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Optimization and Utilization of Condensing Air Waste for Drying Application

Thesis submitted in accordance with the requirements of the Technical University of Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering in Manufacturing Process

By

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This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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DECLARATION

I hereby, declared this thesis entitled "**Optimization and Utilization of Condensing Air Waste for Drying Application**" is the results of my own research except as cited in references

Signature : ………………………………………….

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ABSTRACT

In this project which is about the 'Optimization and Utilization of Condensing Air Waste for Drying Application' is focusing on how to create this project becomes an effective and useful. This project has several main features which are categorized into designing the storage and designing the channel. In designing the storage, there will some drawings are created and calculation involved ensuring this storage suitable for the application. While for the designing the channel, a study about the air flow and calculation that involved in designing the channel has been emphasized. At then end of this project, expected cost will be calculated. Under this circumstances the material selection must be considered and play an important role in contributing to the product price. In this project, knowledge about thermodynamic and heat transfer need to be gained and brushed up in order to deliver the best result. This project creates a huge opportunity in applying CAD/CAM software called CATIA.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CAD	-	computer aided design
CAM	-	computer aided manufacturing
CE	-	concurrent engineering
Cu	-	cuprum
in	-	inches
kg	-	kilograms
km	-	kilometer
m	-	Meter
Max	-	maximum
Min	-	minimum
s	-	Second
Si	-	silicon
SSM	-	semisolid-metal
V	-	velocity
Zn	-	zinc
^0C	-	degrees Celsius
^0F	-	degrees Fahrenheit
$	-	dollars
%	-	Percent
+/-	-	plus or minus

CHAPTER 1

INTRODUCTION

1.1 Introduction

Air conditioning may be defined as the simultaneous control of all (or at least the first three) of those affecting both the physical and chemical conditions of the atmosphere within any structure. These factors included temperature, humidity, motion, distribution, dust, bacteria, odors and toxic gases, most of which effect human health and comfort to a greater or lesser degree.

Air that has been properly conditioned has had one (or a combination) of the foregoing processes performed on it. For example, it has been heated or cooled; it has moisture removed from it (dehumidified); it has been placed in motion by means of fans or other apparatus; and it has been filtered and cleaned. These processes may be placed in the following order for ready reference:

I. Heating
II. Cooling
III. Humidifying
IV. Dehumidifying
V. Circulating
VI. Cleaning and filtering

The impression prevailing in many instances is that refrigerating or heating equipment cools or heats a room. This is only partly true since all the work performed by the equipment is on the air within the room, not on the room itself. Air is a tangible item, and every cubic foot of air surrounding a person has a certain weight, depending on its temperature, the amount of moisture it is carrying, and its altitude above sea level.

Air is a mixture made up primarily of two gases, being approximately 23 parts oxygen and 77 parts nitrogen by weight. Other gases in air include carbon dioxide, carbon monoxide, ozone, neon (in small quantities), and certain gases that are of no particular interest in the field of air conditioning.

Air conditioning equipment must circulate a sufficient volume of air at all times for two main reasons. The air must be constantly moving to carry away the moisture and heat immediately surrounding the body. If this is not done, the occupants soon become uncomfortable, even though the relative humidity of the room as a whole is comparatively low. The air must be constantly drawn into the conditioner and passed out over the cool evaporator so that the moisture it absorbs from the room may be condensed and eliminated through the drain. Although the movement of a sufficient volume of air at all times is most essential, direct drafts must be prevented.

Domestic air conditioning is most prevalent and ubiquitous in developed Asian nations such as Japan, South Korea, Singapore and Hong Kong, especially in the latter two due to most of the population living in small high-rise flats. In this area, with soaring summer temperatures and a high standard of living, air conditioning is considered a necessity and not a luxury. Japanese-made domestic air conditioners are usually window or split types, the latter being more modern and expensive. It is also increasing in popularity with the rising standard of living in tropical Asian nations such as India, Malaysia and the Philippines.

In the United States, home air conditioning is more prevalent in the South and on the East Coast, in most parts of which it has reached the ubiquity it enjoys in East Asia. Central air systems are most common in the United States, and are virtually standard in all new dwellings in most states.

In Europe, home air conditioning is less common in part due to higher energy costs. The lack of air conditioning in homes, in residential care homes and in medical facilities was identified as a contributing factor to the estimated 35,000 deaths left in the wake of the 2003 heat wave.

1.2 Problem Statements

As we know, today most of the house in our country has the air-conditional unit. This air-conditional system contains the split unit that has the indoor and outdoor unit that produces the hot air. Nowadays, the hot air that has produce by the outdoor unit of air-condition unit not used in effective. The hot air that produces if not used in correct way may cause wasting energy means wasting the hot air without any application. If this hot air we can transfer for other application it may make our air-conditional unit more effective and useful.

