CONCEPTUAL DESIGN FOR DRYING FABRICS USING WASTE HEAT FROM AIR CONDITIONING CONDENSER

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DECLARATION

I declare that this project report entitled "Conceptual Design For Drying Fabrics Using Waste Heat From Air Conditioning Condenser" is the result of my own work except as cited in the references

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Plant and Maintenance).

Signature : .....

Name of Supervisor : NORASRA A.RAHMAN

Date : 12/7/2017

DEDICATION

To my beloved mother, father and family.

ABSTRACT

Waste of energy always occur around us without we noticing it. This wasted energy occur in so many place regardless the condition and can be find in any form of energy. In order to maximize the usage of energy, this wasted energy need to be take and reuse for other purpose. In this project, the heat waste from air condition condenser is the main target to be reuse. The heat is rejected from the indoor to our door in order to cool the indoor region. During this process, the heat is released to the outdoor surrounding without any further purpose. Thus, the idea to use the rejected heat to dry up wet cloth had been purpose. This project will come out with conceptual design of the cloth dryer that operate using the rejected waste heat from air condition condenser. In this cloth dryer conceptual design, the air condition unit that installed at residential area is focused on. This can help the problem to dry up wet cloths during the non-present of sunlight time such as night time. The idea for the cloth dryer is generated from the literature review and the survey that has been done. The conceptual design is then constructed and analysed with the help of software. The result gained from the analysis is then discussed in order to identify either the designed cloth dryer is operated as expected or not.

ABSTRAK

Pembaziran tenaga sering terjadi didalam kehidupan seharian kita tanpa kita sedari. Pembazir tenaga ini boleh berlaku di dalam apa juga keadaan dan di dalam pelbapai bentuk. Dalam usaha untuk memaksimumkan penggunaan tenaga, tenaga yang dibairkan perlu digunakan semula untuk kegunaan lain. Dalam projek ini, sasaran utama ialah untuk menggunakan semula tenaga yang dibazirkan di dalam sistem penghawa dingin. Tenaga haba yang disalurkan keluar daripada kawasan dalam rumah ke luar bertujuan untuk menyejukkan kawasan di dalam rumah. Semasa process ini, haba panas disaluran keluar rumah tanpa penggunaan lanjut. Oleh yang demikian, idea untuk mengeringkan pakaian yang basah menggunakan haba yang di bebaskan oleh sistem penghawa dingin telah dicetuskan. Projek ini akan menghasilkan konsep rekabentuk pengering pakaian yang beroperasi menggunakan haba daripada kondenser penghawa dingin. Dalam konsep rekabentuk penggering pakaian ini, unit penghawa dingin di kawasan perumahan akan ditumpukan. Konsep rekabentuk ini berkeboleh untuk membantu mengeringkan pakaian di waktu ketiadaan cahaya matahari dikala malam. Cetusan idea untuk rekabentuk penggering ini di lakukan berdasarkan kajian ilmiah dah kaji selidik. Kemudian, lakaran 3 dimensi dibina dan dianalisis menggunakan perisian komputer. Hasil daripada kajian kemudian dibincangkan untuk mengenal pasti sama ada reka bentuk penggering pakaian yang di usulkan mampu beroperasi seperti yang sepatutnya atau tidak.

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to my supervisor Dr. Asra for giving me this opportunity to do final year project with her. I am feeling very thankful for her patient and commitment in conducting and guide me until I complete my project.

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LIST OF ABBEREVATIONS

HVAC	Heating Ventilation Air Conditioning
COP	Coefficient of Performance
AC	Air Condition
SMER	Specific Moisture Extraction Rate
3D	3 Dimensional
PVC	Polyvinyl Chloride

LIST OF SYMBOL

m	=	Mass
t	=	Time
$\dot{m}$	=	Mass flow rate
$\dot{Q}$	=	Energy flow rate
$\dot{W}$	=	Work
X	=	Moisture Content
Q_H	=	Heat rejected
Q_L	=	Input Power
P_{fan}	=	Power of fan

CHAPTER 1

INTRODUCTION

1.1 Background

As we well know, in this urbanisation era, the usage of energy is highly demand in many sectors since most technology that developed nowadays required more energy for them to be operated. Due to this, engineering start to think and invent a lot of innovation in order to reduce the amount of waste energy during the operation of all kind of system that required energy to function. As example in the operation of air conditioning system, in order to reduce the temperature in a room to make it cool, the heat is removed from the room using evaporator and transferred to condenser before released to surrounding. Since the heat is also a kind of energy, so releasing it to the surrounding without any further purpose is a kind of waste. Thus, the idea to use the wasted heat energy had come across into a lot in engineer mind.

