PREVENTIVE MONITORING OF CAR AIR CONDITIONING SYSTEM UNDER SCHEDULED MAINTENANCE

MUHAMAD HAZIQ BIN KHAIRUL ANUAR

B091910338

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY WITH HONOURS

2023

Faculty of Mechanical and Manufacturing Engineering Technology

PREVENTIVE MONITORING OF CAR AIR CONDITIONING SYSTEM UNDER SCHEDULED MAINTENANCE

Muhamad Haziq Bin Khairul Anuar

Bachelor of Mechanical Engineering Technology with Honours

2023

PREVENTIVE MONITORING OF CAR AIR CONDITIONING SYSTEM UNDER SCHEDULED MAINTENANCE

MUHAMAD HAZIQ BIN KHAIRUL ANUAR

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical and Manufacturing Engineering Technology with Honours

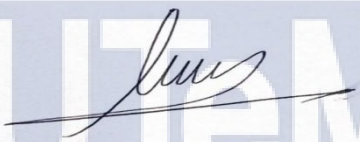
Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled “Preventive Monitoring Of Car Air Conditioning System Under Scheduled Maintenance” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

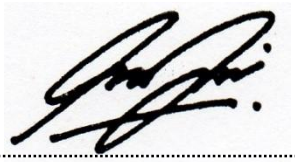
Signature : 

Name : MUHAMAD HAZIQ BIN KHAIRUL ANUAR

Date : 11/1/2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology with Honours.

Signature : 

Supervisor Name : PROFESOR MADYA TS. DR. MUHAMMAD ZAHIR BIN HASSAN

Date : 11/1/2023

DEDICATION

To my beloved parents, my supervisor, lecturer and my cherished friends.

ABSTRACT

The automotive air-conditioning system has long been a major source of concern in terms of maintaining air quality and providing comfort to passengers. To solve the problem, a variety of equipment has been developed, including experimental investigations. The goal of this project is to evaluate the performance of the automobile air conditioning system before and after 10,000 kilometers of maintenance using the design of experiments (DOE) method in the static instability of a car that leads to its performance. A present methodology is introduced whereby a thermometer is carried out to monitor the temperature of the air conditioner in the AC system of Perodua Myvi. In the meantime, the oil compressor analysis is studied to check the wear debris and viscosity on the oil compressor. The temperature inside the car's cabin area, as well as the oil analysis, are derived from the experimental setup. The varied surrounding temperatures have an effect on the functioning of the automotive air conditioning system, the study of the ambient inside temperature is examined in order to anticipate the proper pressure inside the system. An experimental investigation using a thermometer is also carried out to measure the panel register airflow temperature and cabin ambient temperature, which leads to a validation of the results. Measurements for the present experimental investigation were set for a period of 15 minutes. Parametric settings on the changing the receiver drier and cleaning the blower and air filter are included in servicing car AC. The data shows that the overall performance of the air conditioner system is decreasing by 14.88% after 10,000 kilometers. After that, the oil analysis of the experimental investigation is being investigated by using the viscometer and rotating disc spectrometer to validate the results of viscosity and wear debris in oil compressor analysis before and after 10,000 kilometers. The viscosity and viscosity index is taken at 40°C and 100°C. The result of the viscosity shows that its performance decreased by as much as 1.17% from 0 kilometer to 10,000 kilometers of oil compressor sample. Meanwhile, the wear debris of an oil compressor was divided into 4 chemical elements such as Aluminium, Copper, Iron and Silicon. The result of the wear debris in 0 kilometers oil sample undetectable for Aluminium, Iron and Silicon. After 10,000 kilometers the wear debris of silicon has the highest average point of 1.092. The outcome of this experiment is that after a 10,000 kilometers interval, service maintenance is unnecessary.