In recent years, split-type air-conditioning system is widely adopted as a standard provision in high-rise residential buildings in many Asian cities. The advantages of the split-type units lie in the quiet operation and flexibility in multi-room services. However, installation of more than 100 condensing units of the split-type air-conditioning system in a high-rise residential building has become a common problem for architectural design. Building developers often try to squeeze the space to a narrowly confined area due to skyrocketing land price while architects usually seek a solution to hide the condensing units at building re-entrant surrounded by walls on three sides or even four sides based on aesthetic consideration. A potential problem for a significant temperature rise in the confined space due to the heat rejected from a large number of condensing units can lead to serious consequences. High temperature in the confined space not only causes uncomfortable thermal environment to neighbouring residents, who have access to the space such as windows or balconies, but also affects seriously performance of the air-conditioning system and shorten the lifespan of the compressors. If the on-coil temperature of a condensing unit is raised by 1 °C, the coefficient of performance (COP) of the system drops by around 3%. The escalating impact of the temperature increase in the confined space should not be underestimated. The higher that the ambient temperature becomes, the more work for the compressor is required to achieve the cooling duty. The higher the compressor load becomes, the more heat released from the condenser.

In this project I try to make the warm air that produce from air condition unit more useful so that it can make our live more convenient by using this product. We can use this warm air for more valuable application by design the product that can apply this warm air.

1.3 Objectives

To make sure that this project meets the goals and requirement, the objectives of this project are defines below according to the points:

- Design a method to channel the condensing air produced by air conditioner.
- Design a suitable storage for drying purposes focus on residential used.
- Apply theoretically and practically of thermodynamic learnt in an academic session.
- Get early exposure in the real manufacturing field and designing.
- Practically applied in using CAD & CAM software.

1.4 Scope of study

Air conditioners (for cooling) and heat pumps (for heating) both work similarly in that heat is transferred or "pumped" from a cooler "heat-source" to a warmer "heat-sink". Air conditioners and heat pumps usually operate most effectively at temperatures around 50 to 55 degrees Fahrenheit. Typically when the heat source temperature falls below 40 degrees Fahrenheit, the system begins to reach a point called the "balance point", where the system is not able to "pull" any more heat out of the heat-source (this point varies from heat pump to heat pump). Similarly, when the heat-sink temperature rises to about 120 degrees Fahrenheit, the system will operate less effectively, and will not be able to "push" out any more heat. Ground-source (geothermal) heat pumps don't have this problem of reaching a "balance point" because they use the ground as a heat source/heat sink and the ground's thermal inertia prevents it from becoming too cold or too warm when moving heat from or to it. The ground's temperature does not vary nearly as much over a year as the air above it does.

Many traditional air conditioners in homes or other buildings are single rectangular units. Air conditioner units need to have access to the space they are cooling (the inside) and a heat sink; normally outside air is used to cool the condenser section. For this reason, single unit air conditioners are placed in windows or through openings in a wall made for the air conditioner. There are vents on both the inside and outside parts of the unit, so inside air to be cooled can be blown in and out by a fan in the unit, and so outside air can also be blown in and out by another fan to act as the heat sink. The controls are on the inside. A large house or building may have several such units.

Ductless mini-split air conditioners combine some traits of central air conditioning systems with some traits of window or through-the-wall units. They were invented as an alternative to window air conditioners for buildings where the cool-air distribution ducts of a central air conditioning system could not be installed or would be prohibitively expensive to install. An outside unit including the compressor is mounted on an exterior wall of the building, and an inside unit including the evaporator is mounted high on an interior wall, or on or in the ceiling, of the room to be cooled. They are connected refrigerant tubing, condensate drain, and control wires through a hole drilled in the room's exterior wall. An outdoor unit can be connected to one, two, or three indoor units.

Like window air conditioners, a ductless mini-split system requires no air ducts throughout the building and allows separate "zones" in the building to have independent temperature controls. However, like a central air conditioning system, it does not block a window or require another window-sized hole in the wall, and it puts the main source of noise (the compressor) outside the building. Equipment to cool a given amount of inside space is more expensive than with window units but less expensive than with central systems. Customers buy them mostly for their quietness compared to window units, and their lower cost and ease of installation as compared to central systems. In a very large building, the need for ventilation and the need to cool air space that is far from the building's outer walls make ductless mini-split systems and window units impractical.

The scope of project that arrange by the most important area is explained below in ascending order.

