UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE AIRBORNE FUNGI CONTAMINANT IN LIBRARY CENTRE AT UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM): ASSESSMENT ON THE HVAC SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Refrigeration and Air-Conditioning Systems) (Hons.)

by

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TAJUK: **The Airborne Fungi Contaminant in Library Centre at Universiti Teknikal Malaysia Melaka (UTeM): Assessment on the HVAC System**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Refrigeration and Air-Conditioning Systems) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Mikrob bawaan udara telah dikesan menjadi salah satu pencemaran utama yang membawa keapada kualiti udara dalaman yang rendah. Kajian ini bertujuan untuk menkaji tahap pencemaran kulat di dalam pusat perpustakaan kampus utama Universiti Teknikal Malaysia Melaka (UTeM). Pencemaran udara ditentukan melalui kaedah pemendapan dengan menggunakan Malt Extract Agar (MEA). Jumlah purate kepekatan kulat untuk keseluruhan bangunan perpustakaan adalah 324 CFU/m³. kepekatan kulat juga ditentukan pada setiap aras tingkat di mana, tingkat tanah mempunyai kepekatan kulat pada 131 CFU/m³, tingkat satu dengan 695 CFU/m³ dan tingkat dua dengan 79 CFU/m³. Dapatan ini menunjukkan bahawa pusat perpustakaan mempunyai tahap latar belakang yang signifikan dengan pencemaran kulat. Pemilik bangunan mestilah sedar akan status penyelenggaraan bangunan untuk melindungi penghuni dari segi keselamatan dan masalah kesihatan.

ABSTRACT

Airborne microbe has been detected to been one of major contaminant that lead to poor indoor air quality. This study intended to investigate the level of fungal contaminant in the library center of main campus of Universiti Teknikal Malaysia Melaka (UTeM). The fungal contaminant is determined by using sedimentation method with the use of Malt Extract AGAR (MEA). The total mean of concentration of fungal for the whole library building is 324 CFU/m³. The fungal concentration also determined in each level where ground floor has concentration of 131 CFU/m³, first floor with 695 CFU/m³ and second floor with 79 CFU/m³. These findings indicates that the library center do have some significant background level of fungal contaminant. The building owner should be aware to their building maintenance status to protect the occupant from safety and health problem.

DEDICATION

This project report is dedicated to my parents and family who have supported me all the way since the beginning of my studies.

A special feeling of gratitude to my loving parents, Ghazali B. Md Isa and Zaiton Harun who have given me words of encouragement push me into finishing this project report.

My sister, Siti Noor Hasanah, who always giving me advice in confronting the problems and always give me moral support, I dedicate this project report to you.
I also dedicate this dissertation to my friends who have supported and encourage me throughout the process. I will always appreciate all they have done, especially to my group mate of final year project who's always been there for me whenever I encounter problems in completing this project.

Finally, this thesis is dedicated to all those who believe in the richness of learning and also the people in my life who touch my heart. Without their love and support, I would not have made it to where I am today.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Air Conditioning
ANOVA	-	Analysis of Variance
BRI	-	Building Related Illness
CFU	-	Colony Forming Unit
CH2HO	-	Formaldehyde
CO	-	Carbon Monoxide
CO2	-	Carbon Dioxide
COP	-	Code of Practice
ETS	-	Environmental Tobacco Smoke
F	-	F Test (ANOVA)
HVAC	-	Heating, Ventilating and Air Conditioning
IAQ	-	Indoor Air Quality
ICOP	-	Industrial Code of Practice
MEA	-	Malt Extract Agar
O2	-	Oxygen
PM	-	Particulate Matter
SBS	-	Sick Building Syndrome
SD	-	Standard Deviations
TLV	-	Threshold Limit Value
VOC	-	Volatile Organic Compound
>	-	More than
<	-	Less than

CHAPTER 1
INTRODUCTION

In this chapter, introduction to this project will be briefly discussed for the reader to get the brief idea of this whole project. The background of study of this project will be added in this chapter, which will explain generally the topics of this subject. The problem statements of this project study are also stated which it explains the problem that needs to be solved and be the main reason why this study is conducted. The objectives of this study will also be stated which included the general and specific objectives. This chapter also explains the scope of this study.

