**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

# ANALYSIS OF ENERGY CONSUMPTION IN AIR CONDITIONING SYSTEM AT TECHNOLOGY CAMPUS UTeM, MELAKA

This report is submitted in accordance with the requirement of the University Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning System) with Honours.

By

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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **ANALYSIS OF ENERGY CONSUMPTION IN AIR CONDITIONING SYSTEM AT TECHNOLOGY CAMPUS UTeM, MELAKA**

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I hereby, declared this report entitled "**Analysis of energy consumption of air conditioning system at Technology Campus UTeM, Melaka**" is the result of my own research as cited in references.

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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 Mechanical Engineering Technology (Refrigeration and Air-Conditioning system) with Honours. The member of the supervisor is as follow:

…….

(Puan Ezzatul Farhain Binti Azmi)

# ABSTRAK

Pada era modenisasi ini, system penghawa dingin sangat penting dalam kehidupan seharian dalam memberikan keselesaan dan peraliran udara yang baik kepada pengguna di dalam sesuatu ruang. Kekurangan pengetahuan tentang penggunaan sistem penghawa dingin ini mampu mengakibatkan pengguna mengalami kerugian wang ringgit apabila tenaga yang digunakan oleh sistem ini berlebihan. Tujuan projek ini dijalankan adalah untuk mengukur penggunaan kuasa oleh sistem penghawa dingin daripada enam ruang unit pengendalian udara (AHU) dan menilai penggunaan tenaga oleh sistem penghawa dingin di bangunan Fakulti Teknologi Kejuruteraan (FTK). Terdapat beberapa factor yang menyebabkan pengunaan tenaga pada sistem penghawa dingin meningkat. Antaranya ialah suhu luar yang tinggi, aktiviti penghuni dan peralatan eletrik yang juga menyumbang kepada peningkatan haba di dalam bangunan ini. Berdasarkan susur atur bangunan ini, terdapat enam unit pengendalian udara (AHU) dan juga 35 unit gegelung kipas (FCU) yang digunakan untuk menyalurkan udara ke seluruh bangunan. Eksperimen ini dijalankan pada enam kawasan yang berbeza iaitu di Kawasan kiri dan kanan bangunan FTK untuk tiga tingkat yang berbeza di mana data akan diambil pada suis utama kotak pengagihan yang terletak di dalam bilik ahu dengan menggunakan alat FLUKE 435 siri-ll. Penilaian ini dilakukan untuk menegnal pasti penggunaan tenaga oleh sistem penghawa dingin untuk 3 tingkat yang berbeza. Pengambilan data akan dilakukan dengan menggunakan peralatan yang boleh mengesan penggunaan tenaga iaitu peranti penganalisis kualiti tenaga. Projek pnilaian tenaga ini akan dilakukan di bangunan FTK dari jam 9 pagi hingga 5 petang pada hari bekerja. Merujuk kepada keputusan, data penggunaan tenaga merekodkan penggunaan tertinggi adalah oleh tingkat 1 iaitu 104.56 Kwh, diikuti oleh tinkat bawah iaitu 104.40 Kwh dan tingkat 2 iaitu 85.60 Kwh. Keputusan ini adalah disebabkan aktiviti pengguna di tingkat tersebut.

# ABSTRACT

In this era of modernization, air conditioning systems are very important in everyday life in providing comfort and good air flow to users in a room. Lack of knowledge about the use of this air conditioning system can result in consumers losing money when the energy used by the system is excessive. The purpose of this project is to measure the power consumption of air conditioning system from six AHU room and analyze the energy consumption by air conditioning systems in the Faculty of Engineering Technology (FTK) building. There are several factors that lead to increased energy usage in the air conditioning system. These include high outdoor temperatures, occupancy activities and electrical appliances that also contribute to the increase in heat in this building. Based on the layout of this building, there are six air handling unit (AHU) units and 35 fan coil unit (FCU) units used to supply air to whole building. The experiment was carried out in six different areas namely the left and right areas of the FTK building for three different floors where the data will be taken at the main switch inside the distribution box (DB) which located inside the ahu room by using FLUKE 435 series-ll. This assessment is conducted to quantify the energy use by air conditioning systems for three different levels. Data collection will be done using equipment that can detect energy consumption, namely energy quality analyzer. This energy evaluation project will be conducted at the FTK building from 9 am to 5 pm on weekdays. As the result, the data of energy consumption recorded by three different level shows that the highest energy consumption is by level 2 which is 104.56 Kwh followed by ground floor level 104.40 Kwh and level 2 85.60 Kwh. The result is mostly affected by the occupant activities at the floor.