There are a lot of research and invention that developed by researcher in order to use the waste energy from air conditioning system. For example, some of them build a chamber in front of the condenser and mount auxiliary fan and holes on the wall of the chamber to increase the flow rate of the hot air. Some of them make that chamber portable and moveable with mounting wheels. Based on their invention, I combine them and design a better cloth dryer to achieve better performance of cloth dryer with the use of waste heat from air conditioning condenser.

From my research, the parameter that can be used to determine the efficiency level of the dryer is using the amount of mass loss of water against the time (Ambarita, H., Nasution, A., Siahaan, N., & Kawai, H. 2016). That is generally the basic method in order to determine the effectiveness of design of the cloth dryer but this method only possible if the prototype has been made because experiment is required. However, there are few external factors that influence the amount of water loss that need to be considered and control.

For example, the nature of heat regarding the thermodynamic principle, which is the heat energy along with the high temperature will flow from the high temperature region to the low temperature and will stop flowing after achieved Thermal Equilibrium (T. M. I. Mahlia, C. G. Hor, and H. H. Masjuki, 2009). Based on this principle, in order to ensure gain continuous flow of the heat, and external force must be add up into the system to induced the flow of heat eventhough they already achieved the equilibrium state. To make this possible, air energy is required to induce the heat to continuously flow in order to dry the cloth, with the help of auxiliary fan (P. Suntivarakorn, S. Satmarong, C. Benjapiyaporn, and S. Theerakulpisut, 2019).

1.2 Problem Statement

The releasing of heat from air conditioning condenser is a kind of waste because heat also a kind of energy that is useful. In order to fix this scenario, a cloth dryer that operated with the waste heat energy will be design. This cloth dryer will fully get used the heat energy that released from condenser to dry the cloth and designed with characteristic that can increase the drying rate of the cloth.

1.3 OBJECTIVE

There are three main objectives as guidance in order to achieve the conceptual design goal of the dryer: -

1. To design the cloth dryer that operated with the heat energy that come from condenser of air conditioning system.
2. To design a cloth dryer that implementing the factor to increase drying rate of the wet cloth
3. To ensure that the conceptual design of the dryer is suitable for household usage

1.4 Scope of Project

The designing of cloth dryer based on the type of air conditioning unit that used in residential area since this conceptual design is for the household usage.

CHAPTER 2

LITERATURE REVIEW

In order to make a best design for the cloth dryer using the waste heat from the condenser of air conditioning system, the basic concept of the operation of the dryer must be determine. The main elements that have great influence in this design is the air condition system itself, since the waste heat that we going to use for the drying mechanism is come out from air conditioning system. In more specific term, the heat is release by the condenser of the air cond. Hence, the studies regarding the air conditioning need to be done.

The general idea for this dryer is using the waste heat from the air conditioning condenser, which consist of 3 main partition, partition for inlet or the heat to flow in, next to the drying chamber (the region where cloths going to be place), and lastly to the outlet of the heat flow.

2.1 Air Condition system and operation

Every air conditioner (also known as AC, A/C or Air) has a compressor inside it. It works to compress and pump the refrigerant gas. In Malaysia, the common type of refrigerant used is refrigerant-143a. Besides providing power to compress the refrigerant, the compression of refrigerant also produces heat.

