APPROVAL

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Bachelor of Mechanical Engineering (Design & innovation)"

Signature : ....
Supervisor : Professor Dr. Md.Razali Bin Ayob
Date : ....

DECLARATION

"I hereby, declare this thesis is result of my own research except as cited in the references"

Signature	: …………………………..
Author's Name	: Mohd Syafiq Bin Zamzuri
Date	: ....

DEDICATION

Special Dedication to my family members, my friends,
my fellow colleague and all faculty members for all your
care, support and believe in me.

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First of all, I would like to thanks Gods that have given me the opportunity to complete my ‘Project Sarjana Muda’ (PSM). Alhamdulillah, His Willingness has made it possible for me as the author to complete the PSM in time. I worked hard in completing this project within a semester.

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ABSTRACT

The air conditioner is a medium to get an environment pleasant reply. The air condition will generate cool air to the environment such as in homes, offices and building. There are different types of air conditioner such as window unit air conditioner, split unit, ducted unit and the package unit. Air conditioners require energy to produce a cool effect on the environment. Solar energy can also be used to produce that cool effect . The use of solar energy at present is very broad. The electricity consumption can be saved using solar energy. Solar energy used for air-conditioning is to act as a medium of hot water production which can be used to respond with refrigerant to produce cool air. To get hot water, solar evacuated tubes were used for concentration of sunlight energy. Water in the solar evacuated tube will be heated by the sun. This research is focused on the solar system reaction with the air conditioning system. This study also identified a system that has been used to produce the effect of cold air with the aid of solar energy. Factors had been taken into this study is to calculate the number of sets of Solar Evacuated Tube which is needed for cooling the main hall of the Universiti Technikal Malaysia Melaka (UTeM).

ABSTRAK

Penyaman udara merupakan satu medium untuk mendapatkan keadaan persekitaran yang sejuk dan nyaman. Penyaman udara akan menghasilkan udara sejuk kepada persekitaran seperti di dalam rumah, pejabat dan juga banggunan. Terdapat berbagai jenis penyaman udara iaitu jenis tingkap, jenis berasingan, jenis berasingan bersesalur dan juga jenis kemas siap. Penyaman udara memerlukan tenaga elektrik untuk menghasilkan kesan sejuk pada persekitaran. Tenaga solar juga boleh digunakan untuk menghasilkan kesan sejuk pada system penghawa dingin. Penggunaan tenaga solar pada masa kini adalah sangat meluas. Penggunaan tenaga solar dapat menjimatkan penggunaan tenaga elektrik. Tenaga solar yang digunakan untuk penyaman udara adalah bertindak sebagai medium penghasilan air panas yang boleh digunakan untuk bertindak balas dengan bahan penyejuk supaya dapat mengasilkan udara sejuk. Untuk mendapatkan air panas, alat salur paip penumpu matahari digunakan bagi tujuan penumpuan cahaya matahari. Air yang berada di dalam paip tersebut akan dipanaskan oleh cahaya matahari. Kajian yang dijalankan ini memberi tumpuan kepada sistem solar yang dapat bertindak balas dengan sistem penyaman udara. Kajian ini juga mengenal pasti sistem yang telah digunakan untuk menghasilkan kesan udara sejuk dengan bantuan tenaga solar. Faktor yang diambil kira dalam kajian ini ialah bilangan set ‘Solar Evacuated Tube’ yang diperlukan untuk proses penyejukan dewan besar Universiti Teknikal Malaysia Melaka (UTeM).

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CHAPTER 1

INTRODUCTION

Air conditioning that powered by solar energy has great potential in the cooling system design nowadays. It is because of high demand for cooling usually coincides with plentiful sunlight. Solar air conditioning at an economically competitive level could reduce electricity costs for residential and small commercial customers. This would cut the growth of peak electric demand and ease the increasing pressures on generating capacity, transmission, and distribution. Currently available technologies are neither practical nor cost-effective. Photovoltaic (PV) systems require a large roof area and cost many times more than a conventional air conditioner. Thermally driven absorption cooling requires costly, high-temperature collectors and undesirable cooling towers. Furthermore, these systems have a disconnect of several hours between peak cooling capacity and peak cooling demand. That in turn requires electric or thermal storage in order to maximize the solar contribution. A solar air-conditioning system employing relatively inexpensive low-temperature collectors, coupled with an innovative desiccant dehumidification and evaporative process, provides a new prospect for cost-effective solar cooling.

