INTI
INTERNATIONAL UNIVERSITY
LAUREATE INTERNATIONAL UNIVERSITIES

FACULTY OF SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS

BACHELOR OF ENGINEERING (HONS) IN MECHANICAL ENGINEERING

MEE4999 ENGINEERING DESIGN PROJECT

STAGE 2

FINAL REPORT

NAME	Teoh Yan Heng, Leonard (I11008479) Heng Zhi Kai (I11009356) Teoh Kai Dong (I11001981) Koh Ji Wei (I12001316)
PROGRAMME	BMEGI
SESSION	AUG 2014- JAN 2015
COURSE CODE	MEE 4999
SUPERVISOR	Assoc. Prof Ramli

COUNTERMEASURE FOR MOULD GROWTHS IN OPERATION THEATRE

By

Teoh Yan Heng, Leonard (I11008479)

Heng Zhi Kai (I11009356)

Teoh Kai Dong (I11001981)

Koh Ji Wei (I12001316)

Submitted to
the Faculty of Science, Technology, Engineering & Mathematics
in Partial Fulfilment of the Requirements
for the Degree of

BACHELOR OF ENGINEERING (HONS)
in
MECHANICAL ENGINEERING

At
INTI INTERNATIONAL UNIVERSITY
PersiaranPerdana BBN, Putra Nilai, 71800 Nilai
Negeri Sembilan, Malaysia

APRIL, 2015

Declaration

We, Leonard Teoh (I11008479), Koh Ji Wei (I12001316), Heng Zhi Kai (I11009356), and Teoh Kai Dong (I12001981), members of Group 4 for course subject MEE 4999 Engineering Design Project hereby declare that the findings and results conducted for this research project are prepared solely on our own. There is no misbehaviour done such as plagiarism or information taken from other groups to accomplish this research.

Declared by,

Teoh Yan Heng, Leonard

Koh Ji Wei

Teoh Kai Dong

Heng Zhi Kai

Abstract

This project tackles the problem of mould growth in operation theatre as there is a rise in post-operational fungal infection cases among most of the hospitals. This is due to the condensation happened on the walls which caused from the difference in temperature between rooms in hospital and outer surrounding. Hence, a research on how to counter against this issue is conducted to look for the best insulation method for rooms in hospital especially operation theatre. The right material was chosen through decision matrix method by judging whether its properties fulfil the most desired insulation. After that, the material with the thermal resistance which leads to looking for the thickness needed for the insulation of wall is found. Finally, a simulation was run to test whether the thickness works to insulate or not.

Table of Contents

I. List of Figures

II. List of Tables

III. List of Abbreviations and/or Symbols

T_O = outside ambient temperature of O.T.

$T_{S.O}$ = outside surface temperature of wall

$T_{S,I}$ = inside surface temperature of wall

T_i = inside ambient temperature of O.T.

Q_i = heat transfer rate from outside to wall through convection

Q_2= heat transfer rate from outside wall to inner insulation panel through conduction

Q_3 = heat transfer rate from wall to O.T. through convection

D = the height of the wall

1.0 Introduction

1.1 Background Information

Nowadays, air-conditioning system has been playing an important role by providing a comfortable environment and clean air for people to study, work and enjoy. And of course, to ensure the smoothness of any critical cases such as emergency operation, air-conditioning system has been contributing a lot in this field. However, there is a limit to where a human's naked eye can observe and the ability to counter-act towards floating microorganisms such as fungus is also bounded. In the past years, there has been increase in numbers where post-operational fungal cases have been getting exceptionally thoughtful to most of the doctors.

One of the cases that was caused due to exposure towards mold and fungus was about a 71-year old male diabetic patient presented visual acuity decrease and redness in the operated eye at the postoperative 3 months. Although he was continued with treatment for 1 month after his operation, yet fungal cases such as his won't show up immediately as fungus takes time to appear in dense form. He was suspected with Endophthalmitis was inside his system and starting to spread from his eyes. Fortunately, he was immediately admitted back to hospital and medications were taken into action after that. Endophthalmitis secondary to cataract surgery is a rare but serious condition that affects vision. Previous studies have shown that fungi are responsible of 8.6–18.6% of all culture positive postoperative endophthalmitis. [1] [2] [3]

Usually, for patients who have undergone surgeries, especially when those surgeries involve visual organs, fungus have higher tendencies to affect these patients, and thus cause diseases. Chronic postoperative endophthalmitis has a distinctive clinical course, with multiple recurrences of chronic indolent inflammation in an eye that had previously undergone surgery, typically cataract extraction. These cases would not occur immediately, but it may take from few weeks up to few months for the fungus to fully developed and thus bringing problems to the patients. Although cures have been created to counter this matter, yet cases appearing faster than they could cure, and the only way to counter this matter is to prevent as much as possible. [4]

We can conclude that the main reason which brought this disaster is the growth of mold in the walls. In order to counteract this matter, insulation panel was suggested to reduce the chances of the growth of mold.