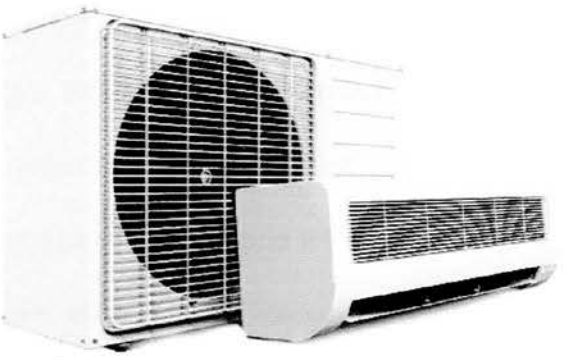


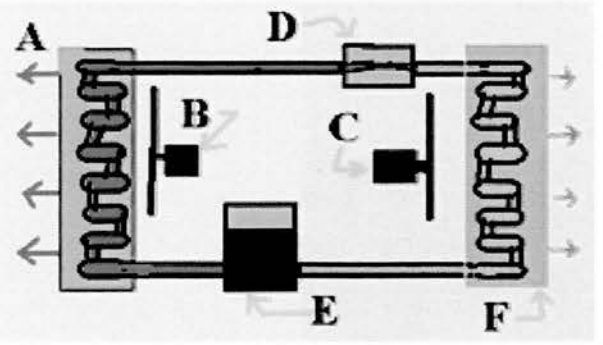
Figure 2.1. : Residential Air Condition Unit

(Source : http://biashara.co.ke/)

To dissipate this heat, compressed refrigerant is pumped to the condenser coils where a fan blows the heat out to outer atmosphere. During this process, refrigerant takes the liquid form. This liquid refrigerant is pumped towards expansion valve. Expansion valve has a temperature sensor connected to it which works in correlation with thermostat settings. Expansion valve releases the appropriate amount of refrigerant to evaporator (cooling coils) where liquefied refrigerant takes gaseous form. Conversion from liquid to gaseous state due to expansion causes cooling because energy is absorbed from the surrounding. The air passes through fins (attached to coils) gets cooled and blown to the room. The gaseous refrigerant in cooling coils then enters the compressor and gets compressed once again. The cycle continues unless the compressor is shut down.

In general terms, air conditioner draws heat from the indoor and releases it to the outdoor. Indoor region acts as a source of heat and outdoor region as a sink for heat. In vehicle air conditioners, a Receiver-Drier is installed between condenser and expansion valve. It serves to collect excessive refrigerant when not required for cooling operation. It also has got a desiccant which absorbs any moisture present in the refrigerant. A refrigerant such as Freon mixed with a small amount of a lightweight

oil (to lubricate the compressor) is compressed by the compressor causing it to become a hot, high pressure gas, this hot gas runs through a series of coils (the red coils in diagram) and with the help of the fan dissipates this heat to the outside. In this process, the Freon cools and condenses into a liquid which then runs thru an expansion valve, at which point the liquid evaporates to become cold low pressure gas (blue coils in diagram).



A. Hot air transferred to Outside region
B. Fan to help improve heat transfer from coils to outside.
C. Fan for more efficient transfer of cool air to inside.
D. Expansion Valve
E. Compressor
F. Cool Air to Inside

Figure 2.2 : Flow of air conditioning Process

(Source : http://www.lg-aircons.co.za/)

Going through another series of coils and with assistance of a second fan, absorbs the heat and thereby cools the inside of the building. The cooling coils (blue) causes moisture in the warmer inside air to condense into water which drips and runs to the outside of the building, this condensation process lowers the humidity on the inside. This condensation principle is also how de-humidifiers work.

2.2 Air Condition Compressor

Since the waste heat that released from air condition unit is produced by the work process of the compressor, little study regarding the compressor need to be done. By determining the heat source capabilities, the amount of released waste heat that

going to be used for cloth drying purpose can be determine. Generally, air conditioning compressor can be considering as the heart of the AC units. This is mechanical component that uses electricity and capacitor as the single energy source to operate it. The air conditioning compressor is the ac parts that cause the refrigerant to flows in a cycle. Compressor provides work to compress the air by converting energy from electrical to kinetic energy.