1.1 Background of Study

The use of air conditioning system in our daily life is a common need nowadays. Almost every building in every country installs air conditioning system and it is used almost throughout their day either during working hours or even in their home to provide comfort. As Malaysia has only one season, and the climate in Malaysia is hot and humid throughout the year, peoples in this country only need to be conditioned with fresh air, and does not need heated air. Unlike these countries, there are countries that consist of many more seasons up to four seasons. For this type of condition, the people in those countries are rather to install types of air conditioning system that could provide not just only air conditioning but also heating. This heating

of air can be used during their winter season. While, air conditioning is preferable used during summer season.

The function of Heating Ventilating and Air Conditioning (HVAC) is to control the temperature, humidity and also the quality of air depends on the chosen condition. The system needs to transfer heat and moisture in and out of the air and also controls the air pollutant either by removing it to the outside air or blending it to the acceptable level. Exposed to a long exposure of indoor air pollution may cause health effects to the occupants (Zainal Abidin *et al.*, 2013). There are many types of air pollutant that produced in the building itself, such as volatile organic compounds (VOC), airborne microorganism, formaldehyde (CH_2HO), particulate matter (PM), radon, asbestos, and combustion gases and by-products. However, in previous studies, it is found that airborne microbe is one of the major contaminant that contributes to the problem of poor indoor air quality (IAQ) (Zainal Abidin *et al.*, 2013). Airborne contaminants can fall into categories of chemical hazards, physical hazards, biological hazards, and ergonomic hazards. In this study, researcher will focus into the study on biological hazard which is the level or the quantity of fungal contaminates in air conditioning (AC) system only. In the indoor environment, we can find a wide variety of fungi (molds, or yeasts) which includes bacteria, viruses and amoeba (Zainal Abidin *et al.*, 2013).

Fungal is hazardous to health as it can cause allergens which is a substance that can cause allergic reactions, irritants, and in some case it can cause potentially toxic substance which is mycotoxins (EPA, 2010). Allergies may happen if someone is in contact with the fungal spore, and the allergic responses may include hay fever-type symptoms, such as sneezing, running nose, red eyes and skin rash (dermatitis) (EPA, 2010). The types of fungi that are reported to cause allergy are Ascomycota, Basidiomycota, or anamorphic fungi (Khan and Karuppayil, 2012). Fungi can grow its population in any types of condition either natural or synthetic materials, especially if they are hygroscopic or wet (Khan and Karuppayil, 2012).

People nowadays are living hectic lifestyles, where we always busy with our works and kept working in a same place for hours. It is common for a normal person to

breath an amount of air ranges from 10 000 to 30 000 liter of air (Zainal Abidin *et al.*, 2013). Thus, it is important for us to keep and to ensure that the air we breathe is clean from any types of pollutant that may harmful to our health. The sick building syndrome (SBS) term is commonly used when health disturbances are related to IAQ (Ross *et al.*, 2004). When an environment is exposed to the indoor air pollution, health hazards such as allergy, infections and toxicity may pose up (Khan and Karuppayil, 2012). The most common sign of SBS is the person will feels headaches, pressure on the head and throbbing, and feelings of tiredness (Khan and Karuppayil, 2012).

The ignorance of the duty in cleaning and checking out of the HVAC systems may allow microbial growth, which causes rhinitis, bronchitis, pharyngitis, pneumonia, conjunctivitis and keratitis in the users (Ross *et al.*, 2004). These kinds of infections may be life threatening, and to control these infections from occurring is proving to be difficult even when air filtration is installed in places (Weaver *et al.*, 2009). It is estimated that over 90% of the time is spent in indoor environments in developed countries and this may contribute to SBS (Li *et al.*, 2007). As a preventive ways of those unwanted problems from occurring, the government in Malaysia has develop a guidelines of code of practice which is entitled "Code of Practice on Indoor Air Quality" (COP-IAQ) developed on 2005 by Department of Occupational safety and Health (DOSH) as a guideline for the building manager in managing the conditions of the building to a suitable state with human adaptation.

Thus, the importance of this study is to create awareness on the importance of maintaining the IAQ of a building and also preventing any SBS from occurring. This study also been carried out to give knowledge to people out there as the study of fungal in AC system is not many being carried out especially in the library. The presence of books, furniture, carpets and people in the building would contribute to the level of fungal contaminant and also the level of IAQ parameters. The purpose of this study is to determine the airborne fungi in the HVAC system in the UTeM Library. This study will be conducted to see the evidence of poor HVAC ducting system that can caused fungi contaminant in the system.

