UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE INVESTIGATION ON THE IMPROVEMENT OF COOLING LOAD CALCULATION AT AIR DISTRIBUTION LABORATORIES IN FACTORY 1 (FTK)

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTEM) for the Bachelor Degree of Engineering Technology (Bachelor of Mechanical Engineering Technology in Refrigeration and Air-Conditioning System with Honours)

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2017

DECLARATION

I hereby, declared this report entitled “The Investigation on The Improvement of Cooling Load Calculation at Air Distribution Laboratory, Factory 1 (FTK)” is the results of my own research except as cited in references.

Signature : …….

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor Mechanical Engineering Technology (Maintenance Technology) With Honours. The member of the supervisory is as follow:

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ABSTRAK

Beban penyejukan adalah kadar di mana tenaga mesti dikeluarkan dari ruang untuk mengekalkan kelembapan dan suhu pada nilai reka bentuk. Sistem penyaman udara digunakan untuk membawa keadaan terma kembali kepada keadaan keselesaan apabila beban terma menundukkan keadaan yang luar jangkauan keselesaan. Makmal Pengedaran Udara adalah salah satu makmal yang menggunakan sesi makmal atau tutorial untuk pelajar FTK. Aktiviti pelajar semasa sesi makmal dan sesi tutorial sama sekali berbeza dan sudah pasti jumlah haba yang menjana dalam badan mereka adalah berbeza dan boleh menyebabkan keadaan tidak selesa semasa sesi pembelajaran. Tujuan kajian ini adalah untuk mengira beban penyejukan dan mengenal pasti tahap keselesaan terma di Makmal Pengedaran Udara untuk mencapai keselesaan terma oleh pelajar. Oleh kerana terdapat beberapa kaedah dalam mengira beban penyejukan, beban penyejukan telah dikira menggunakan tiga kaedah dan hasil data dibandingkan untuk mencari kaedah yang sesuai dalam mengira beban penyejukan. Persepsi para pelajar juga telah dipertimbangkan dari tinjauan soal selidik dan dikaitkan dengan hasil parameter untuk mencari hubungannya dengan tahap keselesaan termal. Hasil daripada kajian ini mengenal pasti bahawa pengiraan manual adalah kaedah yang paling sesuai untuk mengira beban penyejukan kerana ia menganggap semua parameter yang diperlukan untuk mengira beban penyejukan. Kajian ini juga dapat mengenal pasti tahap keselesaan termal di kawasan pengajian yang hanya kelembapan relatif kurang dari keselesaan.

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ABSTRACT

Cooling load is rate at which energy must be removed from a space to maintain the humidity and temperature at the design values. Air conditioning systems are used to bring the thermal conditions back to the comfort conditions when thermal loads push conditions outsider of the comfort range. Air Distribution Laboratory is one of the laboratory that use in lab or tutorial session for FTK students. The student's activities during lab session and tutorial session totally different and definitely the amount of heat generate in their body is different and can lead uncomfortable condition during learning session. The purpose of this study is to calculate cooling load and identify thermal comfort level at Air Distribution Laboratory in order to achieve thermal comfort by students. Since there have several methods in calculating cooling load, cooling load had been calculate using three methods and the data results were compared to find the suitable method in calculating cooling load. The perception of the students were also been consider from the questionnaire survey and being correlated with the parameter result in order to find its relationship with thermal comfort level. Result from this study identify that manual calculation is the most suitable method in calculating cooling load since it consider all parameters needed in calculating cooling load. This study also had able to identify thermal comfort level at study area which only relative humidity is out of comfort range.

DEDICATION

This final year project is dedicated to my beloved family, lecturers, and friends that give me moral support and encouragement to always learned and never give up in life. Thank you to all of you. May Allah bless all of us. InsyaAllah.

Thank you very much.

ACKNOWLEDGEMENT

I would like to thank express my sincere gratitude to Encik Azwan Bin Aziz as my academic supervisor for his guidance, motivation and research support through my degree program. His technical advice and suggestion help me to overcome problem during this research study. I am grateful to my parents for their love and support. They have always been supportive of my academic pursuits. My acknowledgement also goes to all technicians and office staff of Faculty Technology Engineering for their co-operations. To all my fellow friends who involves directly or indirectly which always stay strong and help me in giving moral support and solved every problem throughout this research study. I really thankful and appreciate it very much.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineers
HVAC	-	Heating, Ventilation and Air-Conditioning
°C	-	Degree celsius
m/s	-	Meter per second
BDP	-	Bachelor Degree Project
UTeM	-	Universiti Teknikal Malaysia Melaka
ISO	-	International Standard Organization
DBT	-	Dry Bulb Temperature
kcal/hr	-	kilocalorie per hour
FTK	-	Fakulti Teknologi Kejuruteraan
Btu/hr	-	British Thermal Unit per hour
kg	-	Kilogram
hp	-	Horsepower
LCD	-	liquid crystal display
W	-	Watt
ft	-	Feat
m	-	Meter
CFM	-	Cubic feat per minute
RTS	-	Radiant Time Series
CLTD	-	Cooling Load Temperature Difference

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, introducing the title of Bachelor Degree Project 1 (BDP 1) as well as little background on the concept of cooling load, psychometric chart and thermal comfort and how the problem came about. The title of my project is "The Investigation and Improvement of Cooling Load Calculation at Air Distribution Laboratories in Factory 1".