I. Design the channel to connect the outdoor unit of the air-conditional to the storage by using the suitable equipment. Study the effectiveness of this channel when it is use.
II. Design the storage of the thing that wants to place. Study the effectiveness of the storage and study of things that used for build up this storage.
III. Study about the air conditional system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the broadest sense air conditioning can refer to any form of heating, ventilation, and air-conditioning that modifies the condition of air, typically for thermal comfort. The more common use of air conditioning is to mean cooling and often dehumidification of indoor air, typically via refrigeration.An air conditioner (AC or A/C) is an appliance, system, or mechanism designed to extract heat from an area using a refrigeration cycle. The most common uses of modern air conditioners are for comfort cooling in buildings and transportation vehicles.

Extensive studies on velocity and temperature distributions in rooms, corridors, atrium, and other building structures have been conducted. Jones and Whittle , and Chen and Srebic provided comprehensive reviews on application of CFD techniques in various building structures over last 2 decades. Xue and Shu studied air-mixing characteristics in a room using CFD approach. Nielsen and Kato et al. conducted experiments at laboratory scale and numerical computations for the determination of airflow in large spaces. However, little work has been found to address the thermal environment in the confined space of a high-rise building, where large numbers of condensing units are installed. Kotani et al. studied the heat dissipation in a light well of a high-rise apartment building. Chow et al. carried out computer simulations to investigate the performance of split-type air conditioners in respect to the temperature rise of condensing units installed at building re-entrant. To investigate the thermal environment in the confined space of a high-rise building and provide useful information on regulating the ventilation requirement, Xue et al. built a 1/20 similitude model of a confined space with array of heat sources and fans simulating condensing units of air-conditioning system. Temperature rises at the central plane of the space under various geometric and operational conditions were measured. The study unveiled that the distance between the walls where condensing units are installed has a significant impact on the temperature rise.[6]

As an extension of the previous study, numerical simulations of the airflow and temperature distribution near the condensing units in the confined space of a high-rise building were carried out using computational fluid dynamics (CFD) approach. In the present study, the numerical model was first validated against the experimental results in the 1/20 scale model. The numerical simulation was then conducted on a full-size prototype high-rise building. The objective of this work is to characterize the airflow and temperature distributions in the confined space at broad geometrical and operational conditions, and elaborate the impact of important design parameters on temperature rise. Effective means for controlling the temperature rise are then discussed and proposed.[4]

2.2 Definition of Air- Conditioning.

Air conditioning (of which refrigeration is an inseparable part) has its origins in the fundamental work on thermodynamics which was done by Boyle, Carnot and others in the seventeenth and eighteen centuries, but air conditioning as a science applied to practical engineering owes much to the ideas and work Carrier, in the United States of America, at the beginning of this century. An important stepping stone in the path of progress which has led to modern methods of air conditioning was the development of the psychrometric chart, first by Carrier in 1906 and the by Mollier in 1923, and by others since.

Full air conditioning implies the automatic control of an atmospheric environment either for the comfort of human beings or animals or for proper performance of some industrial or scientific process. The adjective full demands that the purity, movement, temperature and relative humidity of the air be controlled, within the limits imposed by the design specification. It is possible that, for the certain application, the pressure of the air in the environment may also have to be controlled. Air conditioning is often misused as a term and is loosely and wrongly adopted to describe a system of simple ventilation. It is really correct to talk of air conditioning only when a cooling and dehumidification function is intended, in addition to other aims. This means that air conditioning is always associated with refrigeration and it accounts for the comparatively high cost of air conditioning. Refrigeration plant is precision-built machinery and is the major item of cost in an air conditioning installation, thus the expense of air conditioning a building is some four times greater than that of only heating it. Full control over relative humidity is not always exercised, hence for this reason a good deal of partial air conditioning is carried out; it is still referred to as air conditioning because it does contain refrigeration plant and is therefore capable of cooling and dehumidifying.

The ability to counter sensible and latent heat gains is, and then the essential feature of an air conditioning system and by common usage the term ‘air conditioning’ means that refrigeration is involved.[6]

2.3 Histories

The 19th century British scientist and inventor Michael Faraday discovered that compressing and liquefying ammonia could chill air when the liquefied ammonia was allowed to evaporate.

In 1842, Florida physician Dr. John Gorrie used compressor technology to create ice, which he used to cool air for his patients.[1] He hoped eventually to use his ice-making machine to regulate the temperature of buildings. He even envisioned centralized air conditioning that could cool entire cities.[2] Though his prototype leaked and performed irregularly, Gorrie was granted a patent in 1851 for his ice-making machine. His hopes for its success vanished soon afterwards when his chief financial backer died. Gorrie did not get the money he needed to develop the machine. According to his biographer Vivian M. Sherlock, he blamed the "Ice King," Frederic Tudor, for his failure, suspecting that Tudor has launched a smear campaign against his invention. After Gorrie's death in 1855 the idea of air conditioning faded away for some years.