Thus, the aim of this study is to determine the level of the airborne fungal contaminant and IAQ parameter (air temperature, percentage of relative humidity, air velocity, carbon dioxide, carbon monoxide, total volatile organic compound, and suspended particulate matter) and their relationship with the poor AC ducting system.

1.2 Problem Statement

The HVAC system is a common thing in our life nowadays, yet there are lacks of evidence of the impact of these systems on human health (Weaver *et al*., 2009). People nowadays are also lacking of awareness of the importance of conducting the maintenance of cleaning the AC system. Lots of building with AC system installed in is always being left without periodical or proper maintenance. Thus, when an AC system in being left for a long time without being cleaned, some of the IAQ parameters may cause the existence of fungal growth due to high humidity in the system. A high humidity would cause a growth of fungi in the system. As mention earlier, fungi are hazardous to health. A high level of dust in the air would also contribute to health problems as dust particles could blend in the air and when breathe it could enter the respiratory parts and lead to further health problems such as asthma. As dust particles, fungi spores can also be flown over by the air and if breathed in, it would cause a very crucial health problem such as allergy and fever.

The fungal growth must be prevented and the way to prevent it is that we must make sure that the condition of the AC system must be free from any conditions that may lead to fungal growth such as wet or leaking. Thus, this procedure must be included in the maintenance of the AC system. The SBS may appear if the occupants of the building are exposed too long to the hazards. Thus, the researcher will intend to prove these two parameters which are fungal growth in the system and also IAQ level in the building which is probably due to low maintenance of the AC ducting system. This study is conducted in the library as the building has cooling tower which is important for the AC system and if there is leaking, it may cause fungal growth. Apart from that, library center has a large volume of occupant entering and

stay in the building for a specific time, thus making the study easier as to compare with the time exposed to the AC system. in a study, it is also stated that the highest fungal counts were recorded at research laboratories and library (Awad and Farag, 1999).

Thus, there is evidence saying that library is a place that has fungal growth. According to Ambu *et al*. (2008) the code of practice (COP) that developed in 2005 act as a safe guard the well-being of building occupants. However, the implementation of this COP is not mandatory, therefore, the set objectives of developing the COP is not successfully achieved. Thus, this study is also conducted to inform people or the building manager in the importance of maintaining the IAQ parameters in the AC system and also in keeping the AC system in proper condition.

1.3 Objectives of the study

The objective included main and specific objective of this study. The objectives become the main reason and the relevant why the researcher conduct this study. The conclusion of the study would also be based on these objectives.

1.3.1 The Main Objective of the Study

To determine the level of airborne fungal contaminant along with IAQ parameter and their relationship with the poor AC ducting system.

1.3.2 The Specific Objectives of the Study

1. To calculate the total quantity of fungi found in the UTeM's library AC system.

2. To identify the IAQ parameter (air temperature, percentage of relative humidity, air velocity, carbon dioxide, carbon monoxide, total volatile organic compound, and suspended particulate matter) of the UTeM's library AC system.

3. To correlate the IAQ parameters (air temperature, percentage of relative humidity, air velocity, carbon dioxide, carbon monoxide, total volatile organic compound, and suspended particulate matter) with the AC system and fungal growth.

1.4 Scope

This study will focuses on the airborne fungi contaminant in Library Centre at Universiti Teknikal Malaysia Melaka (UTeM) with Assessment on the AC system. This library is a three floor building and has six units of working place. Thus, this study will cover all the AC system in each floor of that building. This study involves the data collection data of the fungal concentration. Apart from that, the researcher will also find the IAQ parameter of the building. All the collected data will then be compared with the Industrial Code of Practice on Indoor Air Quality (ICOP-IAQ 2010) standard to check whether the building do comply with the standard or not and then proceed to be related to the AC system conditions. Some general question will be asked to the occupants about their awareness of the problem as further information for this study.

CHAPTER 2
LITERATURE REVIEW

A literature review is a critical look at the existing research or case study that have significant to the proposed project. The existing research, then will be summarized, interprets and critically evaluates in order to establish current knowledge of a subject. The literature review is done by consulting others work in order to see and investigate the problem of the research task. Articles, books, journals and other sources relevant to the particular issues, areas of research or theory have been surveyed in conducting this literature review. The literature review is important in a research because it is needed to give the reader what knowledge and ideas have been established on topic, what the strength and weakness of the study. The aim of the literature review is to provide a justification of the proposed research project, indicating how it will be different from the published study and to develop an argument or case for study based on literature review.