1.1 Cooling load

Cooling load is rate at which energy must be removed from a space to maintain the humidity and temperature at the design values. Air conditioning systems are used to bring the thermal conditions back to the comfort conditions when thermal loads push conditions outsider of the comfort range. While latent heat is associated with the rise of the moisture content in the space, sensible heat into the space will cause its air temperature to rise. Using different heat transfer mechanisms, the building design, occupants, internal equipment and outdoor weather conditions may affect the cooling load (ASHRAE, 2013).

The natural processes and techniques for cooling buildings are passive cooling and natural ventilation. Other than renewable energy sources, it is cooling without any form of energy input. Passive cooling also linked with the thermal comfort of the occupants. According to Kamal (2012), mechanical heat transfer techniques can increase the effectiveness of passive cooling which enhance the natural cooling process.

1.2 Psychometrics

Psychometrics is a term used to describe the field of engineering concerned with the determination of moist air psychometric properties. When at least two data of the air properties are known, it is possible to determine the properties of air in psychometric chart (Aditya Rachman, 2014). According to Gatley (2002), psychometric chart is a convenient for visualizing the changes of properties in a sequence of psychometric process and useful tool to determining moist air psychometric.

1.3 Thermal comfort

One of six key metrics within indoor environmental quality is thermal comfort. One of the important goals of the HVAC (Heating, Ventilation, and Air Conditioning) design engineers is maintaining this standard of thermal comfort for occupants of buildings or other enclosures (ASHRAE, 2013). Thus, air-conditioning system was installed in the building to control thermal environment so that it is in comfort zone.

According to ASHRAE Standard (55-2004), comfort zone shows that humidity ratio has relationship with relative humidity and temperature. However, there is no lowest acceptable humidity value. Comfort zone is the standard used worldwide because in many countries there are no studies and their own comfort zone has not been defined although in reality the climate in each country is different. Several studies in Singapore state that 27.1°C to 29.3°C is the acceptable temperature ranges (Hussien and Rahman, 2009). In ASHRAE Standard 55-2013, for thermal comfort purposes for the human occupancy, temperature could range between approximately 19.5 and 27.7 °C and that of the relative humidity to be controlled less than 65%. Psychometric Chart is one of the major applications in air conditioning. According to Izzi Urieli (2008), the most humans feel comfortable when temperature is between 22°C and 27°C, and the relative humidity φ between 40% and 60%. Psychometric chart as shown in figure 1 below defines the comfort zone.

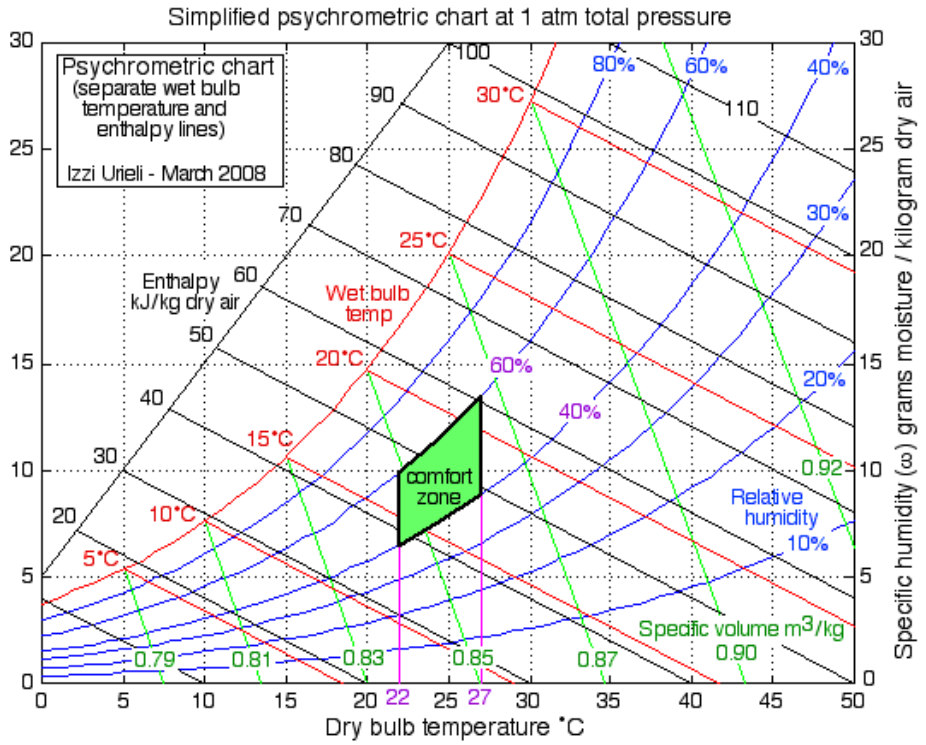

Figure 1.1: Comfort zone
(Source: Izzi Urieli, 2008)

