UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFICIENCY AND COST COMPARISON BETWEEN THE UTILIZATION OF CONDENSED AND EVAPORATED REFRIGERATION ACCUMULATOR AND BATTERY AS BACKUP SYSTEM FOR SOLAR AIR CONDITIONER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning System) with Honours.

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DECLARATION

I hereby, declared this report entitled "Efficiency and cost comparison between the initialization of condensed and evaporated refrigeration accumulator and battery as backup system for solar air conditioner" is the result of my own research except as cited in references.

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Date **:9 December 2016**

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor Mechanical of Engineering Technology (Refrigeration and Air Conditioning System) (Hons.). The member of the supervisory is as follow:

…….

(Norain Binti Idris)

ABSTRAK

solar penghawa dingin adalah penyaman udara yang menggunakan panel Semua penghawa dingin menggunakan banyak tenaga elektrik. penghawa dingin berkuasa solar memerlukan bateri sebagai bekalan kuasa dan sandaran pada siang hari mendung dan malam. Bateri sendiri mempunyai had mereka seperti jangka hayat. Objektif kajian ini adalah untuk membandingkan kecekapan penerima penyejuk dan bateri solar, juga untuk mengira operasi elektrik. Kajian ini adalah mengenai penerima alternatif boleh digunakan sebagai kuasa sandaran, Walau bagaimanapun, pelaksanaan sistem ini belum diterokai. Metodologi projek ini adalah untuk menyiasat tekanan pelepasan selepas di 75 saat dalam 1 hp penyaman udara daripada penerima, untuk menyiasat jumlah pelepasan semasa dalam 75 saat dalam 1 hp pemampat penyaman udara solar. Bateri yang paling biasa digunakan dalam sistem panel solar adalah bateri sel basah; Sebagai contoh adalah bateri asid plumbum. Kecekapan untuk penerima cecair adalah 46.6% dan kecekapan bateri adalah 31.8% .The kecekapan nombor yang lebih tinggi supaya lebih cekap sistem Penerima penyejuk cecair adalah lebih cekap membandingkan 12V bateri (asid plumbum). Penerima penyejuk lebih cekap sebagai kuasa kembali berdasarkan pengiraan keputusan. Kecekapan adalah penting dalam sistem untuk menyediakan sistem yang baik atau buruk. Jika kecekapan adalah rendah itu bermakna sistem tidak baik untuk digunakan. Dalam sistem yang mekanikal, yang lebih cekap produk yang maksudkan ialah menyediakan sistem yang baik tanpa pembaziran tenaga

ABSTRACT

Solar air conditioner refers to any air conditioning system that uses a solar panel. Photovoltaic can provide the power for any type of electrically powered cooling be it conventional compressor based or adsorption based, Though the most common implementation is with compressor. All air conditioners used a lot of electric power. The solar powered air conditioner requires battery as the power supply and backup during the cloudy day and night. Battery itself has their limitation such as lifespan. Objective this research is to compare the efficiency of refrigerant receiver and solar battery, also to calculate the electrical operation. This research is about alternative receiver can be used as power back up, However, the performance of this system are not yet discover. The methodology of this project is to investigate discharge pressure after in 75 seconds in 1 hp air conditioning from receiver, to investigate the amount of current discharge in 75 seconds in 1 hp compressor solar air conditioning. The most common batteries used in solar panel system are wet cell battery; For example is lead acid batteries. The efficiency for liquid receiver is 46.6% and the efficiency of battery is 31.8%.The higher number efficiency so the more efficient of the system The liquid receiver refrigerant is more efficient compare the Battery 12V(lead acid). The receiver refrigerant is more efficient as power back up based on the result calculation. Efficiency is important in the system to provide the system is good or bad. If the efficiency is low that mean the system is not good to use. In a system mechanical, the more efficient of the product that mean is provide the good system without waste of energy

