UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE INFLUENCE OF REFRIGERANT CHARGING FOR NON-DUCTED SPLIT UNIT 1 HORSEPOWER AIR-CONDITIONING SYSTEM

This report is submitted in accordance with the requirement of the University Technical Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Refrigerant and Air Conditioning system with hons)

by

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APPROVAL

This report is submitted to the faculty of Engineering technology of UTeM as a Partial fulfilment of the requirements for the degree of Bachelor of Engineering Technology (Refrigerant and Air Conditioning System with Hons) This Member of the Supervisory is as follow:

……..

(Amir Abdullah Bin Muhamad Damanhuri)

ABSTRACT

Refrigerant and air conditioning split unit system is widely used through the market in the world. The improper maintenance can cause the system overcharge and undercharge. The refrigeration system cannot meet their rated efficiency and cooling capacity. The air conditioning system should be charged with an optimum of refrigerant in order to operate with high performance. Besides, running the system at high refrigerant charge may shorten the life expectancy the system. This project was use split unit non-ducted (wall mounted) air conditioning inverter R410A and non-inverter R22 1 horsepower. This project is to show the comparison current flow, temperature, cooling capacity and coefficient of performance. The result showed that the undercharged and overcharged refrigerant for both system cannot meet their performance. Furthermore, the worst charging is overcharge were the system need more electric consumption for compressed the refrigerant. This project is defined that the of proper charging air conditioning can protect the system and save energy. The proper amount of refrigerant in air conditioning system is very important to give full performance and it can increase the lifespan system.

ABSTRAK

Sistem penyejuk dan penyaman udara unit pemisah digunakan secara meluas melalui pasaran di dunia. Penyelenggaraan yang tidak betul akan menyebabkan sistem pengecasan berlebihan dan berkurangan. Sistem penyejukan tidak boleh mencapai tahap yang efisyen dan kapitsiti penyejukan. Sistem penyaman udaran seharusnya di cas dengan tahap optimum untuk berkerja dengan tahap tertinggi. Selain itu, menjalankan sistem dengan lebihan bahan penyejukakan akan mengurangkan jangka hayat sistem. Projek ini mengunakan unit pemisah tanpa saluran penyaman udara jenis penyongsang R410A dan bukan penyongsang R22 1 kuasa kuda. Projek ini menujukkan perbandingan aliran elektrik, suhu, kapisiti penyejukan dan prestasi sistem. Keputusan menunjukkan bahawa pengecasan penyejukan berlebihan dan berkurangan untuk kedua dua sistem tidak boleh mencapai tahap prestasi. Tambahan pula, pengecasan paling teruk ialah pengecasan berlebihan dimana sistem memerlukan lebihan kuasa elektrik untuk memampatkan penyejukan. Projek ini mentakrifkan bahawa pengecasan yang betul penyaman udara boleh melindungi sistem dan menjimatkan tenaga. Jumlah yang betul bahan pendingin dalam sistem penyaman udara adalah penting untuk memberi prestasi penuh dan ianya boleh memanjangkan jangka hayat sistem.

DEDICATION

I would like to dedicate this thesis to my mother Bimusetatiri Binti Isa@Awang Isa, my father Azman Bin Mohd Salleh, my beloved wife Siti ZurFatin Fatehah Binti Zulkifli for her endless support and my sweetheart son Tuah Yusuf Bin Muhammad Faiz for keep motivated me to accomplish this project. I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout life. I am very thankful for their sacrifice, patience and understanding that were inevitable to make this report possible. Lastly, I would like to acknowledge their comments and suggestion, which are crucial for the successful completion of this study.

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First and foremost, all prise to almighty Allah S.W.T for giving me the strength, health, knowledge and patience to successful complete the Final Year Project report on a given time. I have to thank to my wife and parents for their blessing, love, support me from behind and also pray for me to success in life. I would like to address my deepest feeling appreciation to my respectful supervisor, Mr Amir Abdullah bin Muhamad Damanhuri for their encouragement, comments, guidance and enthusiasm along the time to develop and manage this report properly and successfully. For my co-supervisor Mr Mohd Faez bin Zainol no words can say other than thank you for sharing the experience and guide me to accomplish this project. Special thanks to my friend that have been through thick and thin throughout the completion of this project. This project might be impossible to complete without all of their help. Last but not least, thank you to everyone that directly and indirectly involved in helping me finishing this Final Year Project report.