2.1 Pollutants In Indoor Environments

Exposure to indoor air pollution is becoming a serious issue on public health problems of a wide variety of nonindustrial settings such as residences, offices, schools, hospitals and vehicles. This issue is due to that most people spending their working time in indoor environments (Ismail *et al.*, 2010). It is estimated that over 90% of the time is spent in indoor environments in developed countries and this may contribute to SBS (Li *et al.*, 2007; TSI-IAQ Handbook, 2011).

According to TSI-IAQ Handbook (2011), there are several types of pollutants that affect air quality which include biological (bacteria, fungi, viruses, molds, pollen, animal hair, dander and excrement), chemical (cleaners, solvents, fuels, adhesives, various combustion by-products and emissions from furnishing floor and wall coverings), and particles and aerosols (dust, construction activities, printing, photocopying, manufacturing processes, smoking, combustion and some chemical actions in which vapors condense to form particles). The air pollutants in the indoor environment or buildings, that can be found are volatile organic compound (VOC), airborne microorganism, formaldehyde (CH_2HO), particulate matter (PM), radon, asbestos, and combustion gases, and by-products (Zainal Abidin *et al.,* 2013). In a previous study, it was found that various abiotic agents like dust, particulate matter, wall coverings, synthetic paints, glue, polishes, and VOC may contribute to indoor pollution and may cause SBS (Chao *et al.,* 2002; Horner, 2003). In the indoor environment, we can find a wide variety of fungi (molds, or yeasts) which includes bacteria, viruses and amoeba (Zainal Abidin *et al*., 2013). Many buildings experienced with fungal breakouts, and in previous study, it is found that this complaint mostly occurs in libraries (Schneider, 2004).

2.1.1 Bioaerosols

The term bioaerosols defines airborne material that is or was living, such as mold, and bacteria, parts of living organisms and animal feces (EPA, 1991). In a previous study, the collecting samples of fungi is conducted during winter, this is due that during this season, there is wide use of environment insulation, which probably increases the number of bioaerosols in indoor air, coinciding with high levels of respiratory infections (Ross *et al*., 2004). According to a study, biological contaminants are often found in areas that provide food and moisture or water (Zainal Abidin *et al*., 2011). Meanwhile, any other areas where dust collects may accumulate biological contaminants or even bedding, carpet, wood material, and furniture stuffing (Zainal Abidin *et al*., 2011). Huang *et al*., (2010) states in his study that biological aerosols cannot be captured by filter as the particles would stuck at

the filter and eventually it would re-enter the air stream when the velocity of the filter pores increase, thus increasing the drag force of the particles collected on the filter.

2.1.2 Fungal Concentration In Indoor Environment

In previous study, it is stated that fungal studies have mainly focused on spores, yeast cells, and fragments of these propagules and hyphae that are airborne or established from air (Adams *et al.,* 2013). Zainal Abidin *et al.* (2013) found in his research that the concentrations of total fungi in non-carpeted office at different phases of building commissioning shows that the concentrations fell within e range of 0 till 760 CFU/m³. From his study, he also concluded that the office setting without carpet yield low result of airborne microorganism furthermore reduce the risk of health problems due to unwanted exposure. From Ross *et al.* (2004), the results of the study shows that the genera Aspergillus and Epicoccum were found in all the air indoor sample and air outdoor samples of the four sites (public auditorium, hospital, company and shopping center).

From the results of a previous research, the researcher found that the reported microbe count vary within the building levels area depending on the cleanliness from the dust residual on that level, the outdoor and indoor air movement either mechanical or natural and type of flooring used whether carpet or not (Zainal Abidin *et al*., 2011). According to ICOP-IAQ (2010), the standards acceptable limit of fungal concentration in indoor environment is 1000 CFU/m³.

It is found that during fall and summer, both the indoor and outdoor fungal population is the highest and lowest during winter and spring. This is because the higher outdoor concentrations in the summer and fall may reflect higher temperatures and humidity and causing increases in microbiological activities during these periods (Shelton *et al.,* 2002). The culture of fungi in a study shows that the number of fungi colonies present was assessed the third and fifth days of incubation, and the number of colony forming units was determined per m³ of air (CFU/m^3 air) (Ross *et al.,*