DEDICATION

To my beloved parents, siblings and friends due to their love and support

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LIST OF ABBREVIATIONS SYMBOL AND NOMENCLATURE

%	-	Percentage
°c	-	Celsius
AC	-	Alternative Current
AMP	-	Ampere
COP	-	Coefficient Performance
DC	-	Direct Current
FT	-	Feet
FT	-	Feet
H	-	Height
I	-	Current
KWH	-	Kilowatt Hour
L	-	Length
P	-	Power
Psig		Pressure
PV	-	Photovoltaic
R	-	Refrigerant
TR	-	Ton of Refrigerant
V	-	Voltage

W - Width

CHAPTER 1

INTRODUCTION

1.0 Introduction

Solar air conditioning refers to the air conditioning system that uses a solar power. Photovoltaic is that use in solar power system to generate the electric and supply to the system air conditioning. Solar air conditioning system are generally categorized into three distinct market segment such as residential rooftop, commercial rooftop and ground-mount utility-scale system It consists of an arrangement of several components, including solar panel to absorb solar radiation and convert the sunlight into electricity. Solar system should need the solar inverter to change the electric current from DC to AC power. Grid connected with inverters must supply AC electricity in synchronized to the grid frequency, limit feed in voltage to no higher than the voltage and disconnect from the grid if the grid voltage is turned off. The power supply of solar air conditioning system is from a standard alone system. This system, it requires a steady power input to compressor for smooth operation under variable solar radiation (Li, Zhang, Lv, Zhang, & Wang, 2015). A battery need to stabilize the compressor operation. A battery also acts as storage energy for balance of solar and load power, and smooth operation(Huang et al., 2016).This chapter discusses about overview of solar air conditioning, component and accessories that use in solar system. Next point for this chapter also discuss, the problem statements of this research, general and specific objectives, scope of the research, and the significance of this research.

1.1 Main Component Air Conditioning System and Accessories

There four main components that important in system air conditioning such as compressor, condenser, expansion valve and evaporator. These four components important to get the desired temperature or thermal comfort in a conditioned space and accessories are also important to complete the cycle of refrigeration system.

1.1.1 Compressor

The main purpose of the compressor is to flow the refrigerant in the system air conditioning. The compressor change the phase of the refrigeration from gas to liquid. This concentrates the heat it contains. At the compressor in a system , the low pressure gas was changed to high pressure gas (Sheet, 2014).

1.1.2 Condenser

A condenser is one of device or unit that used to condense a phase from its gaseous to its liquid state, by cooling it. Because of this , the latent heat is given up by the substance, and blow off to the condenser coolant (Huang et al., 2016).

1.1.3 Expansion Valve

Expansion valve is a component in refrigeration and air conditioning systems that will control the amount and flow rate of refrigerant flow into the condenser there manage the superheating at the outlet of the evaporator (Daut, Adzrie, Irwanto, Ibrahim, & Fitra, 2013).

1.1.4 Evaporator

An evaporator is used in an air-conditioning operation system to provide a compressed cooling chemical, such as R-22 (Freon) or R-410A, to evaporate from liquid to gas while absorbing heat in the process or in the condition room (Kim, Braun, & Lafayette, 2010).

1.1.5 Refrigerant Liquid Receiver

The tank on the liquid line between the condenser and expansion valve is a liquid receiver. The purpose of the suction accumulator is to grab and hold liquid refrigerant that didn't boil off in the evaporator (Features, Specifications, & Guidelines, 2013).

1.1.6 Accumulator Refrigerant

An accumulator is a storage device refrigerant. The place of accumulator is between evaporator and compressor. The suction line accumulator is a temporary reservoir for this mixture, designed to meter both the liquid refrigerant and oil back to the compressor at an acceptable rate (Lcye & The, 2016).

1.1.7 Battery

Solar battery is a device a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal, or anode (Lasri, Saadoune, & Edström, 2016).

1.2 Operation When Sunny Day and Night Based on Prototype Design

Most central air conditioners run off of 220/240 V AC to drive a refrigerant through a heat exchanger and to operate a fan. These large units are used to cool entire homes up to 2200 ft^2. On the other hand, room air conditioners run off of 110 V, usually cool up to 300 ft^2 and can be easily powered from power generated from solar panels. Depending on the climate in which location. Solar air conditioning is work on solar power with battery as backup systems. When a day light Solar panel sun will trap the radiation on sunlight and converted in to electricity with solar panel then storage the electricity in to battery. Charger controller is needed to control the amount of energy that can be stored safely (Abdullah, Saman, & Whaley, 2014).

