



## **UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

### **DESIGN AND ANALYSIS FOR DEVELOPMENT OF PORTABLE AIR COOLER USING PHASE CHANGE MATERIAL**

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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Tajuk: DESIGN AND ANALYSIS FOR DEVELOPMENT OF PORTABLE AIR COOLER USING PHASE CHANGE MATERIAL

Sesi Pengajian: 2018

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## APPROVAL

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

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## ABSTRAK

Kajian ini adalah untuk membincangkan dan membangunkan satu produk iaitu sebuah alat penyejukan mudah alih menggunakan lilin paraffin. Objektif kajian ini adalah untuk mereka bentuk dan analisa untuk pembangunan penyejuk udara mudah alih menggunakan perubahan fasa (PSM). Fungsi utama lilin paraffin adalah untuk menyerap haba. Hasilnya membuktikan bahawa lilin paraffin adalah bahan yang boleh menyejukkan atau bahan yg boleh digunakan untuk alat penyejukan. Selain itu kajian ini adalah untuk menyiasat prestasi peranti dalam pelbagai keadaan. Kajian ini dilakukan mengikut carta alir rekabentuk kejuruteraan dari menggunakan perisian CATIA hingga ke proses fabrikasi. Reka bentuk itu kemudian direka menggunakan bahan-bahan yang dipilih. Proses seperti potongan, penyambungan dan pendawaian dilakukan dalam proses fabrikasi. Model akan dibangunkan dan proses fabrikasi dijalankan di akhir dengan reka bentuk yang terbaik. Hasil kajian ini menunjukkan bahawa lilin paraffin boleh menjadi ejen penyejukan untuk alat penyejukan mudah alih dengan mengeluarkan udara yang sejuk.

## **ABSTRACT**

This study is to design and analysis a portable air cooler. The objective of this study is to design and analyze the development of an air cooler a using phase change material (PCM). The main function of paraffin wax is to absorb heat. The result proves that paraffin wax is a cooling material or material that can be used for refrigeration. In addition, this study is to investigate the performance of devices in various situations. This study is based on the engineering design flow from a software CATIA to the fabrication process. The product is then designed using selected materials. Processes such as cutting, joining and wiring are done in the fabrication process. The model will be developed, and the fabrication process will be carried out at the end. The results show that paraffin wax can be a cooling agent for the portable air cooler by producing cool air.

## DEDICATION

This project and thesis are wholeheartedly dedicated to my beloved parents **Fadilah Hanim Binti Abdul Manaf** and **Abdul Aziz Bin Mohd Kaus**, who have been our source of inspiration and gave us strength who continually provide their moral, spiritual, emotional, and financial support. To our brothers, sisters, relatives, supervisor, lecturer and who shared their words of advice and encouragement to finish this study. And lastly, we dedicated this study to ALLAH SWT, thank you for the guidance, strength, power of mind, protection and skills and for giving us a healthy life.

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## LIST OF SYMBOLS

<b>%</b>	-	Percent
<b>F°</b>	-	Fahrenheit
<b>kW</b>	-	Kilowatt
<b>C°</b>	-	Celsius
<b>m / s</b>	-	Meter per second
<b>Lit / min</b>	-	Litre per minute
<b>Pa</b>	-	Pascal
<b>P</b>	-	Pressure

## LIST OF ABBREVIATIONS

<b>PCM</b>	Phase Change Material
<b>DEC</b>	Direct Evaporative Cooling
<b>IEC</b>	Indirect Evaporative Cooling
<b>RH</b>	Relative Humidity
<b>EER</b>	Energy Efficiency Ratio
<b>LHTES</b>	Latent Heat Thermal Energy Storage
<b>AM</b>	Additive Manufacturing
<b>AMF</b>	Additive Manufacturing File
<b>STL</b>	Stereolithographic
<b>FDM</b>	Fuel Deposition Modelling
<b>CAD</b>	Computer Aided Design
<b>HVAC</b>	High Ventilation Air Conditioning
<b>DC</b>	Direct Current
<b>AC</b>	Alternate Current
<b>USB</b>	Universal Serial Bus

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

This chapter will discuss about the background of the product and material. This chapter including the problem statement of the project. Then, the chapter also have objectives to solve the problem and lastly in this chapter are work scope of the project is about to design and study of the product.

### 1.2 Background

When temperature rises, people may look or search to the cooling comfort of an indoor air conditioning. Air conditioning consists various of type such as window, split, inverter variable refrigerant flow and evaporative air cooler. Evaporative air cooler is also known by several names such as swamp cooler, desert cooler and wet air cooler. Evaporative coolers lower down the temperature of air by using the principle of evaporative cooling (Ashutosh Singh, Rahul Dev.2017). The thermal analysis of an indirect evaporative cooling unit is inherently complicated because the cooling process involves simultaneous heat mass transfer at the liquid film-air interface (X.C. Guo and T.S.Zhao 1998).

Evaporative cooling is now-a-days applied in many fields. Several applications include evaporative coolers and cooling ventilation systems, greenhouse cooling, warehouse cooling and product storage, nursery cooling, poultry, hog and livestock cooling, wet cooling towers in thermal power plants, and inlet air cooling of gas turbines. (Ashutosh Singh, Rahul Dev.2017). This shows that the demand for a portable AC such

as evaporative cooler on a hot and sunny weather. Paraffin wax is a colorless chemical material in solid form from petroleum, coal or oil shale that consists mixture of hydrocarbon containing between 20 and 40 carbon atoms. It's become solid when at room temperature and the melting point when it's achieved temperature at 37 °C and its boiling point is 370°C. The application of paraffin wax is used in lubrication, electrical insulation and candles.

