"I admit that I have read this report
and I found that it is suffice from the aspect of
scope and quality for the award of the degree of
Bachelor of Mechanical Engineering (Thermal & Fluid)"

Signature : _____

Supervisor : Prof Dr Md Razali bin Ayob

Date : _____

DESIGN OF THERMAL CLIMATE TEST CHAMBER FOR SMART BUILDING INVESTIGATION

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A project report is submitted to the Faculty of Mechanical Engineering in partial fulfillment of the requirements for the award of the degree of
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Faculty of Mechanical Engineering
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"I admit this report is done all by myself except statement that I have already stated on each one of them"

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To all my family especially my beloved parent, Mr. GANESAN MUTHI a/l ANNAMALAI and Mrs MANONMANI a/p SOMASUNDRAM, to my brothers, to my supervisor Prof Dr MD RAZALI bin AYOB, all my lectures and all my friends.

Thank you for the motivation and full support

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ABSTRACT

This project of designing and application of a system to control the HVAC system is divided in two parts. First part of the project is about proposal and the second part is about producing the system. This report fully describes about the combination of both part, which contains six chapters starting from introduction, literature review, methodology, results, discussion and conclusion respectively. The main objective of the project is to buy and apply an existing smart system that control the cooling load of HVAC unit based on the heat load of the environment. There will be a testing chamber being built to conduct the test on the smart system. The conceptual design of the platform of testing chamber has been done through sketching by using free hand. After that, the design of the platform of testing chamber was being created by using software such as Solidwork. The process of manufacturing of the platform of testing chamber is done after completing the assembly design in software. This system will be using heat sensor to activate the HVAC system and alter the cooling load from HVAC system depending on the heat load of the environment. The experiment was done successfully. The data was tabulated and graph drawn with discussion based on graph is done. The conclusion is only two of three objective was achieved. The platform was built and experiment was conducted in it. It is found that the air condition unit has only smart system to control the temperature only.

ABSTRAK

Projek ini yang membabitkan proses merekabentuk dan pengaplikasian sistem yang mengawal sistem HVAC terbahagi kepada dua bahagian. Bahagian pertama adalah mengenai pengenalan kepada projek tersebut dan bahagian kedua adalah mengenai penghasilan sistem kawalan. Laporan ini secara keseluruhan mempunyai 6 bahagian yang bermula dengan pengenalan, kajian ilmiah,methodologi, keputusan, perbincangan dan akhirnya kesimpulan. Bahagian pengenalan menceritakan tentang objektif dan skop serta keputusan yang akan terhasil daripada projek ini. Objektif utama projek ini adalah untuk membeli dan mengaplikasi sistem cerdik yang sedia ada untuk mengawal sistem HVAC berasaskan beban haba sekeliling. Sebuah bilik ujikaji akan dibina untuk menjalankan ujikaji ke atas sistem cerdik. Lukisan menggunakkan tangan akan dibuat pada peringkat awal untuk menyediakan asas rekabentuk platform bilik ujikaji.Projek ini akan menggunakan perisian Solidwork untuk proses merekabentuk platform bilik ujikaji. Proses pembuatan platform bilik ujikaji akan dimulakan selepas lukisan produk tersebut telah disiapkan menggunakan perisian komputer Sistem akan menggunakan pengesan haba untuk mengaktifkan sistem HVAC dan mengubah beban sejuk yang dihasilkan oleh sistem HVAC berasaskan beban haba sekeliling.Eksperimen berjaya dijalankan. Data telah dikumpul dan graf berdasarkan data yang diperolehi dilukis dengan perbincangan berdasarkan graf tersebut dibuat. Kesimpulannya ialah dua dari tiga objektif dicapai. Platform berjaya dibina dan eksperimen berjaya dilakukan di dalam bilik ujikaji. Sistem pendingin yang digunakan hanya dilengkapi dengan sistem cerdik untuk mengawal suhu

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LIST OF ABBREVIATION

ABBREVIATION	DESCRIPTION
PSM	Projek Sarjana Muda
3D	Three Dimension
HVAC	Heat, Ventilation and Air Conditioning
BAS	Building Automation System

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Chapter I

Introduction

1.1 Introduction

Energy management became a main concern in this era with increase in oil price and global warming. Best way of energy management is by reducing its usage mainly in buildings since most of energy are used and wasted here. There is no proper management in most of building and it is difficult to manage the energy used in every floor or unit in building by human. There is also energy waste done by human by forgetting to turn off the power supply of equipment they were using. Another problem is most of the time the HVAC systems are not used properly. Some of the cooling provided by HVAC system is used in empty space and sometimes more cooling are produced then required which also a form of energy waste. The HVAC system uses most of the energy in the building hence by managing its energy supply we can help to reduce the energy usage in a building. There is a new development in HVAC system where the new system of controlling the HVAC is known as smart HVAC. This system helps to reduce the energy wastage and proper use of the HVAC system.