Early commercial applications of air conditioning were to industrial processing rather than personal comfort. In 1902 the first modern electrical air conditioning was invented by Willis Haviland Carrier. Designed to improve manufacturing process control in a printing plant, his invention controlled not only temperature but also humidity. The low heat and humidity were to help maintain consistent paper dimensions and ink alignment. Later Carrier's technology was applied to increase productivity in the workplace, and The Carrier Air Conditioning Company of America was formed in to meet the rising demand. Over time air conditioning came to be used to improve comfort in homes and automobiles. Residential sales expanded dramatically in the 1950s.In 1906, Stuart W. Cramer of Charlotte, North Carolina, USA, was exploring ways to add moisture to the air in his textile mill. Cramer coined the term "air conditioning," using it in a patent claim he filed that year as an analogue to "water conditioning", then a well-known process for making textiles easier to work. He combined moisture with ventilation to "condition" and changes the air in the factories, controlling the humidity so necessary in textile plants. Willis Carrier adopted the term and incorporated it into the name of his company.

The first air conditioners and refrigerators employed toxic gases like ammonia and methyl chloride, which could result in fatal accidents when they leaked. Thomas Midgley, Jr. created the first chlorofluorocarbon gas, Freon, in 1928. The refrigerant was much safer for humans but was later found to be harmful to the atmosphere's ozone layer. "Freon" is a trade name of Dupont for any CFC, HCFC, or HFC refrigerant, the name of each including a number indicating molecular composition (R-11, R-12, R-22, R-134). The blend most used in direct-expansion comfort cooling is an HCFC known as R-22. It is to be phased out for use in new equipment by 2010 and completely discontinued by 2020. R-11 and R-12 are no longer manufactured in the US, the only source for purchase being the cleaned and purified gas recovered from other air conditioner systems. Several ozone-friendly refrigerants have been developed as alternatives, including R-410A, known by the brand name "Puron".

Latest air conditioners usually have air sterilization effects, such as the recent air conditioners that have germicidal and neutralization benefits.[7]

2.4 Air Conditioning System Basics and Theories

2.4.1 Refrigeration cycle

Due to the decrease of condensing temperature and increase of evaporating temperature on part load conditions, the refrigeration cycle changed from 1-2-3-4 to 1′-2′-3′-4′, shown in Fig 1. Under part load conditions, the refrigeration effect increased from $q_0 = h_1 - h_4$ to $q_0' = h_1' - h_4'$, and the power consumption per unit refrigerant descended from $w_0 = h_2 - h_1$ to $w_0' = h_2' - h_1'$. From the analysis above, it was certain that the COP of the chiller plant increased.[2]

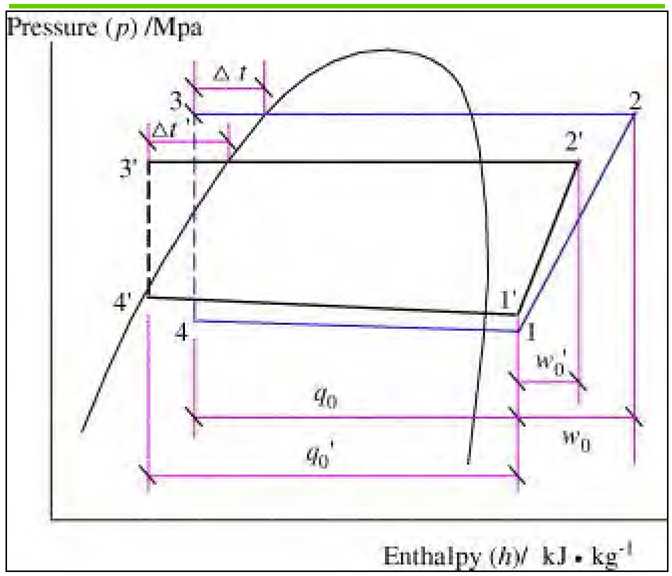

Figure 1: Change of refrigeration cycle shown on *p–h* diagram.

An air conditioning system, or a stand-alone air conditioner, provides heating, cooling, ventilation, and humidity control for all or part of a building. 'Central', 'all-air' air conditioning systems are often installed in modern residences, offices, and public buildings, but are difficult to retrofit (install in a building that was not designed to receive it) because of the bulky air ducts required. A duct system must be carefully maintained to prevent the growth of pathogenic bacteria in the ducts. An alternative to large ducts to carry the needed air to heat or cool an area is the use of remote fan coils or split systems. These systems, although most often seen in residential applications, are gaining popularity in small commercial buildings. The remote coil is connected to a remote condenser unit using piping instead of ducts.

A dehumidifier is an air-conditioner-like device that controls the humidity of a room or building. They are often employed in basements which have a higher relative humidity because of their lower temperature (and propensity for damp floors and walls). In food retailing establishments, large open chiller cabinets are highly effective at dehumidifying the internal air. Conversely, a humidifier increases the humidity of a building. Air-