Such an affect could be the results of the feedback between the thermal sensation of subjects and their behaviour (Nicol and Humpreys, 1973). Students' satisfaction and performance have significant relationships with laboratories environmental conditions such as humidity, indoor air quality and acoustics. As students, it is crucial to maintain laboratories environment and thermal comfort as it will effects the student behaviour in engaging activities which will promote student to deeply understanding concepts, problem solving and attitudes toward learning.

Over the past several decades, research has established relationships between the classroom environment and student outcomes and identified determinants of learning environment (Fraser, 1994). Indeed, research indicated that student's achievement is higher in those environments which students feel comfortable and positive in (Waldrip & Fisher 2003). Few researches had been done on physical characteristics such as thermal comfort of the classroom that might affect the learning environment experienced by the students. Therefore, further actions should

be taken in order to achieve the suitable thermal comfort level as improvement for occupants at Air Distribution Laboratories in Factory 1.

1.4 The purpose of the research

The purpose of this research is to calculate total cooling load at Air Distribution Laboratory in order to achieve thermal comfort by students. Since there have several methods in calculating cooling load, cooling load were calculate using three different methods and the data results will be compared to find the suitable method in calculating cooling load.

1.5 Problem statement

For a past few decades, the public awareness towards thermal comfort in Malaysia is on the rise. Waldrip and Fisher indicated that student's achievement is higher in those environments which students feel comfortable and positive in learning sessions. Air Distribution Laboratory is one of the laboratory that use in lab or tutorial section for FTK students. The occupants inside the laboratory generate lots of heat and the amount of heat release depends on occupants activities. Since the lab and tutorial section have a different activity, the amount of heat generate definitely different and also can give comfortable effect to students during learning session. Next, there is no research about thermal comfort that had been conducted at this laboratory before. Thus, there is a need to conduct a study on air-conditioning system at Air Distribution Laboratory in order to achieve the level of thermal comfort at study area.

1.6 Objectives

Based on the problem stated above, "The Investigation on The Improvement of Cooling Load Calculation at Air Distribution Laboratory in Factory 1", the objectives below are pursued.

a) To calculate total cooling load at Air Distribution Laboratory using three different methods.

b) To compare three methods in calculating cooling load at Air Distribution Laboratory.

c) To determine the level of thermal comfort at Air Distribution Laboratory and compare the parameter results with ASHRAE Standard.

1.7 Scope of the research

The research study focuses on cooling load calculation and determined the parameter of thermal comfort at Air Distribution Laboratory, Factory 1 at Technical University of Malaysia Melaka (UTeM). Cooling load will calculate using manual calculation, Chvac Software and FloPro Designer Software. The parameter thermal comfort like air temperature, relative humidity and air velocity will be determined with LEV Monitoring Device and air probe.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Thus chapter will discussed about air conditioning system, heat transfer, factors which affect heat gain, parameter of thermal comfort and review of thermal comfort studies.

2.1 Air-Conditioning System

Air-Conditioning system is a system that remove heat from one space, and transfer it to another space with the purpose of control the temperature of the intended space, control the humidity, air quality, stickiness, sound level and air weight. (Modern Refrigeration and Air-Conditioning,18th Edition, 2000)

Air-Conditioning system can be divided into many types such as window unit, packaged unit, split unit and central unit. The types of AC System depends on the requirement such as the volume of the building, working attributes and total occupants.

2.2 Heat Transfer

Heat transfer is a study of the mechanism of transfer of energy in the form of heat/thermal. Heat transfer is a transition of energy, which when occurs, resulting in temperature gradient and differences. This temperature differences is the driving force that cause heat to flow from higher temperature to lower temperature. We are surrounded by heat transfer in everyday life such as cooking, heating water, etc. While in industrial applications, heat transfer used to forgings steel, dissipating heat waste from power plant, power up vehicles and many more.

The rate of heat transfer is not only dependent on the temperature differences between systems, but also the conductivity of the medium through which the heat energy is transferred. When heat energy is transferred, the system involved will have internal energy changes. Thus applying the First Law of Thermodynamics, which is the law of conservation of energy. The direction of heat transferring is from a higher temperature region to lower temperature region, thus obeying the Second Law of Thermodynamic, which stated that the more energy transferred or transformed, the more energy is wasted and there is a tendency that the isolated system can be degenerate to be in disorder state. This means, in heat transfer term, heat transfer will move in direction toward increasing the lower temperature region entropy.

Heat transfer is stop once the thermal equilibrium is reached. This means that the systems/body involved has reached the same temperature. (Source: Fundamentals of Heat and Mass Transfer 7th Edition)