‘I admit that I have read this report and in my opinion this report is fulfilled the scope and quality for award condition of Bachelor of Mechanical Engineering (Thermal-Fluids)’

Signature : .....

Supervisor’s Name : .....

Date : .....

STUDY ON PREDICTIVE MAINTENANCE OF HVAC SYSTEM

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This report was adduced in partial fulfillment for award condition of Bachelor of Mechanical Engineering (Thermal-Fluids)

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"I hereby, declare this report is the result of my own research except as cited in the references"

Signatures :…….

Author 's Name:…….

Date :……

Special Thanks To My Beloved Parents, Ismail and Zainab…

My Whole Family,

Abang Ki, Kak Na and Family

Kak Yah, Abang Yie and Family

Abang Wi

Abang Ha

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For All Your Commitments and Supports

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ABSTRACT

Heating, Ventilating and Air Conditioning (HVAC) is humidity equipment that comes in one package to provide comfort ability to people. Commercial HVAC systems provide the people working inside buildings with conditioned air so that they will have a comfortable and safe work environment. There are three main systems in HVAC system, which are heating, ventilating and air conditioning. For each main system, there are many others equipment or components in it. The maintenance of HVAC system is very important in order to maintain humidity services to people. So, many academics and researchers make a study about HVAC maintenance to always propose new method which is better than conventional maintenance method and replace it. In this paper or report, it is also mentioned about the methodology in order to do research about the HVAC maintenance which is focused on chillers and AHU only. The best method in HVAC maintenance is by predictive maintenance. Actually, there are many types of technologies used in predictive maintenance like, vibration analysis, oil analysis, eddy current testing, IR thermography and also ultrasonic testing. This type of maintenance has more advantages than disadvantages.

ABSTRAK

Pemanasan, pengalihudaraan dan penyaman udara merupakan alat pelempap udara yang digabung menjadi satu sistem dan dipanggil sebagai sistem HVAC. Sistem ini berupaya untuk memberi keselesaan kepada manusia dengan terhasilnya udara yang lembap di dalam bangunan yang asalnya bersuhu tinggi. Ini membolehkan manusia melakukan aktiviti mereka dengan selesa dan dalam keadaan yang selamat. Terdapat tiga sistem yang utama dalam sistem HVAC ini iaitu pemanasan, pengalihudaraan dan penyaman udara. Setiap sistem ini pula mengandungi pelbagai alat kelengkapannya yang tersendiri. Penyelenggaraan sistem HVAC ini amat penting untuk menjamin dan mengekalkan kebolehfungsiannya dalam memberi keselesaan kepada manusia. Oleh itu, ramai antara ahli akademik dan pengkaji yang melibatkan diri dalam kajian ini untuk mencari satu kaedah penyelenggaraan yang baru dan lebih baik daripada yang sedia ada dan menggantikannya. Kertas kajian ini ataupun laporan ini turut mengandungi metodologi untuk menjalankan kajian tentang penyelenggaraan sistem HVAC ini dan menumpukan kepada dua komponen iaitu alat pendingin air dan unit pengelola udara (AHU). Penyelenggaraan jangkaan adalah kaedah yang paling sesuai dan tepat dalam proses menyelenggara system HVAC ini. Sebenarnya terdapat pelbagai teknologi yang digunakan dalam kaedah penyelenggaraan jangkaan ini antaranya ialah analisis getaran, analisis minyak, ujian arus pusar, thermografi inframerah dan juga ujian ultrasonik. Kaedah penyelenggaraan ini mempunyai banyak kelebihan daripada kelemahan.

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LIST OF ABBREVIATIONS, SYMBOLS & UNIT

HVAC	Heating, Ventilating and Air Conditioning
IAQ	Indoor Air Quality
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
%	Percentage
°F	Fahrenheit Degree
LPG	Liquid Petroleum Gas
cfm	cubic feet per minute
OA	Outside Air
MUA	Make-up air
fpm	feet per minute
CT	Cooling Tower
CWP	Condenser Water Pump
CWS	Condenser Water Supply
CWR	Condenser Water Return
CH	Chiller
CHWP	Chilled Water Pump
CHWS	Chilled Water Supply
CHWR	Chilled Water Return
CC	Cooling Coil
HC	Heating Coil
HWS	Heating Water Supply
HWR	Heating Water Return
HWP	Heating Water Pump

HHWS	Heating Hot Water Supply
B	Boiler
SAF	Supply Air Fan
SAD	Supply Air Duct
MVD	Manual Volume Damper
CD	Ceiling Diffuser
RA	Return Air Inlet
RAF	Return Air Fan
RA	Return Air Dampers
ATC	Automatic Temperature Control Damper
EA	Exhaust Air (Dampers)
F	Filters
ATC	Automatic Temperature Control Valve
MBV	Manual Balancing Valve
AHU	Air Handling Unit
RTU	Roof Top Unit
Btu/hr	British thermal unit per Hour
MVD	Manual Volume Dampers
TR	Ton of Refrigeration
FDD	Fault Detection and Diagnostic
m^2	meter square
mm	milimeter
FCU	Fan Coil Units
COP	Coefficient of Performance
MBFDD	Model-Based Fault Detection and Diagnosis
SVM	Support Vector Machine
SMO	Sequential Minimal Optimization
Hz	Hertz
AC	Alternating Current
DC	Direct Current
JKR	Jabatan Kerja Raya