Figure 2.3 : Compressor mounted in housing

(Source : https://s-media-cache-ak0.pinimg.com/)

In air conditioning, there are five main types of air conditioner compressors that exist:

1. Reciprocating
2. Centrifugal compressor
3. Rotary compressor
4. Scroll compressors
5. Screw compressors

All five type of Heating, Ventilation and Air Conditioning (HVAC) compressors have same working principle, but their internal methods of compressing refrigerant vapors are different depend on the components. Since my project scope relate to the air conditioning system used in residential area, I am going to focus on

the reciprocating compressor since that is most common compressor used in residential area. It comes into two domes or housing:

1. Open compressors
2. Hermetic compressors

Hermetic compressor is the most common air conditioner compressors found in residential AC units and light commercial units. So, the only compressor we'll being focusing here is hermetic compressors.

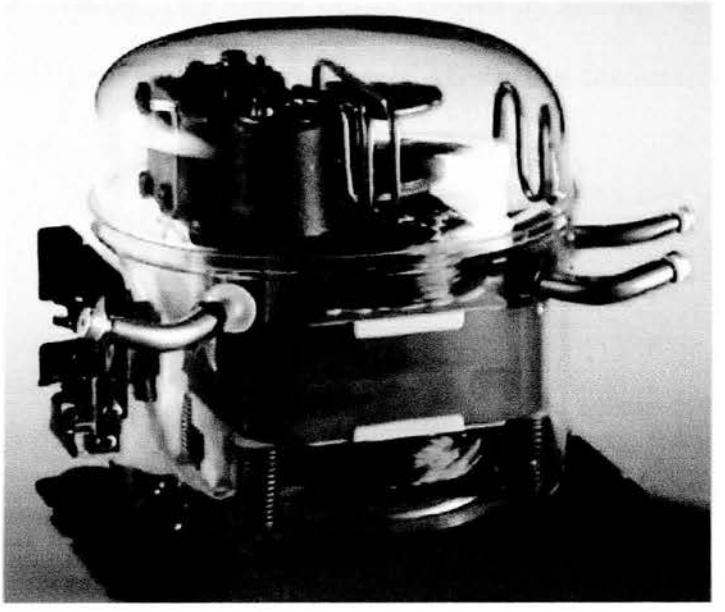


Figure 2.4 : Example of Hermetic compressor (transparent)

(Source : http://tehranfreon.com/)

Hermetic compressor comes into two types:

1. Sealed or welded hermetic compressors
2. Semi-hermetic (this compressor has nuts and bolts holding it together.)

- Sealed hermetic compressors

Welded hermetic compressors aka tin can or sealed hermetic are throwaway compressors. There is no way of get inside the compressor, unless it is cut open. There are few companies that open this compressor; they are specializing in this kind of works. The compressors manufacture opens the sealed hermetic compressors to examine it. Otherwise, it is a throwaway. In sealed hermetic compressors, the motor and crankshaft are in vertical position. It used the suction refrigerant from the air conditioner evaporator to cool the internal compressor at an operating temperature.

The air conditioner compressors have a safety device inside to protect the compressor from heating. This safety device known as Internal Overload. The air conditioning compressor is the most expensive AC parts in condenser units; it's wise to protect the compressor.

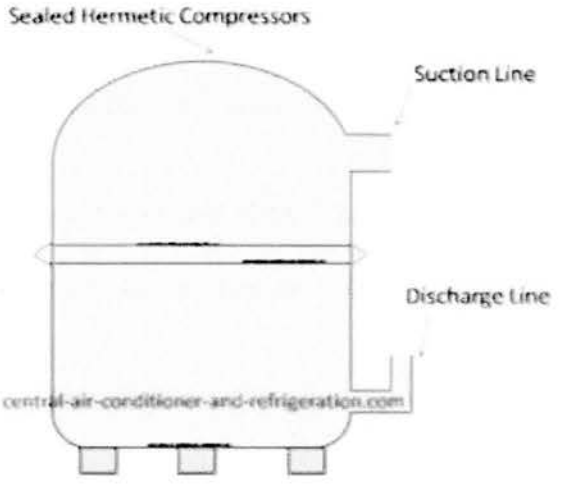


Figure 2.5 : Image of Suction and Discharge Line in Hermetic compressor

(Source : www.central-air-onditioner-and-refrigeratio.com)

In a hermetic compressor, there are two important tubes that welded with the hermetic shell. These two tubes are: