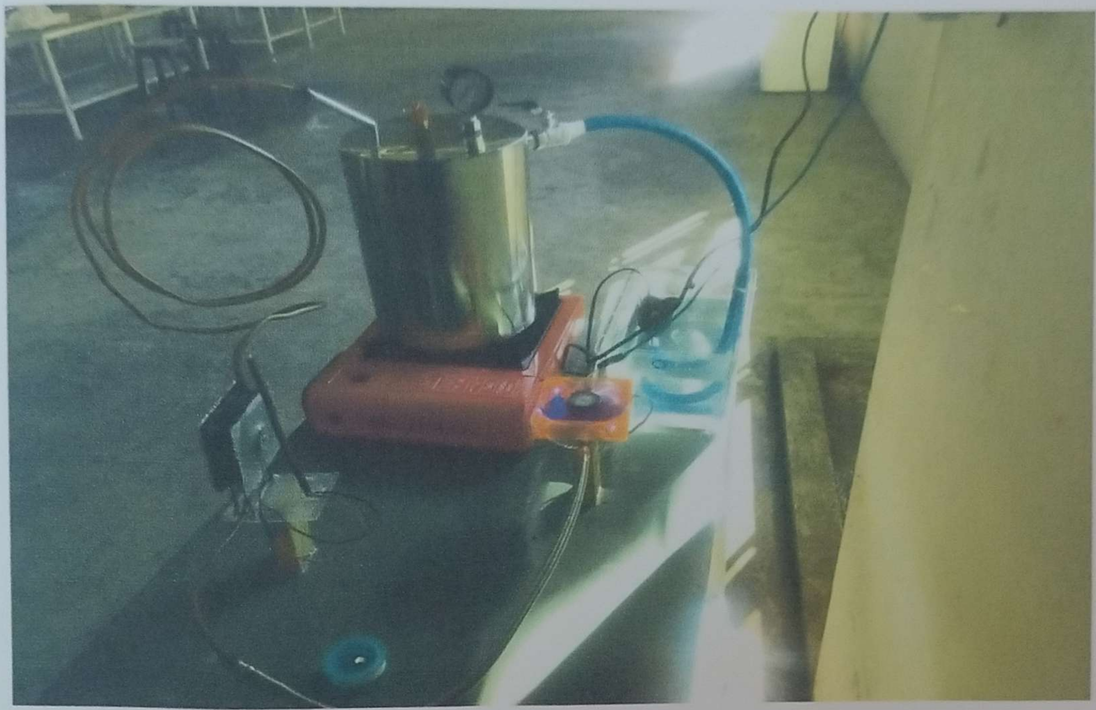


Nota:

: *Milestone*

: *Activitie*

Appendix 2: Project 2 Gant Chart



Appendix 3: Assemble 4 main component