THE STUDY OF ENERGY SAVING ON ACMV (AIR-CONDITIONING AND MECHANICAL VENTILATION) SYSTEM FOR FKM BUILDING

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

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SUPERVISOR DECLARATION

'I hereby that I read this dissertation and found its content and form to meet acceptable presentation standards of scholarly work for the award of Bachelor of Mechanical Engineering (Design and Innovation) with honours'

Signature :……..

Supervisor : Dr. Reduan Bin Mat Dan

Date :……..

DECLARATION

I hereby, declare this project entitled “the study of energy saving on acmv (air-conditioning and mechanical ventilation) system for fkm building ” is the result of my own research except as cited in the reference.

Signature:……

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Date: 31 May 2012

For my beloved parents, siblings and friends

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ABSTRACT

This project presents the energy consumption and ACMV (air- conditioning and mechanical ventilation) system of the FKM building. ACMV refers to the equipment, distribution network, and terminals that provide either collectively or individually the mechanical ventilating or air conditioning process to a building. The main objectives of this study are to investigate the relationship between building energy consumption and ACMV system and evaluate the building ACMV system performance through physical measurement. Improvement methods in ACMV system is later being proposed to reduce building energy consumption. This study is also tend to provide a baseline estimate of current energy use which can be used for calculation of the energy saving impact of various options for reducing energy usage. In doing this project, physical measurement is being conducted involving air velocity, temperature and air change rate. Window area and the building wall area measured to obtain the OTTV (Overall Thermal Transfer Value). The lower OTTV value is better for a building. Included proposals to reduce energy consumption and reduce the OTTV in this report. The analysis conducted consists of building cooling loads, energy saving estimates and costing for the building.

ABSTRAK

Projek ini membentangkan penggunaan tenaga dan ACMV (penghawa dingin dan pengudaraan mekanikal) sistem bangunan di Fakulti Kejuruteraan Mekanikal (FKM). ACMV merujuk kepada peralatan, rangkaian pengedaran dan terminal yang menyediakan sama ada secara kolektif atau individu pengalihudaraan mekanikal atau proses penyaman udara untuk bangunan. Objektif utama kajian ini adalah untuk mengkaji hubungan antara penggunaan tenaga elektrik bangunan dan sistem ACMV dan menilai prestasi sistem bangunan ACMV melalui pengukuran fizikal. Kemudiannya, kaedah penambahbaikkan dalam sistem ACMV yang dicadangkan untuk mengurangkan penggunaan tenaga bangunan. Kajian ini juga cenderung untuk menyediakan suatu anggaran asas penggunaan tenaga semasa yang boleh digunakan untuk pengiraan kesan penjimatan tenaga pelbagai pilihan untuk mengurangkan penggunaan tenaga. Dalam melakukan projek ini, ukuran fizikal dijalankan yang melibatkan halaju udara, suhu dan kadar perubahan udara. Luas tingkap serta luas dinding bangunan diukur untuk mendapatkan nilai OTTV(nilai keseluruhan pemindahan haba). Semakin rendah nilai OTTV semakin bagus untuk sesuatu bangunan. Disertakan cadangan untuk mengurangkan penggunaan tenaga serta mengurangkan nilai OTTV. Analisis yang dijalankan terdiri daripada membina beban penyejukan, anggaran penjimatan tenaga dan kos penggunaan ACMV untuk bangunan.

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LIST OF SYMBOLS AND ABBREVIATION

A	area
U	heat transfer coefficient
TD	temperature difference
CLTD	cooling load temperature difference
CLTDc	corrected cooling load temperature difference
Q	cooling load
SHGF	solar heat gain factor
SC	shading coefficient
CLF	cooling load vactor
RT	refrigerant ton
LM	correction for latitude and month
$\boldsymbol{K}$	Thermal Conductivity
$\boldsymbol{\alpha}$	Thermal absorptivity
$\boldsymbol{\omega}$	Specific Humidity
$\dot{m}$	Specific mass flow rate
ϕ	Relative humidity
T	Absolute Temperature

h	Enthalpy
h_{fg}'	Enthalpy of vaporization
Q_L	Latent heat transfer
Q_S	Sensible heat transfer
Q	Heat transfer rate
W	Work
COP	Coefficient of Performance
OTTV	overall thermal transfer value
ACMV	air conditioning mechanical ventilation
PSM	“projek sarjana muda”

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CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

The project tries to find ways on reducing the energy consumption of the ACMV (air- conditioning and mechanical ventilation) system of the FKM building. Air Conditioning is the control of the humidity of air by either increasing or decreasing its moisture content. Added to the control of the humidity is the control of temperature by either heating or cooling the air, the purification of the air by washing or filtering the air and the control of the air motion and ventilation. Ventilation refers to the process of supplying and removing air by natural or mechanical means to and from any space, Such air may or may not be conditioned.

Building energy standards or codes are becoming more and more important in energy efficiency policies [1]. These standards can help raise concern and awareness of building energy conservation, promote energy efficient designs in buildings, encourage the development of energy efficient building products, and form a basis for assessing building energy performance and developing energy efficiency programmers [2]. Many countries in the world are now developing or upgrading their building energy standards in order to achieve the energy efficiency goals.

In response to broad concerns regarding the environment and climate change, Green Buildings are becoming much more common and are increasingly in demand by building owners and occupiers [3]. As a result, they are featuring more prominently in the portfolios of most building developers, architects and engineering consultants. The current green trends are quickly becoming the new standard.

1.1 OBJECTIVES

The objectives of this study are:

i. To reduce OTTV (Overall Thermal Transfer Value) of FKM building and complying requirement of MS (Malaysia Standard) 1525.

ii. To propose methods on ACMV system maintenance and operation that can reduce building energy consumption.

iii. To estimate saving energy consumption for FKM building by calculate cooling load.