1.2 Problem Statement

The problem is without any system to control the energy in the building will make the building management difficult and complicated. The energy that didn't manage properly will be wasted and increase the cost for building management. Another problem is human doesn't know how much of cooling should be produced at a time directly proportionally to the amount of heat created in the area so that the cooling is maintained. Hence a system is required to control the amount of the heating or cooling load send in a certain area such that it is energy efficient and satisfying the occupant comfort level.

1.3 Objective

The objectives of this project are to design a portable testing chamber which will be use to conduct controlled experiments. Then apply an existing smart controlling system to control and monitor the usage of the HVAC. This system should able to control the cooling and heating load of the HVAC. An experiment using the system which control and monitor the HVAC system will be conducted in the testing chamber.

1.4 Scope of the project

The scope of the project will be study on existing building automation. The testing chamber will be manufacture for the experiment. The system which controls the smart HVAC system will use a heat sensor that will be used to activate the smart HVAC system. System activation by temperature module will be applied

1.5 Expected Result

It is expected that, the created system will be able to fulfill the task required. Firstly proper system is developed which means the developed system follows the required conditions without system errors. Through the developed system and design of the smart HVAC, the occupant no needs to adjust the temperature level to their comfort level and high energy efficiency can be achieved. This will also help to prolong the life cycle of the HVAC system which will run at required optimum temperature level without work overload

CHAPTER II

Literature Review

2.1 Introduction

It is necessary to review some researches done in the past that are related to this study. These related past dissertations, journals, reference books and websites would be introduced.

2.2 Heating, Ventilation and Air Conditioning (HVAC)

Heating, Ventilation and Air Conditioning (HVAC) is an important part of a building since it plays an important role in maintaining the comfort of the building occupant. The basic principle of thermodynamic, fluid mechanic and heat transfer can be found in the application of the HVAC. Heating and refrigeration of buildings consume the largest part of energy expended in domestic uses (Paravantis 1995) hence by reducing the energy usage in the HVAC we can save energy and reduce the cost of maintenance. HVAC is used to control the level of humidity, temperature and air flow in certain space or area. The HVAC has mainly three types of process which are heating, ventilation and air conditioning. This process is used to control the comfort level of the occupant.

2.2.1 Heating

Heating function is widely used in cold climate country. The system normally located in the center of the area such as furnace in a house or mechanical room in building. The boiler, furnace or heat pump is used to heat the water, steam or air. The heated fluid will be circulated by ductwork, forced air system or piping system. Some systems are mounted on wall or buried in floor to give under-floor heating

Boiler fed system uses pump to circulate water around the system to maintain the heat at constant level. Forced air system uses ductwork to distribute the hot air to required area. This duct system can be used for air conditioning in hot weather. Electric heating or resistance heating also has been used commonly. This type of heat can be found in electric baseboard heaters, portable electric heaters, and as backup or supplemental heating for heat pump (or reverse heating) system.

2.2.2 Ventilation

According to Advanced English Dictionary (2004), vent means a hole or opening that allows air, gas, or liquid into or out of confined space. There is two type of ventilation which is natural ventilation and forced ventilation.

Natural ventilation means to bring outside air without help or use of mechanical system into a building or confined space. Usually it can be done with installing operable windows to allow the air move. This system use less energy but may affect the occupant comfort since the noise, odor or humidity from outside can come in and the level of cooling can’t be maintained at required temperature since it is natural. This problem is solved with forced ventilation which uses mechanical system.

Forced ventilation uses the mechanical system to circulate the air and control the temperature in the confined room. Direct drive fan, exhaust fan, air condition, ceiling fan, table fan and other type of instrument is used in forced ventilation. The level of humidity or odor of the air can be control using this system via dilution or

replacement with outside air. This system can maintain the level of comfort of occupant but uses more energy and high cost.

