ENERGY AND THERMAL COMFORT ANALYSIS FOR AIR CONDITIONING AND VENTILATION SYSTEM IN LABORATORY

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This thesis is submitted in partial fulfilment of requirement for the award of Bachelor of Mechanical Engineering

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DECLARATION

"I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged"

Signature : ……..
Author : NOOR ASEKIN BINTI MD YASUKIN
Date : ……..

Special for

My Parents

My Supervisor

My Panel

My Friends

My Siblings

My Teachers

My family

Be part of my story

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ABSTRAK

Manusia sentiasa mahu hidup dalam keadaan yang selesa, dimana jika suhu terlalu tinggi mereka mahu rendahkan suhu. Masalah ini memberi kesan kepada keselesaan manusia dan sebagai penyelesaian kebanyakkan caranya adalah memasang penghawa dingin atau meningkatkan sistem pengudaraan bangunan. Prestasi dan penggunaan tenaga penghawa dingin dan sistem pengudaraan telah dikaji untuk memberikan suasanan yang selesa. Dalam masa yang sama, cara paling ekonomi telah ditentukan sebagai sistem yang paling berkesan untuk sistem penyaman udara. Suhu, kelembapan, tekanan dan pergerakan udara adalah beberapa pemboleh ubah penting yang sistem penghawa dingin berurusan dengan cara untuk mengawalan alam sekitar dan menyediakan kemudahan bagi membolehkan kehidupan yang lebih baik dan lama. Factor yang mempengaruhi keselesaan manusia telah ditentukan dengan menggunakan Thermal Microclimate HD32.1 dan akan mengunakan analisis DeltaLog10. Dari kajian, Min Undi Jangkaan (Predicted Mean Vote,PMV) dan Peratus Jangkaan dari Ketidak puasan hati (Predicted Percentage of Dissatisfied) telah ditentukan. Kawasan yang telah membazirkan tenaga adalah satu meter dari pintu kerana parameter didalam makmal akan mendapat ganguan daripada iklim luar. Terdapat beberapa langkah yang boleh membantu untuk mengurangkan kos tenaga yang digunakan.

ABSTRACT

People always want to live in a comfortable, where the temperature is too high they want low the temperature. This problem effect on human comfort and as solution most of way are installing air conditioner or improve ventilation system of the building. The performance and the energy use of air conditioning and ventilation system was studies to give most comfortable situation. In same time the most economical ways was be determined as the most efficient system for air conditioning system. Temperature, humidity, pressure and air motion are some of the important variable that refrigeration and air conditioning deals with the techniques to control the environment and provide comforts to enable the better and longer lives. A factor that affect human comfort was be determined by using Thermal Microclimate HD32.1 and be analyses using DeltaLog10. From the study, the Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied have be determined. The area that have being waste the energy is one meter from door because the parameter inside the laboratory will get interruption from outside climate. There are few step that can help to reduce the cost of energy used

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σ	=	Stefan-Boltzmann constant, 5.67×10^{-8} $Wm^{-2}K^{-4}$
α_k	=	Absorption Coefficient For Short-Wave Radiation
COP	=	Coefficient of Performance
EER	=	Energy Efficiency Ratio
F_i	=	Angular factors between a person
K_i	=	Short Wave Radiation Fluxes
L	=	Thermal Load, Btu
L_i	=	Long Wave Radiation Fluxes
M	=	Metabolic Rate, mel
PPD	=	Percentage of Dissatisfied
PMV	=	Predicted Mean Vote
S_{str}	=	Mean Radiant Flux Density, W/m2
ε_p	=	Emissivity Of The Human Body
T_c	=	Cold Temperature
T_h	=	Hot Temperature
T_{MRT}	=	Mean radiant temperature

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter is about background information of the study. The problem statement, objectives and scope will be covered in this chapter. The problem statements will explain ideas for this study and the objectives must be achieved in order to overcome the problem statement. This chapter also explains the scope for this study that explains the limitation of this project.

1.2 BACKGROUND OF STUDY

1.2.1 Case Study

The world is now suffering an increasing temperature regarding outcome from global warming. It has been estimated that the rise in greenhouse gas emissions over the past few decades has already warmed the planet by 0.8ºC (Watson et al., 1996).The anxieties over global warming and the need for reduction of high emission of greenhouse gases demand the utilization of plans for indoor climate modification in promoting comfortable indoor environment (Givoni, 1994). People always want to live in a comfortable, where the temperature is too high they want low the temperature.