Next inverter is also need to change the DC electric power to AC electric power because the compressor will run if AC power has. Compressor will compress the refrigerant and evaporated refrigerant gas from cooling coil. Condenser will cool the hot compressed refrigerant into liquid refrigerant. When the liquid refrigerant cooling is done by releasing the liquid refrigerant through a single or multiple capillary tube in to the cooling coil. Where the heat from the room (by means of the blower fan) evaporates the liquid refrigerant vapour. Evaporated refrigerant will flow in copper tube than evaporated refrigerant gas will back to the compressor for compressing. This cycle of refrigerant and gas, compressed liquefied and evaporated by heat from the room to be cooled goes on and till get the desired temperature.

During the day, the PV solar module will supply the electrical power to the compressor. The compressor compresses the refrigerant through the system. After the condenser, the refrigerant will charge the receiver tank till it is fully charge. The flow of the refrigeration is controlled by the 3-way solenoid valve. When the receiver tank is fully charge, the solenoid valve will open and allow the refrigerant to flow through the other component. The solenoid valve that used for the receiver tank is the normally open solenoid valve. The normally open solenoid valve used at the receiver tank is to ensure that the valve is open to the receiver tank when there is no electrical supply to the solenoid coil. When the pressure inside the receiver tank is reach, the pressure switch will give signal to the solenoid valve to close the valve to the receiver tank and open the valve to circulate the entire system like typical air

conditioning system. After the evaporator, the refrigerant will flow directly to the compressor. The solenoid valve used at the accumulator tank is 3-way normally close solenoid valve. The 3-way solenoid valves do not allow the valve open to the accumulator if the coil is not energized.

During the cloudy day or night, the PV solar was no longer supply the electric current to the compressor. When the compressor is not operating, the pressure switch detects the low pressure at the discharge line after the compressor. The pressure switch gives signal to the 3-way normally open solenoid valve at the receiver. The solenoid valve then energizes to open the valve from the receiver and discharge it through the system. The high pressure refrigerant in the receiver tank will discharge the refrigerant to the thermal expansion valve and evaporator. The refrigerant evaporated in the evaporator then will store in the accumulator. The 3-way normally close solenoid valve at the accumulator will allow the refrigerant enter the accumulator. The process will continue till the liquid refrigerant in the receiver is fully discharge.

1.3 Problem Statement

Now day all air conditioning used a lot of electric power to cool the space in the building. Energy storage has been a hot topic in energy news during the past years because it is widely considered to be one of the primary mean by which renewable can entirely replace fossil fuel to generate the electricity.

The development of air conditioning technology in this era is quite advanced in all over countries. Many inventions and modifications have been achieved in order to upgrade the efficiency of conventional air conditioning system. The conventional air conditioner with constant speed compressor consumes a large amount of electricity. Therefore, one of the alternative methods to reduce the power consumption by air conditioner is by using the renewable energy such as solar powered air conditioner.

The solar powered air conditioner requires battery as the power supply and backup during the sunny day. However the battery itself has their limitation such as

lifespan, quantity, capacity and cost in order to cover up the air conditioner system during cloudy day and night. Therefore, this research will design a prototype of backup system for a solar air conditioner by using refrigerant receiver and accumulator to reduce the usage of battery or no battery needed during the cloudy day and night. Batteries are most expensive part of solar system. People now days hates running out of batteries. Solar energy also one of our most promising energy technologies and also may have battery problem while running a system.

