UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Teaching Aid Device to Enhance Technologist understanding on The Second Law of Thermodynamics using Pugh's Method

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours

by

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I hereby, declared this report entitled DEVELOPMENT OF TEACHING AID DEVICE TO ENHANCE TECHNOLOGIST UNDERSTANDING ON THE SECOND LAW OF THERMODYNAMICS USING PUGH'S METHOD is the results of my own research except as cited in references.

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Date: 6 Dec 2019

APPROVAL

This report is submitted to the Faculty of Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Technology Automotive) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Pemahaman terhadap hukum kedua termodinamik telah menjadi salah satu keperluan penting bagi jurutera terutama yang terlibat dalam sistem penyejukan kerana ia adalah pengetahuan asas kepada sistem. Projek ini dijangka untuk mencipta alat bantuan pembelajaran mudah alih yang dapat menjalankan konsep hukum kedua sistem penyejukan termodinamik. Sebagai jurutera, adalah perlu untuk memahami termodinamik kerana terlibat di semua tempat, ia terlibat dengan proses mana-mana enjin yang semua atau beberapa yang mengikuti hukum termodinamik lain di mana enjin adalah satu mekanisme untuk memindahkan tenaga ke bahagian yang lain. Tidak kurang juga, prinsip termodinamik digunakan oleh jurutera mekanikal dalam bidang penukaran haba dan analisis tentang penyejukan tidak dapat dilakukan jika kekurangan pengetahuan mengenai termodinamik. Sistem penyejukan telah menjadi sumber yang memberi kesan kepada pemanasan global sebagai Hydrofluorocarbon (HFC) yang dikeluarkan oleh sistem penyejukan iaitu HFC perangkap ribu kali lebih banyak haba di atmosfera seperti karbon dioksida. Semua komponen dalam sistem penyejukan juga perlu belajar untuk menambah baik sistem yang sedia ada dan menjadikan gaya hidup sihat yang lebih baik dalam masyarakat. Kaedah Pugh digunakan dalam proses reka bentuk untuk memilih konsep terbaik untuk mencipta alat bantuan pengajaran ini. Terdapat tiga sub-komponen sistem penyejukan dalam peranti bantuan pengajaran yang akan dijalankan untuk membandingkan coeffiecien of performance (COP) sistem untuk memberikan gambaran yang lebih jelas tentang bagaimana sistem berfungsi. Mekanisme yang bergerak seperti kipas dan diod pemancaran cahaya akan menjadi sokongan dan dikendalikan oleh Arduino dalam litar dengan kod diprogram yang diterapkan.

ABSTRACT

The understanding of the Second Law of Thermodynamic has become one of a crucial requirement for the engineers especially those which involve in the refrigeration system as it was the basic knowledge for the system. This project is expected to design a portable teaching aid device that able to carry out the concept of the Second Law of Thermodynamic refrigeration system. As an engineer, it is important to understand the Thermodynamic as it is involved everywhere, as it involved with the processes of any engines that all follow some or the other thermodynamics laws whereby the engine is a mechanism to transfer the energy to another part. Also, thermodynamics principles are applied by mechanical engineers in the fields of heat conversion and analysis of refrigeration cannot be done if lacking in the knowledge of thermodynamics. The refrigeration system had become of the source that effects the global warming as the Hydrofluorocarbon (HFC) which the bad is they trap thousands of times as much heat in the atmosphere as carbon dioxide. All of the component in the refrigeration system also need to be learn in order to improvise the existing system and made a better health style in the community. The Pugh method is involved in the design process to pick out the best concept to design the teaching aid device. There is three sub-component of the refrigeration system in the teaching aid device that will be conducted to compare the coefficient of performance (COP) of the system to give a clearer picture of how the system working. The moving mechanism such as the fan and the light-emitting diode will be support and controlled by the Arduino in the circuit with a programmable code applied.

DEDICATION

This work is dedicated to my beloved parents, Mohd Hamdan Bin Paimon and Nur Liyana Leong Binti Abdullah, my family, and friends whose supports and prayers have been endless during a long period of my studies. To my honored supervisor, Profesor Madya Dr Muhammad Zahir Bin Hassan and all UTeM lecturers, thank you very much for providing me with the best education and patiently supervise me throughout the project thesis.

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My sincere appreciation to all my housemates and others who have provided assistance at various occasions time by time. Through their continued support and interest, this project had been accomplished as their constructive opinions and expert tips are useful indeed throughout my study period. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members as well which they provide me help regarding to my project, invaluable advice and positive vibes were given to me as to moral support. . Last but not least, I am very grateful for all that giving me additional information directly or indirectly for basic conceptual idea of the project.

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LIST OF SYMBOLS

Q - Heat

W - Work Done

LIST OF ABBREVIATIONS

3D	Three Dimensional
AC	Alternating Current
CAD	Computer Aided Design
CATIA	Computer Aided three-Dimensional Interactive Application
CFC	Chlorofluorocarbon
CO2	Carbon dioxide
COP	Coefficient of Performance
DC	Direct Current
GHG	Greenhouse Gases
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
LED	Light-emitting diode
RPM	Revolution per minute
USB	Universal Serial Bus

LIST OF PUBLICATIONS

CHAPTER 1

INTRODUCTION

1.0 Overview

Nowadays, especially for modern community, word ‘refrigeration’ have already give out an imagination of a device in their homes which is used to cool and freeze the food and beverages (Carson, 2013). These device may be seen as a normal device but it play an important role in our daily life especially in the home uses besides improving our life quality better. In 1800s, for insulation purpose the natural ice was being collected then was kept in large quantities with sawdust. By then, the supply of harvested ice was unpredictable and getting low rely on the weather till the mechanical type refrigeration systems were being invented (Callahan, 1945). There are various type of refrigeration systems that had been invented but the major household cooling system is the vapor-compression cycle, which relate to four main component that are condenser, compressor, evaporator, and expansion valve (Serah and Nuri, 2015).