Solar cooling technologies use solar thermal energy provided through solar collectors to power thermally driven cooling machines. Cooling demand is rapidly increasing in many parts of the world, especially in moderate climates, such as in most EU member states. This results in a dramatic increase in electricity demand on hot summer days, which causes an unwanted increase in the use of fossil and nuclear energy and furthermore threatens the stability of electricity grids. As many cooling applications, such as air conditioning, have a high coincidence with the availability of solar irradiation, the combination of solar thermal and cooling obviously has a high potential to replace conventional cooling machines based on electricity. Larger solar cooling systems have been successfully demonstrated and smaller machines, which could be used in (small) residential and office buildings, are entering the market.

1.1 Objective

The main objective of this project are to do the feasibility study in applying the solar absorption system in the cooling system at the Univertiti Teknikal Malaysia Melaka (UTeM) main hall and establish the number of set solar evacuated tube panel required for the air conditioning by using absorption system.

1.2 Problem Statement

The uses of air condition are widely, air condition is very important for the people because it can make a better environment for the people. Nowadays the temperature of the earth is increasing. That why the air condition is very important. But the uses of the air condition will increase the uses of electrical energy. To settle this problem, this research will come out to decreasing the uses of the electrical energy. The concept of this air condition is use a solar energy to produce a hot water that can transfer to the air condition and will generate the cold air. The hot water helps to produce a cold air by using the absorption chillers and cooling tower.

1.3 Scope

This work will limit itself to the study of solar cooling. The absorption refrigerant system is studied where the heat for the generator is supplied by solar energy. Design for the use of commercialized Solar evacuated tube is made to be applied to the UTeM main hall.

CHAPTER 2

LITERATURE REVIEW

2.1 Air conditioning

An air conditioner is an appliance, system, or machine designed to stabilise the air temperature and humidity within an area typically using a refrigeration cycle but sometimes using evaporation, commonly for comfort cooling in buildings and motor vehicles. The air conditioning system transfers heat from a cooler low-energy reservoir to a warmer high-energy reservoir. (Laurie Mcguire 2003)

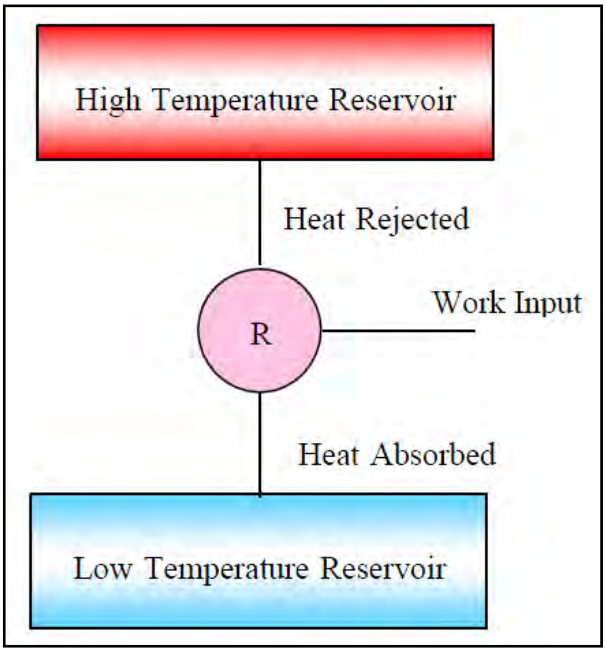

Figure 1: Air condition diagram (Source: Laurie Mcguire)

Basically air conditioning system has four components. The first component in the air condition cycle is the compressor. The compressor takes low temperature refrigerant gas and compresses it into a high pressure, high temperature gas. The refrigerant is then sent to the condenser which sits in front of the radiator. The condenser removes some of the heat from the refrigerant which causes the refrigerant to change phase from a hot gas to a warm liquid. In the expansion valve air condition system, the warm liquid is then passed through a receiver-drier which removes moisture from the refrigerant to maximize the efficiency of the heat exchange capability of the refrigerant. From there, the refrigerant is then passed through the expansion valve.

