UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE APPLICATION OF WASTED HEAT FROM AIR CONDITIONER FOR LAUNDRY DRYING

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A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

Except as stated in the sources, I declare that this selected an item named "The Application of Wasted Heat from Air Conditioner for Laundry Dryer" is the product of my study. The selected item has not been approved for any degree and is not being submitted for any other degree at the same time.

Signature : 

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Date : 17 January 2022

APPROVAL

I thus declare that I have reviewed this thesis and that, in my opinion, it meets the requirements for the granting of the Bachelor of Mechanical and Manufacturing Engineering Technology (Air Conditioning and Refrigeration System) with Honours.

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DEDICATION

My job is dedicated to my family, supervisor, and colleagues. I am grateful to my supporting parents, Mohamad Zaiddie Bin Bujang and Norizan Binti Zaini, for motivating and encouraging me to complete my studies. Mr. TS. Azwan Bin Aziz, my supervisor, has given me the chance to accomplish my study and has provided me with technical information on the equipment and testing. Not to mention that my dissertation is dedicated to my coworkers. Last but not least, I will always be grateful to all of those who have contributed their time and knowledge to the experiment and study.

ABSTRACT

This project is to study and discusses and experiment to show the efficiency of drying clothes with waste heat from a split-type air conditioner In terms of drying time and energy consumption, the study compares the efficiency of this drying system to that of a typical one. The project has three aims: one general purpose and two particular objectives. The overall goal is to create a clothes drier that utilises unused heat from an air conditioner. And the temperature of waste heat that may dry wet garments is being measured in order to establish the usefulness of waste heat from air conditioners in drying laundry. The experiment will be undertaken with three different drying conditions: outside natural drying at midday, inside natural drying, and air-conditioner waste heat drying. After all, this project will be designed to fit any style and size of home, as well as demonstrate how waste heat recovery may be used to dry wet clothes.

ABSTRAK

Projek ini adalah untuk mengkaji dan membincangkan dan mencuba untuk menunjukkan kecekapan pengeringan pakaian dengan haba buangan daripada penghawa dingin jenis split Dari segi masa pengeringan dan penggunaan tenaga, kajian membandingkan kecekapan sistem pengeringan ini dengan yang biasa. . Projek ini mempunyai tiga matlamat: satu tujuan umum dan dua objektif khusus. Matlamat keseluruhan adalah untuk mencipta pengering pakaian yang menggunakan haba yang tidak digunakan daripada penghawa dingin. Dan suhu sisa haba yang boleh mengeringkan pakaian basah sedang diukur untuk menentukan kegunaan sisa haba daripada penghawa dingin dalam mengeringkan pakaian. Percubaan akan dijalankan dengan tiga keadaan pengeringan yang berbeza: pengeringan semula jadi di luar pada tengah hari, pengeringan semula jadi di dalam dan pengeringan haba buangan penghawa dingin. Lagipun, projek ini akan direka bentuk agar sesuai dengan mana-mana gaya dan saiz rumah, serta menunjukkan cara pemulihan haba sisa boleh digunakan untuk mengeringkan pakaian basah.

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Also, a heartfelt thank you to my family and friends for their direct and indirect contributions to the completion of this study. Finally, this thesis is dedicated to my beloved father and mother. This piece of achievement is dedicated to both of you. Thank you and Alhamdulillah.

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LIST OF SYMBOLS AND ABBREVIATIONS

˚C	-	Degree celcius
C_p	-	Specific heat capacity (kJ/kg K)
Q_{out}	-	Cooling capacity of a room air conditioner (kJ)
COP	-	Coefficient of Performance
m_{air}	-	Mass of the air (kg/s)
P_c	-	Power input to the compressor (kW)
RACD	-	Room air-conditioner dryer
W_{in}	-	Power consumption (kWh)
T_{in}	-	Air temperature entering the evaporator (˚C)
T_{out}	-	Air temperature leaving the evaporator (˚C)

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CHAPTER 1

INTRODUCTION

1.1 Background

Waste heat may know as the unused heat that given to the surrounding environment which is in form of thermal energy by a heat engine in a thermodynamic process in which it converts heat to useful work. The most significant amount of waste heat are being lost in industrial and energy generation processes, the exact amount of industrial waste heat is difficult to quantify. Decreasing energy losses and heat recovery are important research topics. There are many types of devices have been developed to re-use some of the waste heat.

Energy saving is one of the key issues not only in view point of energy conservation but also for the aegis of global environment. Waste heat is the heat generated all along most of the operations of system and then it is dumped into the surroundings even though it could be still utilized for some other beneficial and remunerative purposes. Waste heat is often dissipated into the atmosphere, or large bodies of water like lakes, river and ocean.