# DEDICATION

I would like to dedicate my final year project to my beloved family, project supervisor and friends. And I would like to express my deepest gratitude to my father Mr. Mohd Sabri bin Duhdi and my mother Mrs. Maimon binti Md. Zin for their love, dream and sacrifice throughout my life. Their sacrifice has made to become who I am today. Not to forget my appreciation to my project supervisor Mdm. Ezzatul Farhain binti Azmi for supporting me throughout of my academic journey especially on this project and for whatever knowledge rendered to me from the beginning till the end of my final year project.

Lastly, I would like to send my gratitude to my friends and lecturers for their contribution whether it is directly or indirectly to my final year project.

# ACKNOWLEDGEMENT

First, all praise to Allah the Almighty for giving me the strength, knowledge, healthy body and patience to complete my final year project report successfully in time. I must thank my parents for their love, sacrifice and support throughout my life and made me to become who I am today. I also would like to address my appreciation to my project supervisor Mdm. Ezzatul Farhain binti Azmi for her support, guidance and encouragement through the time for developing my final year project report. I am deeply grateful to lab assistant, Mr. Ahmad Maulana bin Mat Isa for the trust and guidance that given to me and making the data collection process possible. Lastly, my full appreciation for those who are directly or indirectly contribute and support me to finish this final year project report. Thank you.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of study

In general, air conditioning can illustrate any technology that changes the air condition, usually inside the building or facility. These modifications or "conditioning" may refer to space heating, cooling, moisture control, cleaning, ventilation, or air circulation. However, mostly people when they think about "air conditioning", they refer to a mechanical, or man-made system that will help to cool down and control the indoor air humidity. In the context of building services, a complete building service system that delivers space heating, mechanical ventilation and referred air conditioning is commonly referred to as HVAC (Heating, Ventilation & Air Conditioning).

According to Patidar (2015), Buildings constitute a very elevated proportion of power usage relative to other financial industries. Although percentages differ from nation to nation, structures are accountable for around 30–45 percent of worldwide power supply. In Malaysia, the usage of air consumption in homes is rising these days. Energy demand created by this appliance forms up to 50% of home energy consumption, and 20% usage of energy consumption by residential sector. With the rising number of households that will use this system, significantly the energy consumption of this appliance will increase. The implications of air behavior aspects need to be understood for determining the actual use of energy in home. Hours operation, temperature setting, and other operating parameters are factors to determine the demand for cooling power by using the air conditioner. Therefore, others behavioral factors that ultimately affect operating parameters are required

investigated. This study looks at consumer behavior in the use of air conditioners in Technology Campus, Universiti Teknikal Malaysia Melaka (UTeM).

This study is conducted to analyze the energy consumption of air conditioning system in Fakulti Kejuruteraan Mekanikal (FTK) building. By doing this research, the result can be concluded, and we can find a way to minimize the usage of the air conditioning energy consumptions.

## 1.2 Problem statement

These days, the extreme temperature that experienced by the user forced them to use the air conditioning system to cool down their surroundings. Some places especially in Technology Campus, UTeM also experience the extremely hot weather resulting in increased use of the air conditioning system. When the use of the system is increased, the energy usage of the air conditioning system also grows. This will cause the university to suffer losses when electricity bills are rising due to the increasing use of air conditioning systems. Not only the weather that cause the energy consumption to increase, but there are also several factors that can cause the energy consumption of the air conditioning system to increase. In this project, the energy consumption will be compared for three different level which is ground level, level 1 and level 2 to see the variation of the energy usage in the FTK building.