PM	Preventive Maintenance
PdM	Predictive Maintenance
PaM	Proactive Maintenance
FBM	Failure Based Maintenance
BAS	Building Automation System
DDC	Direct Digital Control
CBM	Condition Based Monitoring
MCSA	Motor Current Signature Analysis
IR	Infrared
FAM	Facilities and Asset Management
SMS	Short Messaging System

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CHAPTER 1

INTRODUCTION

1.1 Background

Heating, ventilating and air conditioning (HVAC) system is very useful to people especially those live in the working building that need comfortable and safe work environment. Many large buildings and campuses have HVAC system. Maintaining and optimizing the performance of HVAC equipments like pumps, chillers and motors can be challenging. These systems often have hidden performance problems that waste energy and cause excessive wear on equipment. A preventive and predictive maintenance plan is an excellent way to maintain an efficient system, save energy dollars, prevent costly breakdowns, and extend equipment life. Today, the HVAC system is one of the main necessities in the working building but to maintain it works smoothly and can provide good environment, it needs a good maintenance. Building systems are the lifeblood of any facility. Without lighting, water, or heating and cooling, a building would be uninhabitable. That is why a strong preventive and predictive HVAC maintenance program is not an option but it is the thing that we should do. So, with the blooming of technologies nowadays it should have the alternative way in HVAC maintenance to replace the old ones.

1.2 Objectives

While doing this study or research, they are some objectives that should be achieved based on problems that we want to encounter. The objectives are to:

i. Identify the problems that commonly occurred on the HVAC system.
ii. Study the predictive maintenance or condition monitoring of the HVAC system
iii. Analyze the advantages and disadvantages by using condition monitoring on HVAC maintenance.

1.3 Problem Statements

Nowadays, HVAC system is very important to use and be a main necessity or requirement either to working building or living building like commercial buildings, offices, supermarkets and campuses building. To get good environments in the buildings, HVAC system should be monitored and controlled effectively, in other words the scheduled maintenance are required in order to maintain good working of HVAC systems. The cost of the maintenance is became the most factors to dispute and argue among engineers. So, they need to find a solution how to detect and identify developing problems before failure and extensive damage can occur. By this, they can make proper and suitable actions to avoid the HVAC equipments from breakdowns otherwise they will have problems to repair and maintenance. So, the best solution is by make a predictive maintenance on HVAC system based on condition monitoring methods and technologies.

1.4 Scope

This research is about the study on the predictive maintenance on HVAC system. Means that, this research want to study what are the methods and technologies used in order to monitor the condition of the HVAC equipments in terms of problems occurred during the operation of these equipments. There are many types of HVAC equipments like boiler, chiller, cooling tower and air handling unit (AHU). But, in this research it will focus just on the chiller and AHU. In order to study about predictive maintenance, the basic information about the problems or failures that are commonly occurred on chiller and AHU need to be identified first. Then, how the predictive maintenance is going to overcome these problems need to study as a climax of the research.

CHAPTER 2

THEORY

HVAC actually is an acronym for heating, ventilating and air conditioning. HVAC system is very important especially in working building or office building that involves many people in order to provide comfort ability to people. According to Samuel (2005), provide an acceptable level of occupancy comfort and process function is one of HVAC system objectives beside to maintain good indoor air quality (IAQ) and to keep system costs and energy requirements to a minimum. The three functions of heating, ventilating, and air-conditioning are closely interrelated. All seek to provide thermal comfort, acceptable indoor air quality, and reasonable installation, operation, and maintenance costs.

2.1 HVAC System

Commercial heating, ventilating and air conditioning (HVAC) systems provide the people working inside buildings with conditioned air so that they will have a comfortable and safe work environment. People respond to their work environment in many ways and many factors affects their health, attitude and productivity. Air quality and the condition of the air are two very important factors. By conditioned air and good air quality, we mean that air should be clean and odor-free and the temperature, humidity and movement of the air will be within certain acceptable comfort ranges. ASHRAE, the American Society of Heating, Refrigerating and Air Conditioning Engineers, has established standards which outline indoor comfort conditions that are thermally acceptable to 80% or more of a commercial building's occupants. Generally, these comfort conditions, sometimes called the "comfort zone", are between 68°F and 75°F for winter and 73°F to 78°F during the summer. Both these ranges are for room air at approximately 50% relative humidity and moving at a slow speed (velocity) of 30 feet per minute or less.

An HVAC system is simply a group of components working together to move heat to where it is wanted (the conditioned space), or remove heat from where it is not wanted (the conditioned space) and put it where it is unobjectionable (the outside air).