1.2 SCOPES OF PROJECT

The scopes of this study are:

i. Building load calculation including OTTV (overall thermal transfer value).
ii. Practical measurements involving temperature, humidity and air change rate.
iii. Standard guidelines of procedures for building maintenance based on the study.

1.3 PROBLEMS STATEMENT AND SOLUTIONS

One of the biggest energy consumption for a non-residential building is the AMCV system. Any saving made on the energy consumption at this system will give significant impact to the cost of running and maintaining the building. Critical analysis and study need to be conducted on which component of the total ACMV system uses the highest energy and innovation and critical thinking is required on how to reduce these consumptions. Present OTTV value need to be determined and new expected OTTV value need to be projected in order to bring about the saving into the system. These are the solution for this problem:

i. Redesign the building properties especially the window and the walls.

ii. Research and find types of air conditioner and the systems of ACMV.

iii. Determine cooling load.

iv. Conduct the measurements including the OTTV, present energy consumption by the ACMV and temperature mapping.

v. Propose Energy estimates, costing and saving.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This literature review is based on term on related topic that was study and has been discussed by a professional and has given a complete explanation on how the things of study work out. The stated review below is important hint in study of saving energy consumption of ACMV (air-conditioning and mechanical ventilation) system relates on GBI (green building index).

ACMV represent Air-conditioning and mechanical ventilation systems. It fills the fundamental principles and systems in a manner that is technically accurate, yet of practical use in the real working world [4]. Today's really, which mandates time and cost effectiveness in ACMV work, dictates this principles approach. By doing this project, some research and observation needed to know energy consumption saving and ACMV systems report [21].

i. Research the energy consumption of air- conditioning and mechanical ventilation, ACMV by the journal by previous study, journal, article, etc.
ii. Research the system of ACMV and their equipment.
iii. Research the green building index Malaysia, MS1525:2007 about energy management system of ACMV.
iv. Research the concept OTTV (overall thermal transfer value) review.

2.1 AIR- CONDITIONING AND MECHANICAL VENTILATION (ACMV) SYSTEM

ACMV stands for air conditioning and mechanical ventilation and refers to the equipment, distribution network and terminals used either collectively or individually to provide fresh filtered air, heating, cooling and humidity control in a building.

A facility can have any combination of heat operated (absorption) and cooling mode to supply the ACMV system. For heating a facility, a gas-or oil-fired boiler or furnace, heat pump, rooftop unit, new technology such as infrared radiation, or electric heat could be employed. Common cooling sources include rooftop units, chillers, heat pumps, air conditioner or some sort of off-peak cooling system.

For the purpose of this part, 'ACMV system' is considered to be of three basic types:

a. Central air- distribution systems

   In this type, either ACMV system equipment or an engineered and field-assembled combination of ACMV system components, receives recirculated room air (plus outside air as required) from a central duct system, performs the required ventilating or air-conditioning functions, and delivers the conditioned air to the central duct system, for final delivery to the conditioned space of the building.

b. Central circulating water systems

   In this type, a centrifugal, rotary, screw, scroll or reciprocating, compression refrigeration or absorption refrigeration type water-chilling package provides chilled water to a central piping system; and the piping system supplies cooled water, as required, to water-air heat exchangers (terminal units) serving the conditioned space of the building. The water chilling package, including its heat-rejecting element and the terminal unit are considered to be ACMV system components.

c. Multiple units systems

In this type, a number of units of ACMV Equipment, each receiving a supply of electric energy, perform the functions of cooling air for distribution to a space or zone of the building.

2.1.1 Air- Conditioning

Air conditioning is treating air for temperature, cleanliness and humidity, and directing its distribution to meet requirements of a conditioned space. Comfort air conditioning is when the primary function of the system is to provide comfort to occupants of the conditioned space. The term industrial air conditioning is used when the primary function is other than comfort.

There are three basic types of air conditioners:

a. Direct expansion coolers include window air conditioners, heat pumps and packaged or rooftop units. Air is cooled and dehumidified as it moves past a cold, refrigerant-filled coil.

b. Chilled water systems use water cooled by a refrigeration machine instead of air. This cool water supplies a coil, which cools and dehumidifies the air.

c. Evaporative (or “swamp”) coolers are usually only appropriate in hot, dry climates and bring hot air in contact with a water spray or damp surface. The result is evaporation of moisture, which lowers the temperature of the air.

2.1.2 Mechanical Ventilation

Ventilation is a process that either supplies or removes air from a space by natural or mechanical means. All air that is exhausted from a building must be replaced by outside air. Outside air must be brought to a certain temperature by makeup air units used throughout the building. Negative building pressure can be a problem during winter heating season and could lead to a number of other problems such as difficulty in opening doors and equipment operation. Air seeps through gaps around windows, doors and ducts. Equations are available to estimate makeup air heating costs in the Guide to Industrial Assessments for Pollution Prevention and Energy Efficiency, referenced at the end of this document

Air is distributed through ducts. Units such as a window air conditioner, distribute air directly from the unit. Other units using baseboards or radiators may deliver heat through water, steam or electric resistance systems. Blowers and registers deliver air in forced air systems.

2.2 GREEN BUILDING

A Green building focuses on increasing the efficiency of resource use – energy, water, and materials – while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance, and removal. Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings. These are the important about green building:

a. Green buildings are designed to save energy and resources, recycle materials and minimise the emission of toxic substances throughout its life cycle.
b. Green buildings harmonise with the local climate, traditions, culture and the surrounding environment.
c. Green buildings are able to sustain and improve the quality of human life whilst maintaining the capacity of the ecosystem at local and global levels.