At the time achieving the upper activation value, the refrigeration compressor is switched on and off again when the needed temperature is reach. By this method, the range of room temperature can be always kept within this range (Bachmann *et al.*, 2010). Hence, the air movement is keep steady in the refrigerated space. Compressor is recognized as the heart of the vapor-compression cooling system (Dincer, 2017). The system of vapor-compression refrigeration system is as shown in **Figure 1.1.**

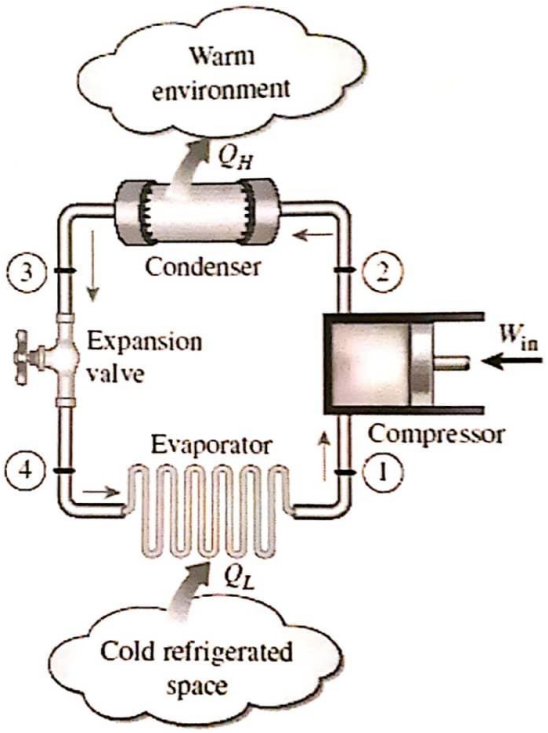

Figure 1.1: Vapor-compression Refrigeration System (Serah and Nuri, 2015)

Refrigeration system same goes for the vehicle that required regularly maintenance on it engine system. All mechanical equipment needs to maintain its service to keep it in the best operating system. By maintaining the service can mean the difference between a few mechanical malfunctions or other problems (Maxson, 1999). If it is not maintained properly, the cooling system tends to lose 5% of its operating efficiency every year due to this buildup, which means it cannot cool like before (Hicks, 2015). However, most used refrigeration cycle method is mechanical compression. It can be apply in both air conditioning, home uses and industrial refrigeration.

Refrigeration moving parts had been suffer from day to day, wear and tear and regularly need to be refilled, replaced, checked and cleaned. So as daily uses, it need to have a simple maintenance and cleaning procedures can improve greatly the life and efficiency of refrigerator. The condenser coils need to be vacuum in order to remove the dust that built up from the coils every three months (Huffstetler, 2019). Stucked or clogged condenser coils might get another several problem in the system, it is important to have a smooth flow in the coils and free from dust so that the refrigeration can work on its supreme capability.

1.1 Research Background

Refrigerator is a device that converts heat transfer from low-medium to high temperatures (Prasad *et al.*, 2009). The main components expansion valve, evaporator, compressor and condenser are responsible during the vapor compression refrigeration system (Arora, 2010). This project will be focuses on the Second Law of Thermodynamics such as in refrigeration laboratory by the differences reading of the coefficient of performance with different setup. The experiment will be accomplish by a smart teaching aid device with the reading of coefficient of performance (COP) of the device on a certain condition but different ways. However, the product are limited to the real effect such as cooling or heating during the demonstration.

1.2 Aim and Objectives of the Research

1.2.1 Aim

The aim of this research is to create a teaching aid device project to come out as new method to enhance technologist understanding on The Second Law of Thermodynamics. The device is expected to help lecturer in higher level learning institutions in delivering lecture to improve the understanding on the Second Law of Thermodynamics.

The device in the present project will focus in the educational demonstration of the refrigeration experiment in the laboratory, which involves the experimental that shows on how the refrigeration system cycle and work. A small scale device with exact shape of the refrigeration system is expected to demonstrate the Second Law of Thermodynamic with the output COP in the classroom.

1.2.2 Objectives

The objectives of this research are as follows:

i. To design a portable teaching aid device that capable to simulate the Second Law of Thermodynamics Refrigeration System using Pugh's Method
ii. To establish a working of prototype of refrigeration system scale model of 1:3.10
iii. To feasibility study of the working prototype to simulate basic air condition refrigeration system that capable of demonstrating Second Law of Thermodynamics

1.3 Scope of Study

This research were organized in laboratory facility that has been conducted to test the demonstration to achieve the exact function as the refrigeration laboratory session. This research is performed by using the teaching aid device to show the difference in the COP with the difference setup of the device. The experiment analyze the COP reading by the effect of the evaporator coil and refrigerant inside the refrigeration system. By performing the exact scale with the refrigeration, it will enhance the understanding of technologist about second law of thermodynamics concept.