ABSTRAK

Sistem penyaman udara automotif telah lama menjadi punca kebimbangan utama dari segi mengekalkan kualiti udara dan memberikan keselesaan kepada penumpang. Untuk menyelesaikan masalah, pelbagai peralatan telah dibangunkan, termasuk penyiasatan eksperimen. Matlamat projek ini adalah untuk menilai prestasi sistem penghawa dingin kereta sebelum dan selepas 10,000 kilometer penyelenggaraan menggunakan kaedah reka bentuk eksperimen (JAS) dalam ketidakstabilan statik kereta yang membawa kepada prestasinya. Metodologi terkini diperkenalkan di mana termometer dijalankan untuk memantau suhu penghawa dingin dalam sistem AC Perodua Myvi. Sementara itu, analisis pemampat minyak dikaji untuk memeriksa serpihan haus dan kelikatan pada pemampat minyak. Suhu di dalam kawasan kabin kereta, serta analisis minyak, diperoleh daripada persediaan eksperimen. Suhu sekeliling yang berbeza-beza mempunyai kesan ke atas fungsi sistem penghawa dingin automotif, kajian suhu dalam ambien diperiksa untuk menjangka tekanan yang betul di dalam sistem. Penyiasatan eksperimen menggunakan termometer juga dijalankan untuk mengukur suhu aliran udara daftar panel dan suhu ambien kabin, yang membawa kepada pengesahan keputusan. Pengukuran untuk penyiasatan eksperimen ini telah ditetapkan untuk tempoh 15 minit. Tetapan parametrik pada penukaran pengering penerima dan pembersihan blower dan penapis udara disertakan dalam menservis AC kereta. Data menunjukkan bahawa prestasi keseluruhan sistem penghawa dingin menurun sebanyak 14.88% selepas 10,000 kilometer. Selepas itu, analisis minyak penyiasatan eksperimen sedang disiasat dengan menggunakan viskometer dan spektrometer cakera berputar untuk mengesahkan keputusan kelikatan dan kehausan serpihan dalam analisis pemampat minyak sebelum dan selepas 10,000 kilometer. Hasil daripada indeks kelikatan dan kelikatan diambil pada 40°C dan 100°C. Hasil daripada kelikatan menunjukkan prestasinya menurun sebanyak 1.17% daripada 0 kilometer kepada 10,000 kilometer sampel pemampat minyak. Sementara itu, sisa haus pemampat minyak telah diselami ke dalam 4 unsur kimia seperti Aluminium, Kuprum, Besi dan Silikon. Hasil serpihan haus dalam sampel minyak 0 kilometer tidak dapat dikesan untuk Aluminium, Besi dan Silikon. Selepas 10,000 kilometer, serpihan haus silikon mempunyai titik purata tertinggi iaitu 1.092. Hasil daripada eksperimen ini ialah selepas selang 10,000 kilometer, penyelenggaraan perkhidmatan tidak diperlukan.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the following individuals who never ceased helping me throughout the whole process of completing my final year project report.

First and foremost, the completion of this report would not have been possible without the unwavering guidance of my supervisor, Professor Ts. Dr. Muhammad Zahir Hassan. He has been such a great mentor who has given me an endless amount of encouragement, support, and positive insights in finishing this report.

My beloved family, I would like to show my appreciation to them for the unwavering moral, emotional, and financial support that they have given consistently throughout my entire time spent managing to complete this thesis.

Lastly, I would like to thank my fellow friends and classmates who were there for me and also for having the willingness to lend a helping hand in completing this project when I required certain assistance.

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

FIGURE **TITLE** **PAGE**

LIST OF SYMBOLS AND ABBREVIATIONS

AC	-	Air Conditioning
AAC	-	Automotive Air Conditioner
FOV	-	Fixed Orifice Valve
TXV	-	Thermostatic Expansion Valve
DOE	-	Design Of Experiment
CFC	-	Chlorofluorocarbon
HFC	-	Hydrofluorocarbons
ODS	-	Ozone Depleting Substances
COP	-	Coefficient Of Performance
mm	-	Millimeter
kg	-	Kilogram
PAG	-	Polyalkylene Glycol
cSt	-	Kinematic Viscosity
°C	-	Degree Celcius

LIST OF APPENDICES

APPENDIX	TITLE	PAGE

CHAPTER 1

INTRODUCTION

1.1 Background

Cars now have an advanced technology in their air conditioning or AC systems to provide a comfortable driving experience. Automotive air conditioning systems work under varying loads to keep passengers comfortable in a variety of weather conditions (Stevanovic *et al.*, 2013). Passengers' perceptions of comfort are influenced by the temperature and humidity in the cabin. The driver's comfort in the cabin is also a factor in driving safety (Zhenying *et al.*, 2018). Based on the **Figure 1.0** The compressor, condenser, evaporator, receiver drier, and expansion valve are the five essential components of an automobile air conditioning system. Each of these elements serves a specific purpose. All of the components of the air conditioning system are connected by rigid tubing and flexible hoses (Ariazone, 2017).

The AC compressor is one of the most important components in the system's essential cycle. The entire AC system will be unable to perform its primary job of providing cold air inside the car if it is not installed. Refrigeration vapour compression systems, like vehicle air conditioning, use lubricant to reduce mechanical losses and extend compressor life. Despite this, only a little amount of lubricant is detected in the compressor, with the most of it being combined with refrigerant (Liu and Hrnjak, 2016). It also can bring damaged to

the whole system of the air conditioner and lower the efficiency of the air conditioner system inside the cabin area.

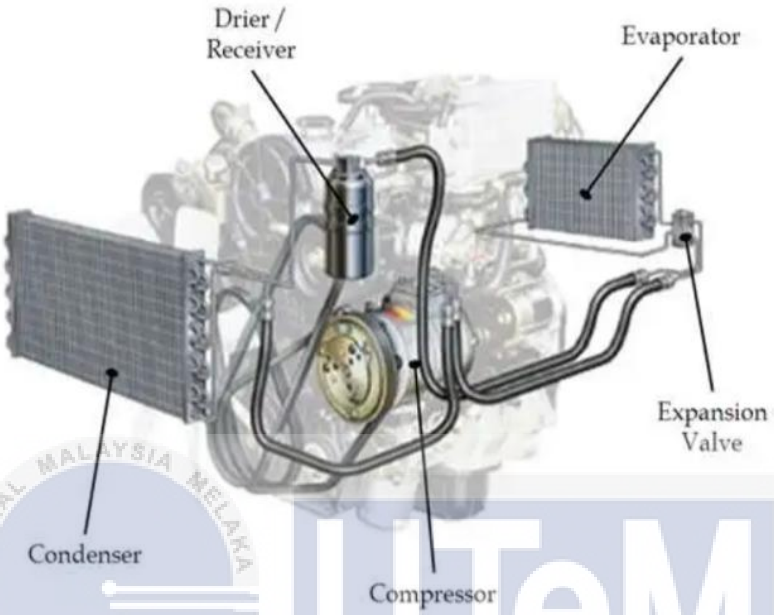


Figure 1.0 : Components of car air conditioner system (Ariazone, 2017)

Furthermore, In today's vehicle industry, there are two basic types of air conditioning systems Fixed Orifice Valve (FOV) and Thermostatic Expansion Valve (TXV). In most cases, only one of these metering devices will be used in a modest air conditioning system (Daly, 2011).

The air conditioning system in an automobile functions similarly to a standard air conditioning system. The refrigerant in an air-conditioning system absorbs heat from the passenger compartment and pumps it to the condenser, where it releases the heat to the outside air before returning to the system to absorb more heat. The air in the cabin is normally cooled by using the engine's power to directly operate the AC compressor.

Because the compressor is a belt-driven unit connected to the engine crank shaft, its cycle rate is perfectly proportional to vehicle speed (Libin, 2022).

Hence, having the car maintained is the greatest way to ensure that it is in good functioning order. If the car is not serviced, it is likely to have numerous problems. Same goes to car air conditioning system, if the car air conditioner is not cleaned on a regular basis, the dirt from air conditioning and numerous types of bacteria buried inside will continue to circulate into the car's air. As a result, maintaining automotive air conditioning is a strict requirement.(Xiaotao, 2022). MAHLE (2021) advises, an air conditioning inspection is for every 12 months and an air conditioning service every two years for automotive air conditioning systems.

1.2 Problem Statement

The automobile air conditioner system playing important role for the vehicle, but only the most important parts of the vehicle, such as the oil filter and engine oil are being serviced during scheduled maintenance. The car's air conditioning system, on the other hand, is not being examined properly.

Damage to the car's air conditioning system can be expansive, particularly if the pump compressor is destroyed. Damage to the compressor pump will cause all of the air conditioning systems not in good working order, resulting the temperature rise in the cabin area. In the air conditioning system, the oil compressor is also crucial. When the compressor oil is not changed for an extended period of time, the entire air conditioning system will need to be replaced. As a result, very substantial costs will be incurred.

1.3 Aim and Objective

The main aim of this research is to evaluate the performance of car air conditioner system under scheduled maintenance and to analyse the oil compressor after a certain kilometre.

The objectives of the present work are as follows:

(a) To develop design of experiment (DOE) to monitor the air conditioner performance subjected to scheduled maintenance for period of 10 000 kilometers.

(b) To collect and monitor cabin ambient temperature subjected to before and after servicing.

(c) To conduct oil analysis of AC compressor subjected to service interval.

(d) To conduct post service interval of car air conditioning system that include ambient temperature, oil compressor and gas air filter.

1.4 Scope of Research

The scope of this research are as follows:

(a) The research is performed by using the same type of car which is Perodua MYVI S.E 1.5L (2015) to monitor the performance of air conditioning system before and after scheduled maintenance.

(b) The experiment is to explore the effect of temperature, ambient temperature and oil compressor analysis before and after 10,000 kilometers.

(c) To investigate the oil compressor effect after a certain kilometre by checking the fluid properties and wear debris of the oil compressor.

1.5 Organisation of Thesis

The remainder of this thesis is comprised of five further chapter as summarised below:

Chapter 2: A review of literature relevant to the present study on the car air conditioner system.

Chapter 3: A review of the experimental setup and the experiment result for the car air conditioner system.

Chapter 4: Result of the study between before and after 10 000 kilometers of the car air conditioner system.

Chapter 5: The conclusion of overall research and recommendation of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The subject of automotive air conditioning system performance during scheduled maintenance has spawned a large body of literature, which includes various ideas attempting to explain how car air conditioning systems work. Studies on the system's performance are divided into two categories: scheduled maintenance after 10,000 kilometre and maintenance before 10,000 kilometre.

This section begins with an overview of the vehicle air conditioning system, including the components and functions of the air conditioning system. The various types of vehicle air conditioning performance are organised by the frequency with which they occur. After that, a study of the literature on automotive air conditioning systems is presented, which describes how car air conditioning performs during scheduled maintenance. To achieve and analyse automotive air conditioning challenges, the scientific discoveries are divided into simulation and experimental methodologies. The next section goes through some of the experimental research that has been done to solve automotive air conditioning issues. Finally, a study review paper on automobile air conditioning under maintenance schedule for 10,000 kilometres is offered, along with an overview of known methodologies and their limitations for resolving car air conditioning concerns. The chapter's structure is demonstrated in **Figure 2.1**.

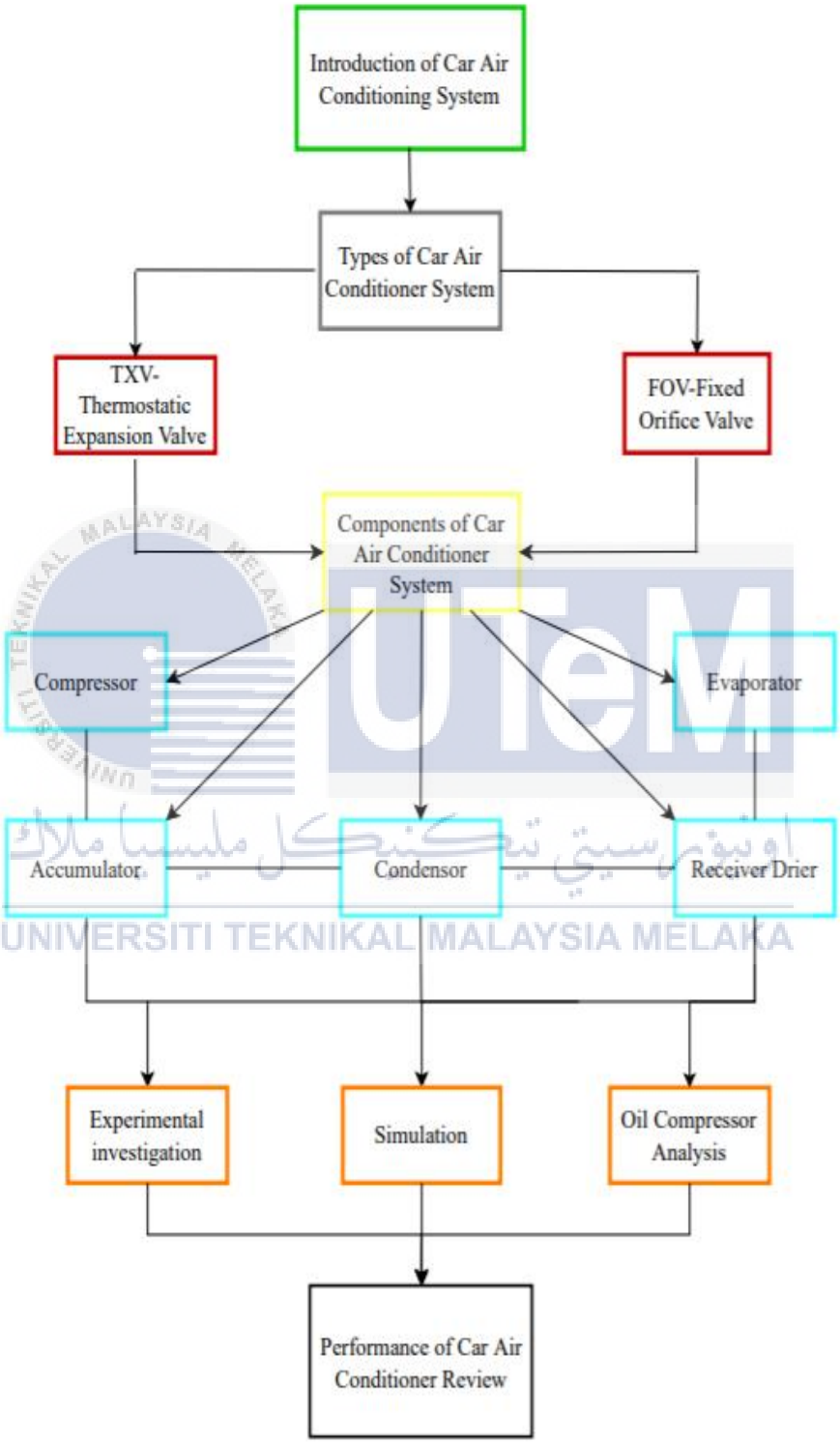


Figure 2.1 : Overview of Literature Review.