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AC	–	Air Conditioning
COP	–	Coefficient of Performance
EER	–	Energy Efficiency Ratio
HVAC	–	Heating Ventilation Air Conditioning
HFC	–	Hydro Fluorocarbon
HCFC	–	hydrochlorofluorocarbon
CFC	–	Chloroflorocarbon
Hp	–	Horsepower
R	–	Refrigerant
CH_4	–	Methane
C_2H_6	–	Ethane

CHAPTER 1
INTRODUCTION

1.0 Introduction

The air conditioning split unit system is the system that needed the specific pressure that can produce the required thermal comfort for human and to prevent the waste electric consumption. The detail in chapter 1 is background study, problem statement, objective and work scope.

1.1 Background Study

Refrigerant and air-conditioning split unit system is famous through the world at the market. The application of refrigerant and air conditioning is at medium-sized and large buildings such asindustrial air conditioning, residential air conditioning, food storage and distribution. The air conditioning are major uses is heating, humidifying and control of air quality. While refrigerant is major at industrial refrigeration including chemical and process industry and food preservation. Meanwhile, the air conditioning system is the mechanical part that have a lifespan that the owner predicts to live if the system is use by following the instruction book. If not follow the instruction book it will give the impact from the refrigerant to earth such as global warming and ozone layer depletion if have leakage in the system. The depletion of ozone layer due to the release of chlorine from CFC and HCFC refrigerant has raised serious concerns about using them in vapour compression system. Therefore, ozone layer depletion is simply the wearing out to do the reduction, the amount of ozone in the stratosphere ozone depletion has been pinned down to one major is human activity. Industries that manufacture things like insulating foams, solvents, soaps, cooling

things like air conditioners, refrigerators and containers use something called chlorofluorocarbons (CFCs). These substances are heavier than air, but over time they are carried high into the stratosphere by wind action.

1.2 Problem Statement

Improper amounts of refrigerant either the overcharge or undercharge refrigerant are classified as improper maintenance. The refrigerant cannot achieve their rated efficiency and cooling capacity for the system. Therefore, the system will unbalance because of low or high refrigerant charges. When the refrigerant is low, the cooling capacity in the system is low causes the piping getting frost. Meanwhile, for overcharge, the current and temperature for the system will rose up because of effect the over amount of gas refrigerant. Furthermore, running the system at low or high refrigerant charges level may reduce the lifespan air-conditioning. Mostly the system is designed to protect the main component such as compressor, condenser, expansion valve and evaporator which to make the system low maintenance. However, if the system operated with high refrigerant charges, it will decrease the life expectancy components because the system will push to the limit until the control of system cut off by their own to protect the system. The effect for both the low or high amount of refrigerant significantly affect the required thermal comfort because the system not achieve the efficiency required.

1.3 Objective

These studies embark several objectives:

- To study the impact of refrigerant charge level on cooling capacity in the system for R22 and R410A
- To compared the efficiency changes as a result of overcharge and undercharge between R22 and R410A.

1.4 Work Scope

This project will use split unit non-ducted (wall mounted) air-conditioning inverter unit and non-inverter unit 1 horsepower Panasonic by using refrigerant R22 and R410A.This project aim to measure the running amp, temperature, refrigerant capacity, different pressure between suction and discharge while the system is running. The thickness for copper pipe is 0.61 mm.

There have several limitations for this project:

- The piping length for the system is 2 meters.
- The environment temperature dry bulb temp and wet bulb temperature is measure 24^{o}c.
- The different system between inverter and non-inverter such as the refrigerant volume, capacity, maximum amp and control system are measure through the experiment.