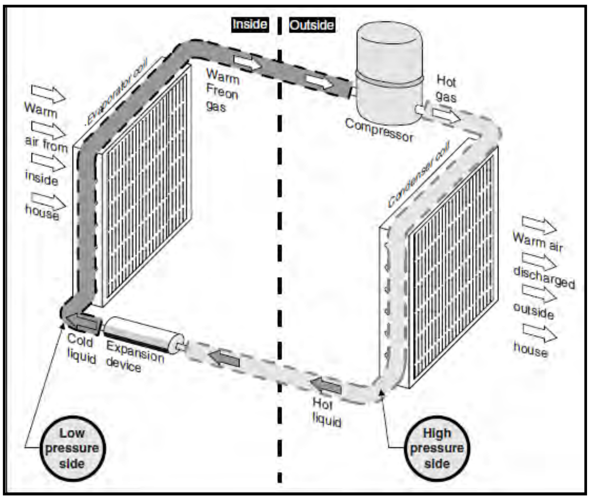

Figure 2: The diagram for air conditioning process

(Source: principle of air conditioning)

2.1.1 Compressor

The heart of the vapour compression cycle is the compressor. The four most common types of the refrigerant compressor are the reciprocating, screw, centrifugal and vane. The reciprocating compressor consists of a piston moving back and forth in a cylinder with suction and discharger valves to allow pumping to take place. The screw, centrifugal and vane compressors all use rotating elements, the screw and vane compressors are positive-displacement machine, and the centrifugal compressor operates by virtue of centrifugal force. (Wilbert F. S/ Jones J.W 1982).

2.1.2 Condensers

The type of a condenser is generally characterized by the cooling medium used. Thus, there are three types of condensers:

a) Air cooled condenser
b) Water cooled condenser
c) Evaporative condenser

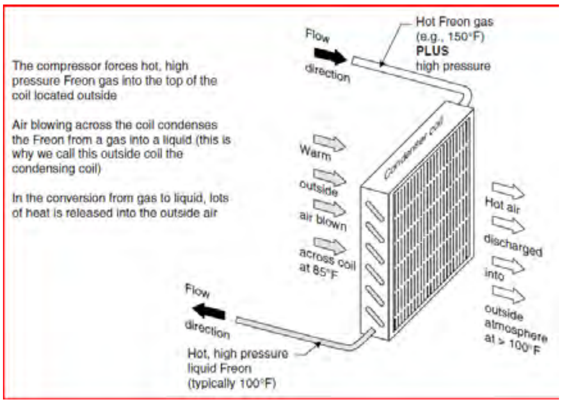

Figure 3: Condenser

(Source: principle of air conditioning)

a) Air cooled condenser

In air cooled condenser, heat is removed by air using forced circulation or by either natural. The condensers are made from steel, cooper or aluminium tubing provided with fins to improve air-side heat transfer. The refrigerant flows inside the tubes and the air outside.

b) Water cooled condensers

Water cooled condenser can be of three types, it is shell and tubes, shell and coil, and double tube. The shell and tubes type, with water flowing through passes insides tube and the refrigerant condensing in the shell is most commonly used condenser. Figure shows the arrangement for a two pass condenser. A shell and tube condenser also serves the purpose of a receiver especially for pumping down the refrigerant, because there is sufficient space in the shell. The bottom portion of the condenser also serves the purpose of a sub cooled as the condenser liquid comes in contact with the entering water at a lower temperature. (Arora CP 2001)

c) Evaporative Condenser

The refrigerant first reject its heat to water and then water rejects its heat to air, mainly in the form of evaporator water. Air leaves with high humidity as in a cooling tower. Thus an evaporative condenser combines the functions of a condenser and cooling tower. (Arora CP 2001)