In warm humid tropics, overheated building interior is common due to solar penetration through the building envelope and windows and lack of ventilation (Rajapaksha et al., 2003). This problem effect on human comfort and as solution most of way are installing air conditioner or improve ventilation system of the building. This study is to identify the energy and thermal comfort analysis for air-conditioning and ventilation system in laboratory. The location of laboratory for this study is at Komplek Makmal, Faculty Mechanical Engineering, Universiti Teknikal Malaysia Melaka. For more specific, laboratory HVAC and air conditioning will be the major location for this study. The definition of acceptable indoor climates in buildings is important to the success of a building not only in making it comfortable, but also in deciding its energy consumption and ensuring its sustainability.

1.2.2 The History of Air Conditioning and Ventilation

1.2.2.1 Air Conditioning

The invention of air conditioning cannot be attributed to a certain date. Its developments, as Willis Carrier noted, "Is the natural outgrowth of busy, intelligent minds aiming towards improvement" occurring over an extended period of time. Although basic forms of air conditioning appeared hundreds and even thousands of years ago, its true beginnings as an art and science began at the end of the 19th Century (Will, 1998)

In 1902, publication being printed in Brooklyn, N.Y was ruin by heat and humidity. At that time, the art and science of air conditioning was just beginning to grow. From solving that problem, the industrial process air conditioning begins, as encouraged by a young engineer named Willis Haviland Carrier. Figure 1.1 shows the flow of air-conditioning history from 1902 until 1999 (Nagengast, 2002).

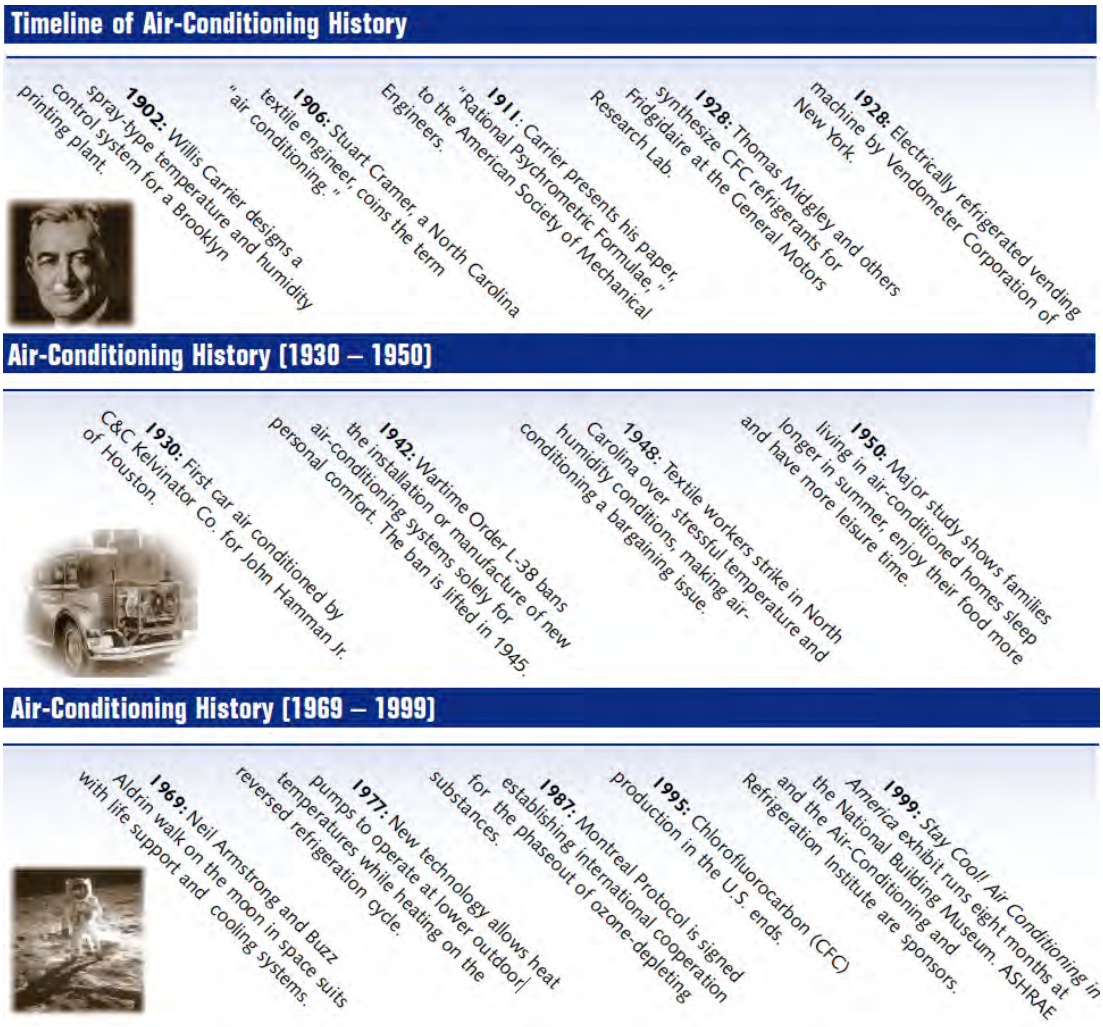

Figure 1.1: The development of air conditioning systems (Source:Nagengast, 2002)