### **1.3 Project Briefing**

This project is about developing a portable air cooler by using phase change material which is paraffin wax. Air cooler is design to cool the ambient surrounding temperature. Paraffin wax is placed inside the air cooler vent to reduce power consumption and produce cool air. The paraffin wax is contained in a thermoplastic polymer packaging material which is melt able when it's at elevated temperature become a liquid form. When the hot air passed through the paraffin wax, it will produce a cool air, the paraffin wax act as cooling agent will decrease the temperature surrounding and produce cool air.

### **1.4 Problem Statement**

- i. Cooling agent or absorption material for an air cooler.
- ii. Size of portable air cooler
- iii. Manufacturing Cost
- iv. Living space

## **1.5 Aim and Objective of Research**

### **1.5.1 Aim**

The aim of this research is to provide thermal efficient cooling and to reduce power usage. The investigation in the present project will be circulating about four major aspects in the system, which are:

- 1) Type of paraffin wax (PCM)
- 2) How the device work
- 3) The device's performance in various situation
- 4) How effective the system

### **1.5.2 Objectives**

The objective of this project is:

- 1) To design and analysis for development of portable air cooler using phase change material (PCM).
- 2) To conduct experimental study and to investigate the device's performance using phase change material (PCM).

## **1.6 Work scope**

The work scope of this project is:

- 1) Design the prototype of a portable personal air cooler.
- 2) Study the effectiveness of the paraffin wax as cooling agent.
- 3) Study how paraffin wax can decrease the temperature for applying on an air cooler.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The literature review is about the research and observation of the previous study on the product. In addition, the discussion of the required data as reference materials and guidelines that needed for projects. The studying that done are included the properties of materials and safety of the materials.

### 2.1.1 K-Chart

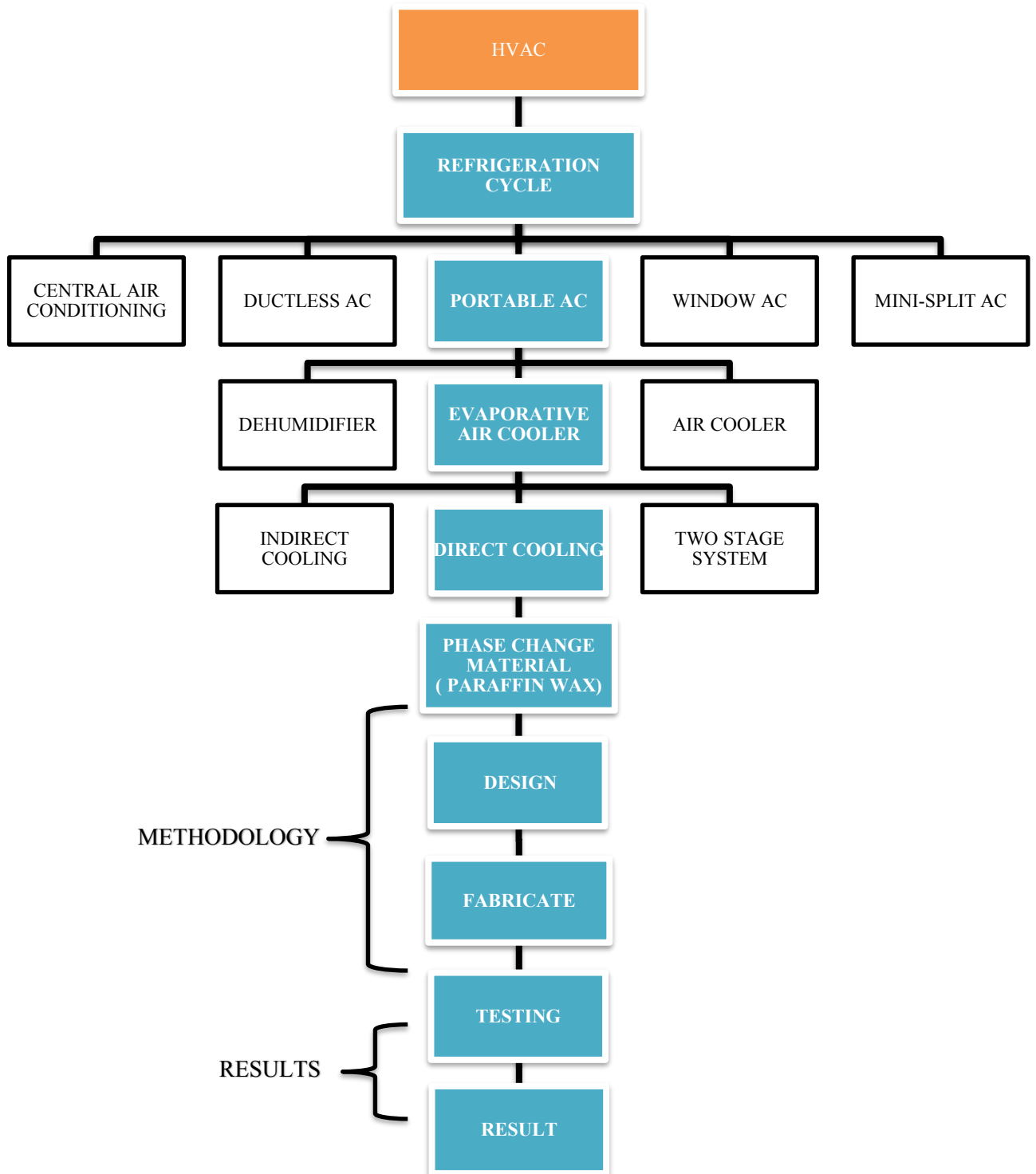


Figure 2.1 : K-Chart