1.4 Objective

The main objective for this project is to investigate as show as below:

- To investigate efficiency of accumulator (receiver refrigerant tank) and to compare the efficiency battery as power back up system.
- To calculate the cost development of the product and calculate the electrical cost

1.5 Scope

This project will start on September 2016 and estimate time this project will finish January 2017.This project will construct at University Malaysia Melaka (UTeM) .The accumulator that use to doing project is refrigerant accumulator, refrigerant receiver and for the battery is lead acid type. Next, component that use in is four basic component of air conditioning system is hand valve and solenoid valve. The data will take after the system 1 horsepower air conditioning running, such as the data will take is:

a) Pressure in and out of receiver by 75 second in 1 horsepower compressor air conditioning to fill in the receiver tank.
b) Amount of power out and power in by 15 minute on the battery.
c) Calculate the cost electrical and cost of development of product.

1.6 Conclusion

Renewable energy is sustainable as it is obtained from sources that are inexhaustible. Renewable energy sources include wind, solar, biomass, geothermal and hydro, all of which occur naturally. Renewable energy, principally, is clean energy and non-polluting to the world as the new sources of energy. Many forms do not emit any greenhouse gases or toxic waste in the process of producing electricity. It is a sustainable energy source that can be relied on for the long term. Interest round the greenhouse effect and global warming, air pollution, and energy security have led to increasing interest and more development in renewable energy sources such as solar, wind, geothermal, wave power and hydrogen. Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar air conditioning. Now day all air conditioning use a lot of electric power .If the electrical apparatus use lot of electric so the electric bill will increase. The aim of this project to reduce the electric energy consumption and cut cost electric bill by using a receiver refrigerant as power back up because the receiver refrigerant don't use a electric to cool the room and only uses a saturated refrigeration that has been charging on sunny day by using the solar panel and the compressor compress the refrigeration in the tank for using in the night.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

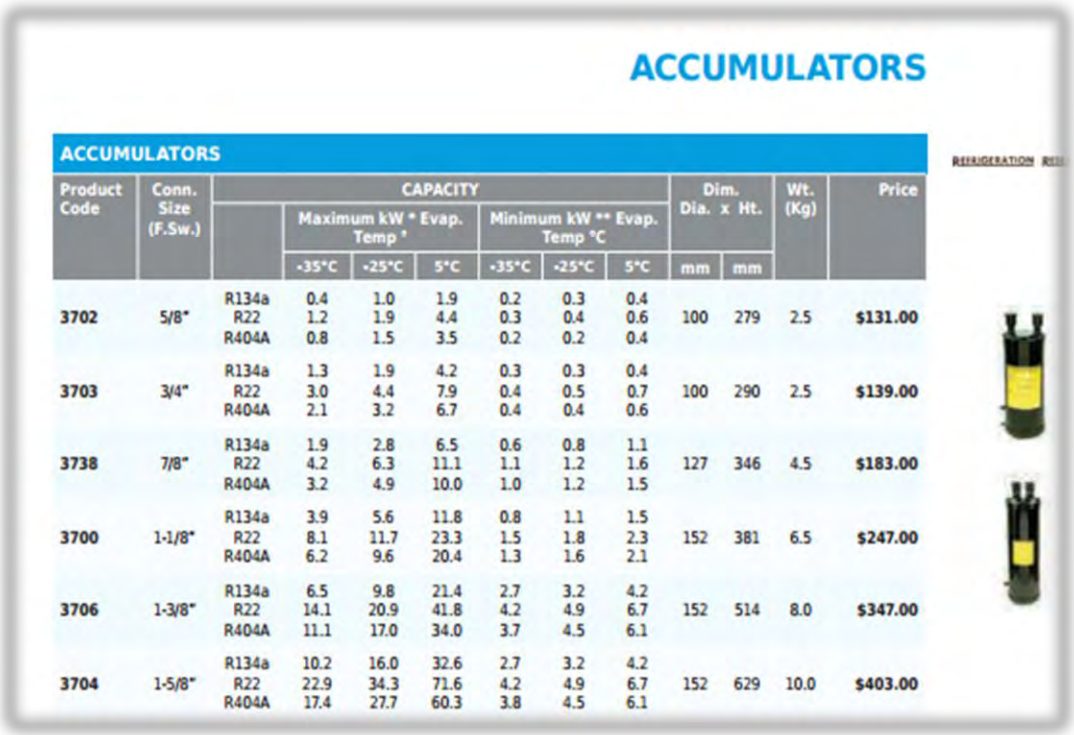
This chapter will focus on theory and terms mainly related to this research which about efficiency between the utilization of condensed and evaporator refrigeration accumulator with battery as power backup. The sources of theory are from previous research and related articles. This chapter aim to give a better understanding about this research should be done. Lately there is numerous studies have been conducted about the efficiency refrigeration accumulator refrigerant, receiver refrigerant and also about efficiency battery that use in solar system. Thus, this research aims to reveal cause to reduce the use of electric power and to focusing green environmental.