1.2.2.2 Ventilation

Control of combustion provided the first incentive for the ventilation of a space. Because the fire warmed the space to a more comfortable temperature, thermal comfort was intimately linked to ventilation (Janssen, 1999). Control of dust was the second recognized need for ventilation (Woods, 1988). According to Klaus (1970), a Cornish mining engineer, T. Tredgold (1836) published the first estimate of the minimum quantity of ventilating air needed. He calculated from the breathing rate that a subject needed 800ml in three minutes of unvitiated air to purge the CO2 from his lungs.

1.3 PROBLEM STATEMENTS

Human comfort and air-conditioning are related to each other. Air conditioning system is designed to satisfy the need of the human body. Temperature, humidity, pressure and air motion are some of the important variable that refrigeration and air-conditioning deals with the techniques to control the environment and provide comforts to enable the better and longer lives. The room that have air conditioning system has their own system performance. The air-conditioning system is needed to maintain desired conditions in the laboratory during different operating conditions in most economical way (energy, cost efficiency). The air conditioning and ventilation system of the laboratory may be installing at area that the energy is being used efficiently and make human feel comfort but not in the most economical way. So the room air-conditioning strategy is fundamental scheme that describe the targeted temperature, humidity and air flow patterns within the air-conditioning room that can be used to this problem.

1.4 OBJECTIVES

The objectives for this project are to identify the areas that energy is being used efficiently or being waste from current air conditioning and ventilation system of the building. Next is to identify the system performance of air conditioning and ventilation system of the building. The current air conditioning and ventilation system in laboratory will be run and the factors that affect the thermal comfort will be calculated to know the efficiency and it performance of system. Lastly is to identify the most economical way of air conditioning and ventilation system for the building.

1.5 SCOPE OF PROJECT

This project will focus on scopes that explain the limitations of project which are:

a) Reviewing and evaluating of current energy consumption.
b) Evaluating the human thermal comfort level in the building.
c) Identify important physical parameters that may influence the system performance.
d) Finding relationship between energy optimization with human comfort.
e) Propose cost saving methods for the audited building.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the literature review will based on previous research, the basic air conditioning system, energy efficiency, principles of air conditioning, factor affecting thermal comfort and system performance.

2.2 PREVIOUS STUDY

There are several researchers that study on thermal comfort in building or room. Adedayo et al (2013) have study "The Analysis of User's Perception on How to Achieve Thermal Comfort in Kano State Luxury Homes". The congestion and speedy increase of urban activities in Kano State has resulted to thermal comfort challenges, this problem have continued stagnant in the air for quite a long time, despite the control in design of buildings that have arose of recent, there still remains the problem of indoor air quality and humid hot interior spaces that affect building occupants. The main aim of this research is to highlight how user's perception can be used to achieve thermal comforts in the luxury homes in Kano, which can be accessed through examining the effects of thermal discomfort on building users, assessing the actions of users on thermal comfort challenges, evaluating users response on how thermal comfort can be achieved. Another researcher is about

"Thermal Comfort Study and Ventilation Evaluation of an Office" by Daghigh (2012). The study is about finding relating to thermal comfort parameters, air exchange rate, age of air values and air exchange effectiveness in main office of Mechanical and Manufacturing Engineering Department of University Putra (UPM) Malaysia for air conditioned office. Thermal condition in study office rooms has to be considered carefully mainly because of the high occupant compactness in these areas and because of the negative influences that an unacceptable thermal environment has on learning and performance. Other is "Potential Design Parameters for Enhancing Thermal Comfort in Tropical Terrace House: a Case Study in Kuala Lumpur" (Sadafi et al, 2007). The design, modification of the house and adaption of the occupants the reasons for thermal comfort conditions in residential buildings vary.