1.5 Summary

In this chapter introduce the problem statement, objective and work scope for fully report. Two refrigerants will be test, R410a for inverter and R22 for constant speed and there are come out with same result which is cooling capacity, pressure ratio, compressor power and coefficient of performance. The next chapter will introduce about the literature review. The literature review is an evaluative report of information found in the literature related for this topic of study. The review will describe, summarise, evaluate and clarify this literature and it also give a theoretical base for the research from the author.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Nowadays, air conditioning usage for building has been raised. The building consumption is the main criteria that the energy consumption has increase. One of the energy is comes from heating, ventilation, air conditioning and refrigeration (HVAC&R). Mostly, HVAC&R use electric energy for resident building. The occupant must save the use of electric energy to future. Besides, split unit or non-ducted air conditioning system is famous at residential building. About 3.5% from 4.73 quadrillion use air conditioner split unit room at US (Goetzler, Sutherland, & Reis, 2013). The usage of electric energy must be controlled and cannot waste it. One of the cause that wasteful electric is excessive use of air conditioning system. The improper maintenance can cause the system undercharge or overcharge. Thus, the system will not give the fully performance, when the system not give the fully performance, the system cannot provide thermal comfort for occupant (Beshr et al., 2014). This is one of the cause that wasteful energy. The undercharge and overcharge also can give the impact for the components in system that can affects the lifetime system. When the system is undercharge, the probability of maintenance is leaking in the system. The refrigerant can cause effect of environment such as global warming potential and ozone layer depletion (Royal Oak, 2014).

2.1 Building Consumption

Last few decades, Malaysia is the countries as the population and the energy consumption in the country tremendously increased for most of the developing. Besides that, Malaysia is the countries experience rapid urbanization and population growth. Occupants of the buildings manipulate ad interact with their environment and structures to obtain the maximum satisfaction requirement. Especially for thermal comfort on buildings that contribution on energy consumption and carbon dioxide emission (Balubaid et al., 2015). Air conditioning has become a very common part in a life. All place need the air conditioning to provide the requirement thermal comfort or for industries use. There have several demands on air conditioning such as resident, commercial, industries and transportation. Thus, using the air conditioning system need a lot of energy to archives the cooling capacity.

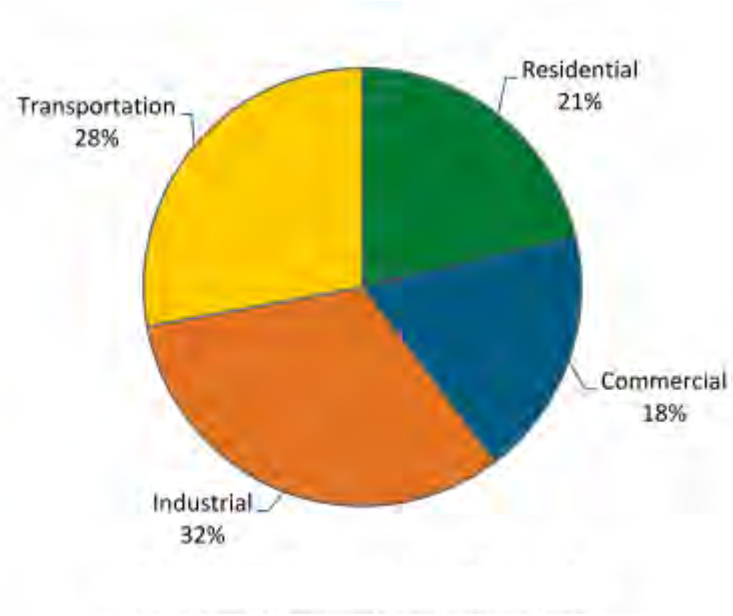

Figure2.1: Total energy consumption

Figure 2.1 show that Transportation is 96.1 which is 28% usage the energy. Resident consumed 21% and commercial consumed 18%. In addition, the highest is industries, it consumed 32% energy. Thus, resident and commercial sectors used the primary energy appliances and equipment for more than 25%. For type heating, ventilation and

air conditioning, in multifamily residential buildings used energy consumption for heating and cooling is become large impact. According to (Goetzler et al., 2013) the total energy consumed 96.1 quadrillion Btu at U.S in 2012.