## 1.3 Objective

The objectives for this research are focused on the energy consumptions in building are stated as below:

- To measure the power consumption of air conditioning system from six AHU room at FTK building
- To compare the energy consumption for three different level in the FTK building
- To analyze the energy consumption of air conditioning system in the FTK building

## 1.4 Scope

The implementation of this project focuses on air conditioning system's energy consumption at Technology Campus, UTeM. The testing location is at FTK building in Technology Campus, UTeM. The duration for testing is during office hour which is from 9.00 am to 5.00 pm. The power consumption data will be taken at the main switch of the distribution box (DB) by six different area which is left-wing and right-wing area for each level (ground floor, level 1 and level 2) in the FTK building by using power quality analyzer meter.

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

This research is aimed to compare the energy consumption of the air conditioning system between three different level in the FTK building. In this chapter, this research will include other research, journal or any related information to this chapter.

## 2.1 Air conditioning system

Fan-forced heating system had developed during the last half of the nineteenth century. Schemes to use the fan system for comfort cooling also appeared. However, use of cold water or evaporative cooling placed a limit on the amount of comfort would be obtained. A means of drastically cooling air mechanically did not exist until artificial refrigeration was invented.

Vapor compression refrigeration had been proposed in 1805, a working model had been developed around 1834, and increasingly broad tests had been led in the middle of 1850s. In the U.S., interest for solid cooling for preparing and later for ice making prompted the foundation of various assembling and introduce total refrigeration systems. This business was settled by 1900. These organizations had the option to give a mechanical cooling framework simply for air cooling as they were for ice making.

Heating system were also rapidly evolving in the U.S. one method of heating, the so-called hot blast or fan system, was adaptable to building cooling. The hot blast

system, also called the plenum system, used a blower fan to force air over a streamer or water-heated surface, distributing the air through ducts to room in large buildings. Normally these systems using 100% outside air, furnished part of the total heating load. Cast-iron radiators, placed at the parameter of the building, carried the reminder of the load (Bernard, 1999).

## 2.2 Central air conditioning systems

According to K. Wang (2000), as part of the heating system using fans and coils, the first basic ice system in the United States, designed by McKin, Mead, and White, was installed at Madison Square Garden in New York City in 1880. This system supplied air in the spaces below seating. In the 1890s, New York City's leading consultant engineer, Alfred R. Wolf, used ice-free air-heating systems and ventilation at Carnegie Hall. In 1890, Buffalo Forge Company of Buffalo, New York built another main ice scheme at the Auditorium Hotel in Chicago. Early-stage main heating and ventilation scheme utilized the fan-based steam engine. The external air and air mixtures are re-released into space. At the top of the space, the pipe coil warms the mixture with steam. At the bottom is a short passage with a buffer to mix condensed air and bypass the air as needed.

Cooling was at first grown efficiently by Willis H. Bearer, which was perceived as a father of cooling. In 1902, Carrier found the connection among temperature and moistness and how to control it. In 1904, he built up an air clothes washer, a space fitted with a few water blends for air humidification and cleaning. Temperature guideline and its moistness, accomplished by controlling the air supply point, are as yet being utilized in numerous mechanical applications, for example, lithographic printing plants and material industrial facilities. Perhaps the first air- conditioned office was the Larkin Organization Building, planned by Frank L. Wright and finished in 1906. Channels are taken care of with towed and exhausted air at the rooftop level. Wright expresses a cooling plant that provisions a cooling water of 10 ° C to the air-cooling coil noticeable all around dealing with system. The US Capitol was cooled in 1929. Cooled air is provided from overhead sweeper to keep up a temperature of 75 ° F (23.9 ° C) and relative moistness of 40 percent amid the late spring, and 80 ° F

(26.7 ° C) and 50 percent amid winter. The measure of air supply is constrained by the weight controller to avoid cold draft in the involved zone.

Maybe the first completely cooled office building was expected to be the Milan Building in San Antonio, Texas, planned by George Willis in 1928. This cooling system comprises of a concentrated plant to serve on the ground floor and numerous little units to serve over the workplace floor.