2.1 General Information related to Accumulator Refrigerant Suction line

A Suction line accumulator are design a compressor protection devices when flooding and migration do occur .A accumulator place between the evaporator and the compressor on the suction line in refrigeration system. Accumulator place and install in the suction line as close to the compressor .Accumulator also can act as suction line mufflers to quiet compressor pulsation noises. Accumulators simply act as temporary reservoir for a liquid refrigerant and oil. The vessels collect liquid from the suction line and hold them until it evaporated and return to the compressor naturally. An outlet tubes to the compressor are located at the highest point in the

accumulator to only let refrigerant vapour enter the compressor (Tomczyk, 2012).This device must also prevent liquid slugging of the compressor at sufficient rate to maintain both system operating efficiency and proper crankcase oil level. System designer must consider the a proper sized and protected oil return orifice is required to ensure the positive oil and refrigerant back to the compressor (C-, 2007). Accumulator have many type such as horizontal and vertical type that use in air condition system .The type accumulator refrigerant that commonly use in air conditioning system in split unit is U tube vertical type. U shaped with the bottom of the U tube accumulator refrigerant in the lower portion of the tank and with the legs extending to the upper portion of the tank. One leg has an open end to receive the fluid and the other leg has a closed end (Refrigerants, 2005) .The cost accumulator is depending the type of brand accumulator that want to use in air condition system. An accumulator is inexpensive device and can be add to almost any system air conditioning that has experienced compressor slugging (Publications, 2014).

Table 2.1 Accumulator Type (Publications, 2014)



ACCUMULATORS

ACCUMULATORS

Product Code	Conn. Size (F.Sw.)		CAPACITY Maximum kW * Evap. Temp ° -35°C	-25°C	5°C	Minimum kW ** Evap. Temp °C -35°C	-25°C	5°C	Dim. Dia. x Ht. mm	mm	Wt. (Kg)	Price
3702	5/8"	R134a	0.4	1.0	1.9	0.2	0.3	0.4	100	279	2.5	$131.00
		R22	1.2	1.9	4.4	0.3	0.4	0.6				
		R404A	0.8	1.5	3.5	0.2	0.2	0.4				
3703	3/4"	R134a	1.3	1.9	4.2	0.3	0.3	0.4	100	290	2.5	$139.00
		R22	3.0	4.4	7.9	0.4	0.5	0.7				
		R404A	2.1	3.2	6.7	0.4	0.4	0.6				
3738	7/8"	R134a	1.9	2.8	6.5	0.6	0.8	1.1	127	346	4.5	$183.00
		R22	4.2	6.3	11.1	1.1	1.2	1.6				
		R404A	3.2	4.9	10.0	1.0	1.2	1.5				
3700	1-1/8"	R134a	3.9	5.6	11.8	0.8	1.1	1.5	152	381	6.5	$247.00
		R22	8.1	11.7	23.3	1.5	1.8	2.3				
		R404A	6.2	9.6	20.4	1.3	1.6	2.1				
3706	1-3/8"	R134a	6.5	9.8	21.4	2.7	3.2	4.2	152	514	8.0	$347.00
		R22	14.1	20.9	41.8	4.2	4.9	6.7				
		R404A	11.1	17.0	34.0	3.7	4.5	6.1				
3704	1-5/8"	R134a	10.2	16.0	32.6	2.7	3.2	4.2	152	629	10.0	$403.00
		R22	22.9	34.3	71.6	4.2	4.9	6.7				
		R404A	17.4	27.7	60.3	3.8	4.5	6.1				