Table 2.1: Outside Air Requirements—ASHRAE Standard 62-1989—are shown in the table above(Source: Arthur A. Bell, Jr., 2000)

TYPE OF SPACE	OUTDOOR AIR CFM/PERSON
Offices	20
Banks, Court Houses, Municipal Buildings, Town Halls	20
Police Stations, Fire Stations, Post Offices	20
Precision Manufacturing	20
Computer Rooms	20
Restaurants	20
Kitchens	15
Cocktail Lounges, Bars, Taverns, Clubhouses, Night Clubs	30
Hospital Patient Rooms, Nursing Home Patient Rooms	25
Hospital General Areas	15
Medical Centers, Medical and Dental Clinics, Dental Offices	20
Residential (CFM/Room)	30
Apartments (CFM/Room)	30
Motel and Hotel Public Spaces	20
School Classrooms	15
Dinign Halls, Lunch Rooms, Cafeterias, Luncheonettes	20
Libraties, Museums	20
Retail, Department Stores (CFM/Sq.Ft.)	0.2 - 0.3
Beauty Shops, Barber Shops	25
Drug, Shoe, Jewelry and Other Specialty Shops	15
Supermarkets	15
Malls, Shopping Centers	15
Jails	20
Auditoriums, Theaters	15
Churches	15
Bowling Alleys	25

2.2.3 Air Conditioning

This air conditioning concept has start even in ancient time where it was practice by Ancient Rome by circulating the water through the wall of the house. Similar techniques in medieval Persia involved the use of cisterns and wind towers to cool buildings during the hot season. Air condition became a necessity in modern day life. Air condition or refrigeration works by removing heat from the surrounding space to another space which is cooler. The heat is transferred by conduction, convection, and radiation using medium such as air, ice, water, or chemical called refrigerant. The medium to be cold so it can absorb the heat at bring it outside where the heat is transferred. An air conditioning system, or a standalone air conditioner, provides cooling, ventilation, and humidity control for all or part of a house or building. The modern air conditioner was invented by Willis Haviland Carrier in 1902. The air conditioner can be divided into four types which are window and through-wall units, evaporative coolers, absorptive chillers and central air conditioning.

There is two type of application of the air conditioning. The process application and comfort application. The process application is where the level of comfort is not given the importance rather the level of temperature, humidity, air flow, cleanliness are given top priority. This type of application are commonly used in hospital, pharmacy, data center, laboratory, mines and etc. the comfort application is more commonly used in shopping mall, restaurant, office, houses, government building, academic building and etc.

2.3 Type of HVAC used in buildings.

There are few type of HVAC unit that commonly used in buildings such as air conditioner, boiler, chiller, cooling tower, fan (mechanical), humidifier and fan coil unit.

2.3.1 Air conditioner

This type is known as window and through wall units and also called as packaged terminal air conditioner (PTAC). This type is popular in hotel and housing sector. It is also used in office type building. It is able to provide cooling and heating. It uses refrigerant such as Freon as a medium to transfer the heat.

The refrigerant provides cooling through a process called the refrigeration cycle. There are few type of refrigeration cycle such as, vapor-compression refrigeration cycle, gas refrigeration cycle, cascade refrigeration cycle, absorption refrigeration cycle, and thermoelectric refrigeration cycle. The most frequently used cycle is vapor-compression refrigeration cycle. By referring to figure below it works by sending refrigerant in saturated vapor form into the compressor (1). It is compressed isentropically to condenser pressure. The temperature will increase above the surrounding temperature. It then enters the condenser as superheated vapor (2) and came out as saturated liquid because the heat, Q_c, is transferred to the surrounding from the refrigerant. The temperature of the refrigerant is still above surrounding pressure and it enters expansion valve (3) where its temperature drops below the refrigerated space temperature. It enters the evaporator as saturated mixture (4) and absorbs the heat, Q_c, and leave the evaporator as vapor. The vapor is then returned to the compressor. A metering device acts as a restriction in the system at the evaporator to ensure that the heat being absorbed by the system is absorbed at the proper rate.

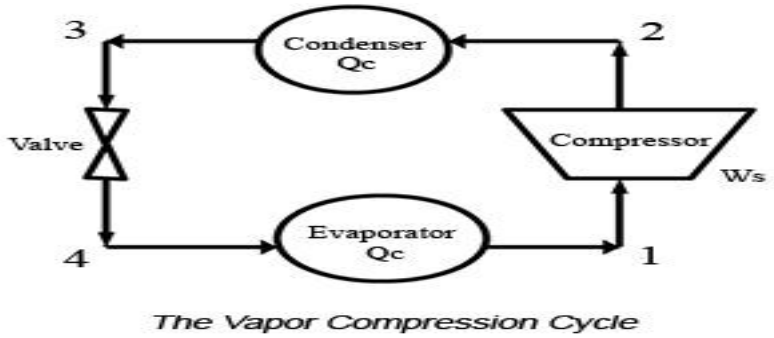

Figure 2.1: The Vapor Compression Cycle

(Source: www.unity.com.ph)