2.1.3 Expansion Devices

The last of the basic elements in the air conditioner cycle, after the compressor, condenser and evaporator is the expansion devices. The purpose of the expansion devices is twofold: it must reduce the pressure of the liquid refrigerant, and it must regulate the flow of refrigerant to the evaporator. An expansion device is essentially a restriction offering to flow so that the pressures drop, resulting in a throttling process. Basically there are two types of expansion devices;

a) Variable-restriction type
b) Constant –restriction type

In variable restriction type, the extant of opening or area flow keeps on changing depending on the type of control. There are two common types of such control devices. It is automatic expansion valve and the thermostatic expansion valve.

The constant restriction type device is the capillary tube which is merely a long tube with a narrow diameter bore. (Wilbert F. S/ Jones J.W 1982).

Figure 4: Expansion Device

(Source: Climate work)

2.1.4 Evaporator

The evaporator is the component of a refrigerant system in which heat is removed from air, water or any other body required to be cooled by the evaporating refrigerant. Evaporators are mainly classified as flooded or direct-expansion such dry. In flooded evaporator, the liquid refrigerant covers the entire heat-transfer surface. In dry evaporator, a part of the heat transfer surface is used for superheating the vapour. (Gupta J.K 2009).

Figure 5: Evaporator

(Source: climate work)

2.2 Mechanical Air Conditioning and Ventilation

The purpose of air conditioning in a building is to control the temperature or heat inside a room or space. Ventilation is the intentional movement of air from the outside building to the inside. The determination of the air conditioning air flow are depending on a various factor, such as the area of the room, the sensible heat, latent heat, the location of the room and the function of room. For example, the server room and control room need a twenty four hour of air condition to maintain it temperature, so that the equipment inside the room were be able to function at it best condition. (J. Hoff,1994).There various types of air conditioning systems available in the market such as;

I. Room Air Conditioners (RAC)

These are also referred to as window units. Essentially, there are compact packaged units housing all components together, namely air cooled condenser, direct expansion evaporator and compressor.

II. Split Units

These are air cooled system comprising an outdoor condensing unit piped to an indoor evaporator unit. The indoor unit may be aesthetically wall mounted, ceiling mounted, concealed ducted or cassette type configuration.

III. Air Cooled Packaged Units

These are essentially larger capacity versions of RACs and Split Units. They are normally ducted installation. Applications include all types of commercial and industrial buildings.

IV. Water Cooled Packaged Units

These are similar to air cooled packaged units except that the heat rejection is not directly to the ambient air but through another medium, normally consisting of a cooling tower and its condenser water circuit.

V. Variable Refrigerant Volume (VRV) Systems

These are essentially multi spilt systems where one outdoor condensing unit can serve up to 8 indoor evaporator units. By means of the VRV feature there are numerous other advantages such as length of refrigerant piping.

2.2.1 Split Unit Air Conditioning

A split air conditioning unit is one that has the two main components separate from each other, with one being inside the building, and the other being outside. A central air conditioning unit is nearly always a split air conditioning unit. There are also air conditioning units called mini split air conditioners. These units operate in a very similar way, but do not use ducts to send the air. These may provide single room air conditioning, or cooling for multiple rooms, and are often called ductless air conditioning units. The two main components of a split air conditioning system have different functions. The unit situated outdoors, called a compressor, cools the air and handles condensation.

This saves the trouble of having to find a way to drain the water created from the air conditioning process indoors. The inside unit, called the blower, is responsible for distributing the air to the rest of the house. This is done through a forced-air system, usually using a fan and a series of ducts that distribute cool air to each room in the home with a vent. An intake vent will return air to the unit.

For those who live in homes without ducts, or who feel they do not need to cool every room, a mini split air conditioning system may be an option. This is much simpler than trying to install the duct work for a traditional split air conditioning unit. There is no need to worry about running ducts, or substantially cutting into walls. These units tend to run more efficiently than window air conditioners, but they do cost more to buy initially. A miniature system works by installing an air handling piece in the room of choice. Two lines are then connected to an outside unit.