In 1937, Carrier developed a ducting selection system for all around convenient stores, where re-circulation of air space was provoked through a coil/cooling coil with high air current rate. This system gives only the compelled proportion of outdoors for its tenants. Air-convertible (VAV) volume system reduces the stream rate of the supply air volume at decreased burden as opposed to changing the supply air temperature as in the consistent volume system. This system was presented in the mid-1950s and increased wide acknowledgment after the vitality emergency in 1973 because of lower vitality utilization contrasted with the ceaseless volume system. With numerous varieties, the VAV system is utilized together for new skyscraper places of business in the United States today.

Because of the quick improvement of room innovation after the 1960s, cooling systems for clean rooms have been created in modern settings with profoundly viable air channels. The focal cooling system dependably gives an increasingly exact, sound, and secure shut condition for elevated structures, expansive business buildings, and exactness producing regions.

### 2.2.1 Refrigeration systems

In 1844, Dr. John Gorrie has planned the primary business cooling machine in the US. First constructed by General Electric Organization for local refrigerators and marketed in 1924, the hermetically sealed engine compressor was used. The carrier makes a double centrifugal crane mounted on the main open type factory in 1922 where compressor is delivered in Germany; and hermetic centrifugal coolant, with a hermetically closed motor compressor get together, in 1934. The direct-driven hermetic centrifugal coolant was presented in 1938 by The Trane Organization. Until

1937, the centrifugal coolant limit expanded to 700 tons.

In the 1930s, the discovery by Midgely and Hene of a non-combustible, non-combustible family of hydrocarbons, called Freon in 1931 was one of their uneven advances in drying. Chloro fluorocarbons (CFCs) are commonly used in the centrifugal compressor and compressor industries as refrigerant-11 and refrigerant-12. Presently, the new coolant has been created by synthetic manufacturers, for example, DuPont to replace CFC, to maintain a strategic distance from exhaustion of ozone layer.

The principal ammonia immune absorption cooling system was made in 1815 in Europe. In 1940, Servel presented the unit utilizing water as a coolant and lithium bromide as an absorbent solution. The limit device varies between 15 and 35 tonnes (52 to 123 kW). The main business bromide adsorption coolant was provided by the Carrier only in 1945. These devices are generated by using low pressure water as the thermal source at a capability of 100 to 700 tonnes (352,2460 kW).

The positive shift screw compressor has been built up in the US since the 1950s and scroll compressors since the 1970s because of higher effectiveness and slower rotational movement contrasted with reciprocating compressors. Presently, the roll compressor step by step replaces the reciprocating compressor in small and medium-sized cooling systems. Another pattern is the improvement of centrifugal cooling and more energy-efficient absorption for energy conservation. Energy consumption per ton of new centrifugal coolant cooling diminished from 0.80 kW/ton (4.4 COPref) in the late 1970s to 0.50 kW/tan (7.0 COPref) during the 1990s. One arrangement of cooling movement 1.12 ONE compressor with small, medium, to huge limit and utilizing a centrifugal, screw, or centrifugal compressor will be expelled from now (K.Wang, 2000).

### 2.2.2 Comfort air conditioning systems

K. Wang (2000) also said that the comfortable air conditioning systems provide residents with a comfortable and healthy inner environment to carry out their activities. Various economic sectors using comfortable air conditioning systems are as follows:

1. Commercial sector including office building, supermarket, building, shopping centre, restaurant, and others. Many high-rise office buildings, including structures like the World Trade Centre in New York City and the Sears Tower in Chicago, use complex air conditioning systems to meet tenant's needs. In lightweight commercial buildings, air conditioning systems function for space built only by single zones or relatively small areas.

2. Institutional divisions include applications such as schools, colleges, libraries, exhibition halls, indoor arenas, movies, theatres, halls of concerts and recreation facilities. For example, one of the main indoor arenas, the New Orleans Superdome, Louisiana, may require 78,000 people.

3. Private and settlement areas comprise of lodgings, motels, condos, and private houses. Numerous systems that feed on homes and condos are worked all the time, on a 24-hour, 7-day week plan, as they can be occupied any time.

4. Healthcare sector includes hospitals, nursing homes, and healthcare facilities. Typical air filters are generally used in clinics for removal from working rooms, kindergartens and intensive care facilities for bacterial and submicrometric particles. Relative moisture often remains at least 30 percent in winter clinical fields.