Significant energy savings can be achieved by reusing this waste heat. Several researchers have conducted research that related to waste heat recovery in many application and sources such as heat recovery from air conditioner. However, it has been found that waste heat from air conditioner can be a useful purpose. Since air conditioning units are designed for remove heat from interior space and reject it to outdoor through

condenser, this waste heat can be utilized for drying purposes. By reuse the waste heat for laundry drying, it also can save the electricity bills and save budget for own the air dryer.

1.2 Problem Statement

Design and analyse the air dryer machine using heat waste normally include an exploration on starting growing a study about the air dryer machine and heat waste. The elements that need to be considered are evaluating heat waste, and developing new products and parcel of most designs and analyse clothes dryer machine. The design need to be considerate on the economic, ergonomic and friendly to use. There are also must be energy efficient and less power consumption.

Currently, power consumption becomes an important issue addressed by our government. They focused more on energy efficient and less power consumption. Other than that, nowadays there are many houses that do not have a big space to put the air dryer machine. Therefore, the use of electrical air dryer can be replaced by utilizing other heat source such as using waste heat from air-conditioning. By using the waste heat from air-conditioning, it will focus on energy saving features in the residential as well as in industrial and commercial sectors. Energy efficiency standards have been implemented as a voluntary basis since 2005.

The increase in energy prices is a reality for Malaysian, but also for many other countries all over the world. Switching to energy saving solutions is the answer for reducing costs and impact of the energy sector on the environment. There are also to improve the usage of space in each house. Efforts are being made to active promote the utilization of renewable energy resources. Heat waste technologies will be developed with emphasis on utilizing cost effective methods as well as strengthening of the cabinet.

The heat waste means free heat is just being wasted to the atmosphere without any benefits. There is disadvantage in releasing heat to the environment which will cause of global warming. This problem can overcome by manipulating the heat waste to flow into a cabinet dryer and remove the moisture from cloths. The heat will cost zero, which mean no energy efficient, save electricity bills and less power consumption.

1.3 Objective

For the purpose of this project, three objectives have been set up to run the project. They are as follows:

1.3.1 General objective

i. To design the system (laundry dryer) that using wasted heat from air conditioner.

1.3.2 Specific objective:

i. To determine the effectiveness of waste heat from air conditioner to dry the wet clothes

ii. To measure the temperature of the waste heat that could dry the clothes.

1.4 Scope of Research

This project will focus on build a prototype laundry dryer to show the effectiveness of waste heat to dry the wet clothes without disturbing the air-conditioning system. The design of the cabinet could be use for every type of house. As we know that nowadays there are a lot of houses that might not have enough space to own the cloth dryer machine. Furthermore, the project will show how the waste heat from condensing unit of air-conditioning system can dry the clothes.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Energy saving is one of the key issues not only in view point of energy conservation but also for the aegis of global warming. Waste heat is the heat generated all along most of the operations of system and then it is dumped into the surroundings even though it could be still utilized for some other beneficial and remunerative purposes. Waste heat is usually correlated with waste streams of air or water and it put into the environment. As we know, air conditioning was designed to remove heat from interior spaces and reject it to the ambient air (atmosphere). Indirectly, it will increases environment temperature which will cause global warming. Air-conditioning are used all over the world that more than a billion units which will results in addition of enormous amount of heat to the atmosphere. That is why it is important to utilize the waste heat.

2.2 Wasted Heat

In a thermodynamic process in which it converts heat to useful work, waste heat is the wasted heat delivered to the surrounding environment (in the form of thermal energy) by a heat engine. When translating a temperature differential into mechanical energy, the second rule of thermodynamics stipulates that waste heat must be produced (which is often turned into electrical energy in power plants). Any heat engine will produce waste heat, and the quantity it produces in comparison to the amount of input heat determines its

thermal efficiency. (Bethal Afework, Jordan Hanania, Kailyn Stenhouse, Jason Donev, May 18,2018)

Waste heat is frequently released into the sky or into huge bodies of water, such as rivers, lakes, and even the ocean. The efficiencies of power plants are limited since waste heat is an essential product of heat engines (see Carnot efficiency) as a result, in order to attain their targeted energy output, they must burn more fuels. This contributes to global warming by increasing greenhouse gas emissions. (Bethel Afework, Jordan Hanania, Kailyn Stenhouse, Jason Donev, May 18, 2018)

Energy cannot vanish or be destroyed after usage, according to the Law of Conservation of Energy. It can only be changed from one form to another. Aside from energy transformed to productive work or chemical energy stored in new goods, residual heat or waste heat from energy application processes has been discharged into the climate system, such as (Qinghan Bian, 2019):