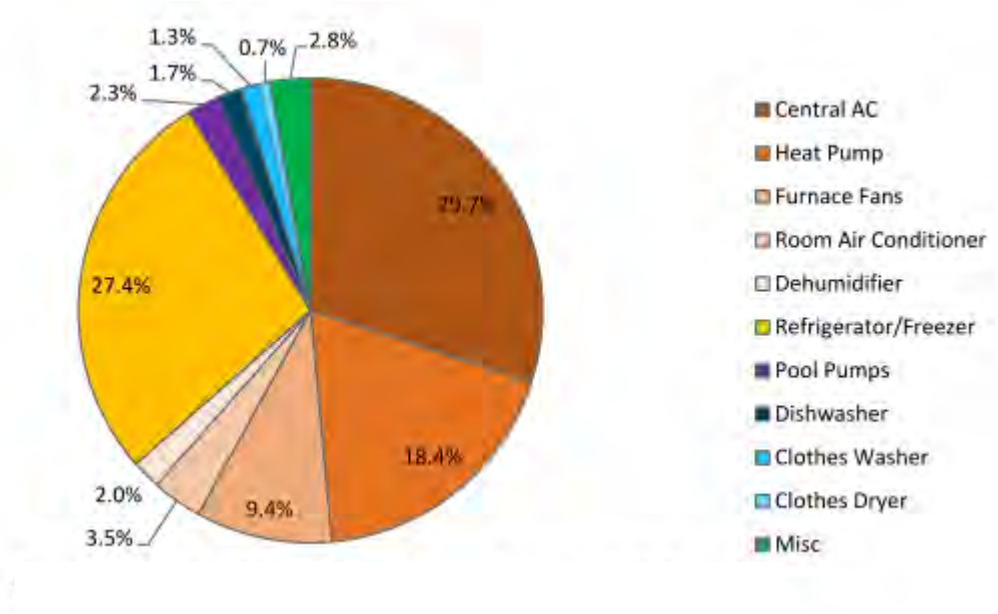

Figure2.2 : Total Residential Energy

Figure 2.2 show that the residential consume 4.73 quadrillion. These reports focus on residential user because at heating, ventilation and air conditioning (HVAC) are the highest energy consumer. Besides, for room air conditioning it consumed of energy is 3.5% and the higher is refrigerant, it uses 27.4% energy consumption. Air conditioning has become a necessity in most modern office building, retail space, house and ware housing.

2.2 Non-Ducted Air Conditioning System

The goal of an air conditioning system is to achieve a highly quality system that functions effectively and is energy-efficient and cost-effective. Ductless system is popular for their high-efficiency cooling. The ductless split system air conditioner provides a quiet system, unobtrusive cooling for multiple zones within a home, office,

or commercial space. Ductless system no need requires ducting like central air conditioners. These systems have two basic parts which is a large condenser unit that installs outdoors and one or more compact wall-mountable blower units that are placed strategically inside the space or zones. When installed, insulated conduit housing the refrigeration lines runs from the outside condenser unit to the blower system indoors. Each wall-mounted blower system can be controlled independently to provide comfortable room cooling right where you need it. Air conditioning comes in many forms. Commercial air conditioning system can be either of these too, but larger system. The selection of the system is depending on design, application, installation, maintenance and cost.

Table 2.1: Types of split unit system

DESRIPTION EQUIPMENT	TYPE
I. Wall mounted Wall mounted is the system that install at wall. The system can flow the cold air through the space or room. When it comes to choosing which split system air conditioner to install, there are two main technologies to be considered the inverter and constant speed air conditioner. These both system is similar function butt are different in terms is the compressor.	

II. Floor mounted Floor mounted can look more discreet that their wall mounted alternative. It can minimize the impact in a room aesthetics. Usually floor mounted are installed large space like mosque.	
III. Ceiling mounted • Exposed type Exposed type can provide air floor up to long distance around 8 meter. It mounted near a wall and just below the ceiling height. • Hideaway type Usually these types are installed at hotel room. The indoor type is hiding between wall and ceiling to give a special decor for the best design. • Cassette type This type provides exceptional coverage and the powerful fan can blow the cold air towards floor. This type are installed at entre of the room and blow warm air in four	  

different direction. It can cover the fairly large room.	
IV. Window and portable These units fit directly inside the window and readily to give wide range air flow. This type is easy to install, low initial cost and portable. It can change to other room with less procedure.	

2.3 Wall Mounted

The air conditioning system is the system that always change the phase or temperature to another place. The phase is recycled from liquid to gas. The temperature is transfer from hot to cold place.

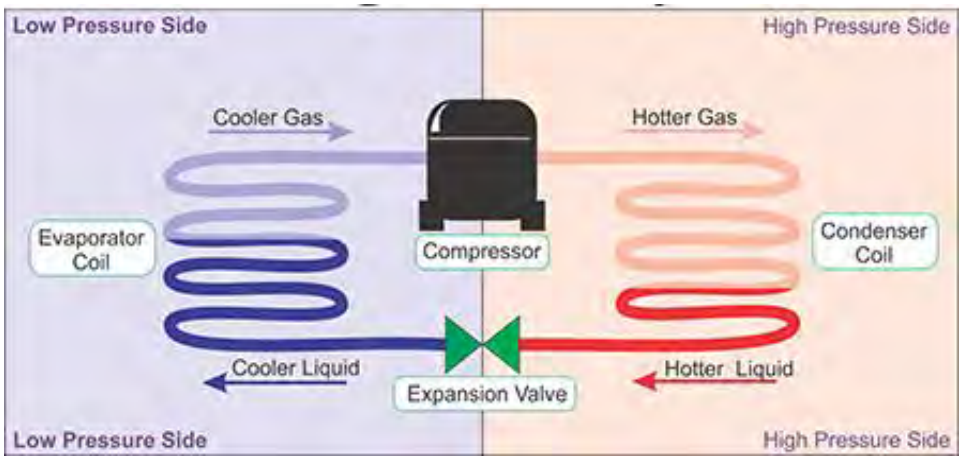

Figure 2.3: Refrigeration Cycle

Figure 2.3 show the refrigeration cycle. The cycle starts from the compressor, compressor compressed the cold refrigerant from evaporator from low pressure and low temperature to high pressure and high temperature. Condenser used to reject the refrigerant heat and change the phase from vapour to liquid refrigerant. At expansion

valve, the refrigerant is change the temperature from high temperature to low temperature. The low pressure and low temperature at liquid phase, the evaporator changes the phase for liquid to vapour. The cycle is rotate until the system cut off. Air conditioning have four basic components which is:

1) Compressor
2) Condenser
3) Expansion valve
4) Evaporator

2.3.1 Compressor

Compressor compressed the refrigerant at high pressure and temperature but in the state of vapor in split unit system, usually the compressor type is reciprocating and scroll. Reciprocating air compressors are positive displacement machines, meaning that they increase the pressure of the air by reducing its volume. This means they are taking in successive volumes of air which is confined within a closed space and elevating this air to a higher pressure. Construction is similar to the reciprocating engine of a vehicle with pistons, cylinder, valves, connecting rods and crankshaft. The compressor functions by drawing gas into the cylinder, compressing it, and sending it out into a holding tank or supply line. This cycle is repeated continuously producing a constant supply of compressed gas. Compared to reciprocating compressors, scroll compressors expel smaller portions of refrigerant more frequently. This leads to smaller pulsations. For installers, this means that mufflers to dampen pulsations do not need to be used as often. The systems featuring scroll compressors are also much less likely to suffer problems with noise or malfunctions in pressure switches caused by pulsations. When the compressor is operating, one of the two spirals is pressed against the other with the help of a medium pressure from a pocket in the scroll set where full compression has not yet been achieved. This results in the two spirals engaging with one another.(Grace, 2002)

2.3.2 Condenser

Heat from refrigerant is transferred to the cooling fluid. Refrigerant condenses to liquid. Condenseris is a tool that to remove heat from the refrigerator gas that is absorbed from evaporator. The heat from refrigerator gas will flow through the condenser walls to condenser medium. The refrigerator gas will be cooling and condense (Elsherbini & Maheshwari, 2010). Usually the wall mounted use finned and tube condenser. Fin and tube using the force air convection, the refrigerant circulates through a coil and air flows across the outside of the tubing. Plus,the air motion caused by natural convection effects when the air is heated or the condenser can include a fan to increase air flow rate. The fin and tube utilize small space. Can saving a cost because the initial installation and maintaining the condenser is easy compare to chilled system.

2.3.3 Expansion Valve

The basic functions of an expansion device in refrigeration systems are to reduce pressure from condenser pressure to evaporator pressure. Regulate the refrigerant flow from the high-pressure liquid line into the evaporator at a rate equal to the evaporation rate in the evaporator. Under ideal conditions, the mass flow rate of refrigerant in the system should be proportional to the cooling load. When the pressure is drop, the temperature is drop from high temperature to low temperature. Besides, expansion valvemaintains a constant degree of superheat at the exit of evaporator. Hence it is most effective for dry evaporators in preventing the slugging of the compressors since it does not allow the liquid refrigerant to enter the compressor. This consists of a feeler bulb that is attached to the evaporator exit tube so that it senses the temperature at the exit of evaporator (Choi & Kim, 2002).