While this will require drilling through an outside wall, it will not require the cutting needed for air conditioning units with ducts. One line will deliver coolant to the inside component. The other line will take away condensation. For those who need multiple rooms cooled, several inside components can be installed to one outdoor component.

2.2.2 Split Unit Flow rate

The split unit flow rate is needed to be determining to select the suitable split to reach a maximum cooling capacity in the room. The volume of the selected room are been multiple by the air change per hour (ACH) such as shown in Table 1, to get the maximum flow rate.

Table 1: Example Split unit flow rate schedule (J. Hoff,1994)

Bil	Code	Zone Name / Space Name	Floor Area (m^2)	Height floor m	Volume (m^3)	ACH	Flow cmh	Flowrates cfm
		ADMISSION REV						
1	L1-AR-06	STAFF TOILET (M)	1.8	2.8	5.04	6	30.2	18
2	L1-AR-07	STAFF TOILET (F)	1.8	2.8	5.04	6	30	18
3	L1-AR-08	GENERAL STORE	17.7	3	53.1	6	319	188
4	L1-AR-14	SOCIAL WORKERS STORE	10.9	3	32.7	6	196	115
		AHU/1F-1/8	14.9	4.5	67.1	6	402	237

2.2.3 Air Change per Hour (ACH)

Air change per hour is a value representing the number of times each hour that an enclosure's total volume of air is exchanged with fresh or filtered air. An air change doesn't represent a complete change of all air in the enclosure or structure. The actual percentage of an enclosure's air which is exchanged in an air change period depends on the airflow efficiency of the enclosure and the methods used to ventilate it. (Bearg, David W,1993)

ACH equation in Imperial units

$$N = \frac{60Q}{Vol} \qquad (1)$$

Where:

N = number of air changes per hour

Q = Volumetric flow rate of air in cubic feet per minute (cfm)

Vol = Space volume $L \times W \times H$, in cubic feet

2.3 Solar Air Condition

Solar air condition is a system that has use a solar water heater to produce a hot water for the chillers. To produce a hot water, the solar evacuated tube was used to get the hot water. The hot water is supplied to the generator to boil off the Lithium Bromide solution. Water vapour or refrigerant from the generator will go to the condenser chamber where it is condenser into liquid refrigerant. The liquid refrigerant will flow helping by gravity into the evaporator chamber. The liquid refrigerant is then pumped through the orifice to be sprinkle to the evaporator coil by the refrigerant pump. The solar air condition has a component such as cooling tower and also absorption chillers. (H.-M. Henning 1999)

2.3.1 Solar Cooling Technology

Solar cooling technologies use solar thermal energy provided through solar collectors to power thermally driven cooling machines. Cooling demand is rapidly increasing in many parts of the world, especially in moderate climates, such as in most EU member states. This results in a dramatic increase in electricity demand on hot summer days, which causes an unwanted increase in the use of fossil and nuclear energy and furthermore threatens the stability of electricity grids. As many cooling applications, such as air conditioning, have a high coincidence with the availability of solar irradiation, the combination of solar thermal and cooling obviously has a high potential to replace conventional cooling machines based on electricity. Larger solar cooling systems have been successfully demonstrated and smaller machines, which could be used in (small) residential and office buildings, are entering the market.

2.3.2 Components of a solar cooling system

A solar cooling installation consists of a typical solar thermal system made up of solar collectors, storage tank, control unit, pipes and pumps and a thermally driven cooling machine. To date, most collectors used in solar cooling systems are the high efficiency collectors available in the market today (often double-glazed flat plate collectors or evacuated tube collectors). New developments for the medium temperature range (100-250°C) could increase the overall efficiency of the cooling systems.

2.4 Solar Water Heater

These systems use the sun to heat either water or a heat transfer fluid, such as water in collectors generally mounted on the roof. The heated water is then stored in a tank similar to a convectional gas or electric water tank. Some systems use an electric pump to circulate the fluid through the collectors. Some water heaters can operate in any climates. Performance varies depending on how much energy is available and how cold the water is coming into the system.