- Showering and drying laundry (save for sun dry) immediately emit heat into the environment, whereas air conditioning warms the air directly.
- Only approximately 12 41% of the fuel spent in transportation is used for "productive labour," with the remainder being released into the environment as heat.
- In industries, drying moisture-containing materials releases all spent energy as heat, together with the evaporated water and heated materials, into the environment.
- Approximately 43.4 percent of the input energy is distributed into the environment as heat during lime production in a typical rotary kiln operation. The waste heat in other types of kilns may be higher;

- About 55.5 68.6% of the input energy in cement manufacturing is lost as heat, via exhaust gas, kiln shell, hot product, and other means.
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Approximately 100% of energy utilised in residential and commercial uses, 75% in transportation, and 70% in industrial applications is released into the environment as heat globally (Qinghian Bian 2019).

There is also a lot of flaring at oil and gas development/processing sites, petroleum refineries and petrochemical plants, coal mining and processing facilities, waste management and landfill locations, and so on, which heats the air and sends heat to the environment all the time (24/7/365) all over the world. Some research have looked at the impact of waste heat, often known as anthropogenic thermal emissions (Flanner 2009). (Murray and Heggie 2016). According to Flanner (2009), nearly all energy consumed for human purposes is lost as heat within Earth's land–atmosphere system, but heat from nonrenewable sources is a climatic forcing term with a worldwide average value of 0.028 W/m2.

When contrasted to the 2.9 W/m2 forcing of GHGs (IPCC Fourth Assessment Report: Climate 2007), it is determined that waste heat from human activities accounts for just approximately 1% of the GHG impact (Skeptical Science 2020). Estimating waste heat forcing at the top of the atmosphere, on the other hand, ignores its absorption by air, exaggerating its influence, if that is suitable. On the other hand, according to Bian (2019), around 30% of industrial energy is transformed to new products in the form of chemical energy, and 25% of fuel is turned to productive labour in transportation. As a result,

Flanner's claim that "nearly all energy... is lost as heat within Earth's land–atmosphere system" appears to be exaggerated and incorrect. Flanner (Flanner 2009) was one of the first to try to include waste heat into GHG-based climate change models, but he didn't look at how the heat directly warmed the air from a thermodynamics standpoint. (Bian, Q. May 10,2020)

2.3 Waste Heat Recovery

The process of "heat integration," or recycling heat energy that would otherwise be disposed of or simply released into the atmosphere, is known as "waste heat recovery." Plants can cut energy expenditures and CO2 emissions while increasing energy efficiency by recovering waste heat.

Waste heat in the form of hot exhaust gases, cooling water, and heat lost from hot equipment surfaces and heated products is estimated to account for 20 to 50 percent of industrial energy input. Recovery of waste heat losses saves money, minimises environmental effect, and enhances work flow and productivity as the industrial sector strives to increase its energy efficiency. (Energy.Gov, January 24, 2017)

In order to achieve the best recovery efficiency, waste heat recovery systems (WHR) are placed in each category of loss. The diagram below depicts heat losses in various industrial sectors and how they are recycled into electrical energy. (H. Saadaoui, 2021)

Waste heat recovery systems are used in a variety of sectors, and with good reason. Recycling heat and energy that would otherwise be squandered may have a startling influence on both individual companies and whole sectors.

2.3.1 Increased Efficiency

We acknowledge the necessity of enhancing efficiency as a society on a regular basis. We are committed to ensuring that our world runs as effectively as possible on a daily basis, from installing high-efficiency equipment in our houses to purchasing fuel-efficient automobiles.

Waste heat recovery systems are crucial when it comes to boosting efficiency on a big scale, such as in major industrial facilities and production plants. Installing these systems is a very little adjustment that may have a significant influence on efficiency, both on a big and local scale.

2.3.2 Resource Conservation

It is a well-known truth that our world's resources are finite. We are frequently depleting resources faster than they can be replenished. As a result, any firm – especially large-scale enterprises – should make ensuring that we are using resources efficiently and saving them wherever feasible a top priority.

Plants and facilities can contribute to resource conservation by reusing waste. In some situations, adding a recovery mechanism might completely eliminate the need for a secondary heat source. When it comes to preserving energy sources, this may make a big impact.

2.4 How Air Conditioning Works

A fan to circulate air, a cold surface to chill and dehumidify the air, a warm surface, and a supply of water vapour are all necessary components of an air conditioning system. There will be a tangle of tubes to distribute and collect the air in a huge system. (Padfield, n.d.)