1.2 Research Statement

In this research, the main reason which cause mould to grow is due to the difference in temperature between rooms and outer surrounding. Hence, it is a priority to understand how difference in temperature will lead to the condensation of water which leads to the growth of mould.

Quoted by Maxwell and Boltzmann, when water molecules can manage to absorb enough energy, they will be able escape from the large body of molecules and escape into air. This is why water can evaporate at any temperature and they become the moisture in the air. Relative humidity is the ratio of moisture in the air now and the maximum moisture the air can stand. In other words, condensation will happen when relative humidity reaches 100%.

By Psychometric chart, with given room temperature and relative humidity, Dew point temperature can be found. Dew point temperature is the temperature when condensations occur.

There are two types of temperature that can lead to find dew point temperature, Dry bulb temperature and Wet bulb temperature. To measure dry bulb temperature, the thermometer is direct exposure at the air to measure sensible air temperature. On the other hand, wet bulb thermometer is cover by a completely wet cotton wick. Wet bulb temperature is the temperature measured by the wet bulb thermometer after water evaporating off the wick by swing the thermometer around. The more dry air, the more water evaporating and the wet bulb temperature will more close to the dry bulb temperate.

The research on insulation details can be started once the dew point temperatures of the rooms and outer surrounding are found. Several details should be taken into consideration while deciding the right insulation, which are:

- Flame proof
- Water proof
- R-value (thermal insulation)
- Chemical resistance
- Sustainability

- Maintenance
- Thickness required

1.3 Objective

The objectives of this research are as below:

- To design an insulation panel which fulfills the vital characteristics such as affordability, high thermal resistance, and sustainability in order to prevent the growth of mold & fungus in a air-conditioned hospital located in a tropical country.
- To achieve a fungal growth-free by re-improving the surrounding of the walls of the operating theatre.

1.4 Scope

This project is carried out to look for the most suitable insulation that is able to insulate the heat of the sunlight on the wall of the operation theatre. Hence, it is important to pay attention on a few vital criteria.

First, there are many other elements that may cause mould to grow in hospitals such as polluted air condition system, conditions of the patients and many more. However, this project was carried out to counter against the condensation that happens on the wall. Hence, the study regarding only insulation is prioritized in this project.

Besides that, to learn about the dew point temperature of the operation theatre, there are a few basic boundary conditions that are important for this research. The boundary conditions are as below:

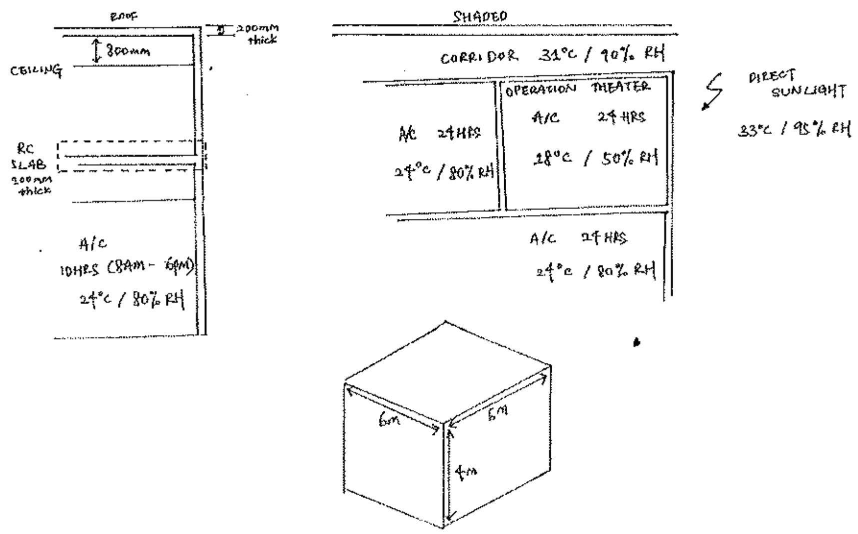

Figure 1.1: Boundary Conditions for Operation Theatre and Other Rooms

Environment	Relative Humidity	Temperature (°C)
Operation Theatre	50 %	18
Other rooms (2^{nd} Floor)	80 %	24
Other rooms (1^{st} Floor)	80 %	24
Corridor	90 %	31

Table 1.1: Boundary Condition

2.0 Literature Review

Before choosing the right material for insulation panel, understanding how mold growth is important as there are roots which causes this to happen. Condensation will form on any object when its temperature is at or below the dew point temperature of the air surrounding the object. Dew point temperature is the temperature when water vapor will begin to condense to liquid phase. Usually, T_{dew} is related to the surrounding temperature and relative humidity (R_H), and 3 of these parameters are widely used indicators of the amount of moisture in air. Hence, by determining T_{dew} for each of the rooms which may affect the mold growth in the operating theatre will aid in concluding which type of insulation panel can be used for the operating theatre (OT). [6]

Besides, an understanding of how heat transfer works could help in choosing the right material. For this case, prior knowledge about heat transfer would be vital, especially which it involves conduction and convection. According to Yunus A. Cengel, conduction is defined as the transferring of energy from one energetic particle to another less energetic one; whereas convection means the transfer of energy between a solid surface and the adjacent fluid that is in motion. Understanding of these 2 attributes of heat transfer can lead to finding heat transfer, Q and minimum thermal resistance, R by using One-Dimensional Steady Heat Conduction. [5]

In natural convection, the fluid motion occurs by natural means such as buoyancy. Since the fluid velocity associated with natural convection is relatively low, the heat transfer coefficien t encountered in natural convection is also low.

Mechanisms of Natural Convection Consider a hot object exposed to cold air. The temperatur e of the outside of the object will drop (as a result of heat transfer with cold air), and the temp erature of adjacent air to the object will rise. Consequently, the object is surrounded with a thi n layer of warmer air and heat will be transferred from this layer to the outer layers of air.

The net force is proportional to the difference in the densities of the fluid and the body. This i s known as Archimedes' principle. We all encounter the feeling of "weight loss" in water wh ich is caused by the buoyancy force. Other examples are hot balloon rising, and the chimney effect. Note that the buoyancy force needs the gravity field, thus in space (where no gravity exists) the buoyancy effects does not exist.

Since the buoyancy force is proportional to the density difference, the larger the temp erature difference between the fluid and the body, the larger the buoyancy force will be. Wh enever two bodies in contact move relative to each other, a friction force develops at the con tact surface in the direction opposite to that of the motion. Under steady conditions, th e air flow rate driven by buoyancy is established by balancing the buoyancy force with the fri ctional force.

The role played by Reynolds number in forced convection is played by the Grashof n umber in natural convection. The critical Grashof number is observed to be about 109 for vert ical plates. Thus, the flow regime on a vertical plate becomes turbulent at Grashof number gr eater than 109. The heat transfer rate in natural convection is expressed by Newton's law of c ooling as: $Q'_{conv} = h A (T_s - T_\infty)$

Natural Convection over Surfaces Natural convection on a surface depends on the geometry o f the surface as well as its orientation. It also depends on the variation of temperature on the s urface and the thermophysical properties of the fluid. The velocity and temperature distribut ion for natural convection over a hot vertical plate are shown in Fig. 3. Note that the velocit y at the edge of the boundary layer becomes zero. It is expected since the fluid beyond the bo undary layer is stationary.

Natural Convection Correlations The complexities of the fluid flow make it very diffic ult to obtain simple analytical relations for natural convection. Thus, most of the relationsh ips in natural convection are based on experimental correlations.

Natural Convection from Finned Surfaces Finned surfaces of various shapes (heat sinks) are used in microelectronics cooling. One of most crucial parameters in designing heat sinks is t he fin spacing, S. Closely packed fins will have greater surface area for heat transfer, but a s maller heat transfer coefficient (due to extra resistance of additional fins). A heat sink with widely spaced fins will have a higher heat transfer coefficient but smaller surface area. Thus, an optimum spacing exists that maximizes the natural convection from the heat sink.

3.0 Methodology

The main objective for this project is to prevent growth of fungus and mould inside an operation theater. Hence method to prevent condensation from happening needed to be focus, in order to eliminate fungus and mould. In this project, to make the project more realistic, the operation theater is actually inside a hospital and it was known that there are several rooms around the operation theater, and all the rooms are 24 hours air-condition. Due to the 24 hours air-condition rooms and the temperature differences between room and room, and the environment, condensations will occurs. Therefore, method to prevent condensation to happen is needed.

In order to determine the condensation around the operation theater will occur or not, simulation is needed by using the FloEFD software and to find temperature inside and outside the wall of Operation Theater. Later the temperature obtained from the simulation is then compared with the dew point temperature. To run the simulation, several boundary conditions are defined. The result of temperatures on and outside the wall of Operation Theater is then obtained.

	Temperature (°C)	Relative humidity	Pressure(kPa)	Inlet air velocity (m/s)
Operation Theater	18	50%	101.325	0.3
Other rooms	24	80%	101.325	0.3
Corridor	31	95%	101.325	0.3

Table 3.1: Boundary Conditions Used for Simulation

Dimension for the rooms around the operation theater, corridors and the operation theater was determined and the sketch for the whole unit were done by using the FloEFD. At first the rooms were sketch part by part using different files, later those rooms were