5. Transport divisions incorporate aircraft, automotive, buses, and shipping boats. Passengers are progressively requesting the comfort and accommodation of the environment, particularly for long distance travel. Today, elevated altitude planes can involve approximately 5 psi pressure distinction between the lodge and the outside environment. In the 1992 US, almost 4.806,000 company structures, covering the ground region of 67.876 million square meters (6.31 billion m2), were reported in the Commercial Building (1994) to cool down by 84.0% and heating by 91.

## 2.3 Air handling unit system

Referring to United State Patent No. US8157892B2 (2012), Heating, Ventilation and Air Conditioning ("HVACs") are standard in mostly every edge of building. For sure, HVAC is regularly one of the biggest parts of the general energy spending plan of most buildings, particularly in extraordinary cases, hot and cold couples. Air conditioning system used to give an agreeable and solid condition for building occupants, as far as temperature, humidity, composition and air cleanliness.

The central of air conditioning system in the building normally includes at least one central air handling unit and air distribution systems, where Air supply is coordinated to a wide range noticeable all around dealing with unit, the air is cooled and/or heated, and filtered and regularly dehumidified and/or humidified, for example, air conditioning systems are well circulated air through buildings while consistently changing temperature and humidity to keep up an agreeable environment. Be that as it may, to keep up a better air quality, not all air is recycled. Some air emits through doors, windows, and others and a small amount of air circulating coincidentally out of the building. This is alluded to as exhaust air. Exhaust air is replaced by outer air admission, otherwise called makeup air, to make exhaust air emitted. This is additionally alluded to as "outside air or ventilation, because the occupants of buildings and equipment take oxygen and emit carbon dioxide (CO) and other pollutants that gradually affect air quality and safety.

Oxygen represents about 21% of the atmospheric air and which is usually the desired internal air level, but CO is only at a very low level in the outer air, typically at about 400 parts per million (ppm). Increased CO or reduced oxygen levels are created, a large amount of outside air is required to carry their respective concentrations near the desired level. To completely recover oxygen and CO concentration practically all the air may should be replaced 10 15 25 30 35 40 45 50 55 60 65 2. The outside airs refer as the expansion and relies upon the outdoor climate conditions that are frequently the case an important length in the air handling unit. On account of hot and damp atmospheres, for instance, outdoor air infused into the central air system may require extra energy to cool and take out outside air and can represent

to an extensive part of the overall heat load and energy utilization of the air conditioning system. Absolute air exhaust and outer air can be acclimated to satisfy air quality guidelines.

The minimum levels of oxygen, CO and different contaminants, different natural gases overall alluded to as natural com or VOC bands, are frequently set to keep up air quality. In the US, the ASHRAE Heating Association, Cooling and Heating Association (ASHRAE) produces rules, including ASHRAE Standard 62, for outdoor air ventilation prescribed for space and the quantity of tenants given. In any case, the more noteworthy the rate of air replacement, the more energy the air conditioning system use.

## 2.4 Energy and building

Buildings represent a high percentage of energy consumption compared to other sectors of the economy. Although the proportion differs from nation to nation, the construction is accountable for around 30 to 45 percent of worldwide power supply. Increased power usage and $CO_2$ emissions in constructed surroundings have rendered energy-saving effectiveness and strategy a main energy policy objective in most nations. One clear example is the European Energy Building Performance (EPBD) Directive which places high demand on building professionals to produce buildings to near-zero energy consumption levels. Commercial buildings, and especially office buildings and universities, are classified among buildings that deliver the highest energy consumption. Thus, the commercial building sector has been the focus of many government energy reducing initiatives to achieve more sustainable development.

Previous surveys indicate that contemporary office structures have a strong capacity for power savings. Research on the site of current college structures operated by Chung and Rhee identifies prospective power preservation ranging from 6 to 29 percent. As indicated by carbon accreditations, 70 to 75% carbon reduction can be accomplished in non-local structures at no net expense. Advances in innovation are expanding to accomplish the ideal decrease in energy consumption objectives yet this does not really prompt overall reduction. Expansive contrasts are being seen among