2.3 BASIC AIR CONDITIONING SYSTEM

The basic components for air conditioning system include an evaporator, compressor, condenser and an expansion device. A refrigerant circulates in this component and it vaporizes in the evaporator by absorbing the heat from warm room air drawn across the evaporator coil. The compressor raises the pressure and temperature of the refrigerant vapours while the condenser condenses the refrigerant and transforms the high pressure vapours into high pressure liquid. Heat is rejected to outside across the condenser. For expansion device, it transforms the high pressure high temperature liquid refrigerant to low temperature mixture of refrigerant liquid and vapour. Lastly, the refrigerant goes to the evaporator and the cooling cycle continues. Refer Figure 2.1 for basic air conditioning system.

Four main room air conditioner construction types can be found on the market:

1. Split air conditioners consist of an indoor- and an outdoor-unit, which are fixedly installed and linked together with the refrigerant line. The condenser and the compressor are located in the outdoor unit, not delivering any waste

heat indoors. Several indoor units can be connected to one outdoor unit – resulting in a multi-split air conditioner. Mobile split air conditioners have a portable indoor unit containing the compressor, which leads to less efficiency.

2. Single ducts consist of one single unit placed freely in the room. The air is expelled through a duct, which requires a window to be open. Warm air is drawn into the room, as the condenser is cooled with air taken from the room – the cooling effect is small and only local.
3. Double ducts also consist of one single unit, but have separate ducts for air intake and exhaust. Either double ducts are moveable and placed next to a window, or the ducts are mounted through the wall.
4. Through-the-window air conditioners (also: compact or through-the-wall AC) are widespread in the USA, but of no importance in Europe. They are too compact to be efficient and require an opening in the insulation.

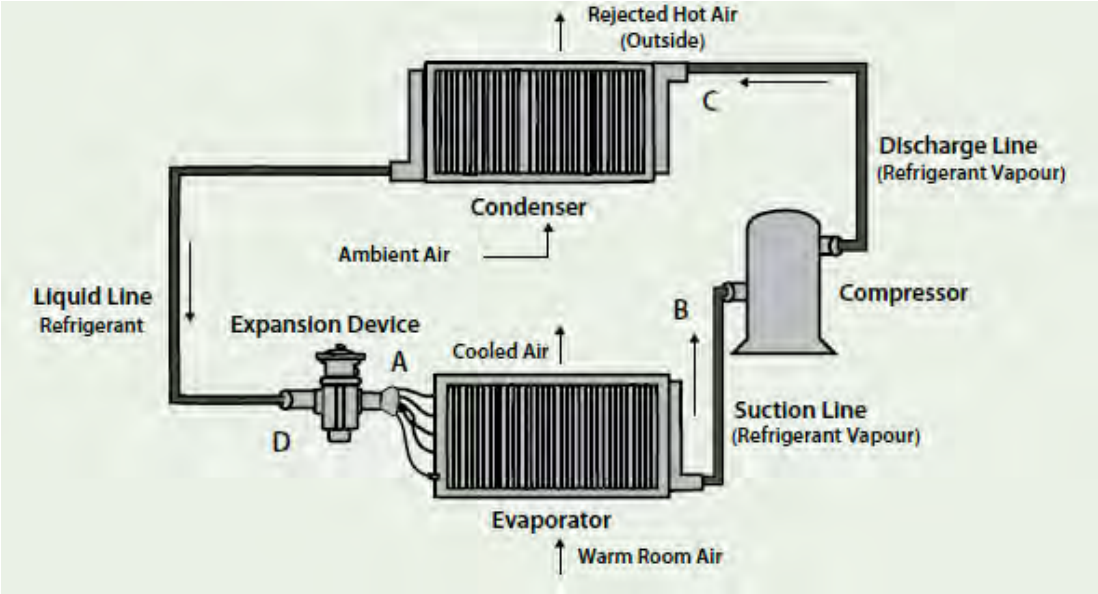

Figure 2.1: The flow of refrigerant

2.4 ENERGY EFFICIENCY

Energy efficiency can be described as the ratio between energy used and the benefits gain from it. It is the most important things to be measured regarding the performance of machine and economical cost. There are several levels and perspectives can be explaining energy efficiency.

2.4.1 Energy Efficiency in the Macro-economic Perspective

Energy efficiency can be denote as energy intensity or (reciprocal) as energy productivity. Furthermore, for ratio to certain physical parameters energy, intensity parameters can be measured on the combined level. In the caring economy, it refers to the specific energy efforts of the supply of domestic production output. Thereby, energy input is related to financial output parameters (Irrek, 2008).

2.4.2 Energy Efficiency in the Context of Energy Conversion

The efficiency of energy conversion in the range of energy supply is mostly characterised by engineering science. For this perspective, energy efficiency can be defined by efficiency factors of the conversion, as for example the ratio of generated end-use energy in proportion to primary energy or to secondary energy used (Irrek, 2008).