UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL STUDY OF THE AIR CONDITIONING DUCTING OF THE BUS FOR OPTIMUM COOLING PERFORMANCE

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

By

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I hereby, declare that this report entitled "Experimental study of the air conditioning ducting of the bus for optimum cooling performance" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	: .....
Author's Name	: MUHAMMAD FAHMI BIN NORDIN
Date	: 17 JANUARY 2020

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology Automotive (Hons.). The member of the supervisory is as follow:

Signature	: .....
Supervisor's Name	: IR MAZLAN BIN AHMAD MANSOR
Date	: 17 JANUARY 2020

ABSTRACT

Air flow dissemination is one of the significant elements that will impact the transport traveler comfort during long distance travel. The main purpose of the study is to investigate the air flow performance of the ducting through experimental and simulation by using Acusolve software in CFD simulation. 3D CAD model are design by using Catia software before run simulation into CFD software namely Altair Acusolve, to determine the airflow rate for every outlets of the air-conditioning system. The simulated result was then validated with experimental data obtained from the collecting data at the real bus. Collaboration with bus builder company are helping to get the experimental actual result.

ABSTRAK

Penyebaran aliran udara adalah salah satu unsur penting yang akan memberi kesan kepada keselesaan penumpang pengangkutan semasa perjalanan jarak jauh. Tujuan utama kajian ini adalah untuk mengkaji prestasi aliran udara salur melalui eksperimen dan simulasi dengan menggunakan perisian Acusolve dalam simulasi CFD. Model 3D CAD direka bentuk dengan menggunakan perisian Catia sebelum menjalankan simulasi ke dalam perisian CFD iaitu Altair Acusolve, untuk menentukn kadar aliran udara untuk setiap cawangan sistem penghawa dingin. Hasil simulasi kemudian disahkan dengan data eksperimen yang diperoleh dari data pengumpulan pada bas sebenar. Kerjasama dengan syarikat pembuat bas amat membantu untuk mendapatkan keputusan sebenar dalam eksperimen ini.

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DEDICATION

Dedicated to my father, Nordin bin Ahmad and my mother, Zainab binti Husin. To my supervisor, Ir. Mazlan bin Ahmad Mansor, lecturers and friends for all of their help and friendship.

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Thanks to my family, who has been the loveliest advisor to give constant support and inspiration through my campus life. Their supports are meant so much to me in finishing this project. Last but not least, I thank everyone who involved directly and indirectly in this project. Without them, this PSM report cannot be completed.

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LIST OF ABBREVIATION

HVAC	Heating, ventilation, air conditioning
CFD	Computational fluid dynamic
AAC	Automotive air conditioning
VCR	Vapor compression cycle
IAQ	Indoor air quality
CAD	Computational aided design
CATIA	Computer aided three-dimensional interactive application
3D	Three dimension.
PCSB	Pioneer Coachbuilder Sdn Bhd.

CHAPTER 1

INTRODUCTION

This chapter will present the problem statement and objective of this project. The problem statement and objective will be representing in this chapter by research background, problem statement, research objectives, scope. of the research, and significant of the research.

1.1 Research Background

Air conditioning is design to give thermal comfort to the human. This comfort is transfer from the circulated system to the interior or indoor space. Automotive air-conditioning (AAC) for thermal comfort in passenger cabins is now a thing of necessity rather than luxury and cooling is especially needed when travelling in summer or throughout the year in countries of hot and humid climate (Tan, Tee, Law, & Lim, 2015) The ventilation is design based on the size of the interior compartment of the vehicle. Application of automotive air-conditioning in the field of passenger transportation was necessary in order to ensure the comfort of passenger and driver while travelling long distance. Thus, control of airflow rate and temperature distribution of automotive air-conditioning system is essential to ensure optimal humidity and comfort inside a long-haul passenger bus.

This experimental study is focus on the air delivery system of the express bus that build by the Malaysian local bus manufacturer Pioneer Coachbuilder Sdn.Bhd to achieve the optimum solution or comfort to the passenger. The express bus is facing the issue of uneven airflow rate when the air is delivered from the air-conditioning system**.** Therefore, a Computational fluid dynamics (CFD) study is necessary in order to investigate the air flow pattern and air flow distribution of the express bus air conditioning ducting, which will help to identify the locations where air distribution is inadequate.

1.2 Problem Statements

The team of Universiti Teknikal Malaysia Melaka is collaborating with one of Malaysia local coach manufacturer, Pioneer Coachbuilder. Sdn. Bhd to make experimental study about the performance of the air conditioning ducting of their product. As we know, air conditioning ducting is the most important system in every vehicle and transportation.

So, the main reasons of this experimental study are to prove and make experimental study to analyse the performance of the air conditioning ducting such as their air flow rate and the time taken from initial condition to reach the optimum level of comfort in the cabin.

1.3 Research objective

The objectives of this report:

i. Expose simulation by using CFD, to stimulate air flow rate in the passenger compartment. Which can help to identify the location where air distribution is inadequate

ii. To compare the simulation result with the experimental result in terms of the velocity of the internal volume of the ducting.

iii. To estimate time taken for the air conditioning to achieve optimum condition

1.4 Scope of the research

The scopes of this report are:

i. Focus only in the automotive HVAC system.

ii. Analysis from the simulation of the air flow rate through the air delivery system of the bus

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

On this chapter is about research from journal, reference book and articles that associated to this experimental study. The journals taken have been referred wisely because there are some knowledge and information from the papers that can be use until end this study. The literature review is a process that will be on going to complete this project.

2.2 Pioneer Coachbuilder

Pioneer Coachbuilder Sdn Bhd is one of the companies that build a bus in Malaysia. PCSB was listed on 6 December 2001 to fabricate and assemble the bodies of the bus and other superior purpose vehicle. The HQ of this company is located at Jalan Telok Gong, Pelabuhan Klang, Selangor as shown in figure 2.1 While their branch is near with the HQ at Jalan Mata Duyung, Pelabuhan Klang. Selangor**.**

Figure 2:1**:** HQ of the Pioneer Coachbuilder

The main of this company are only manufacture, assemble and fabricate the body and the interior of the bus, but the engine is still supplying by the other huge company such as Scania, Hino, Volvo, Hyundai, Isuzu, and Tc truck. It is because in Malaysia there is still no expert engineer or company that can build the engine especially engine for the bus. Most of their clients are from the government, such as from KKM, KPM, KDN, and also PDRM. They provide transportation especially bus for all of this government sector as shown in the figure 2.2 below.

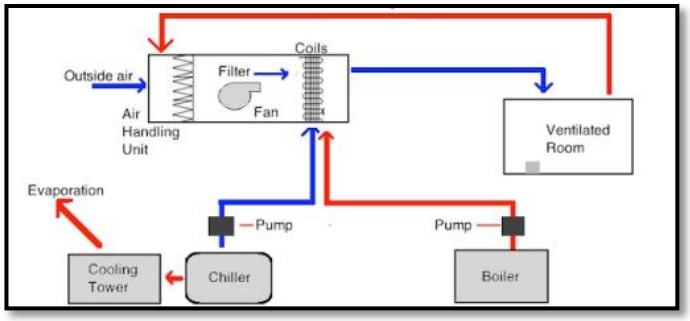
KDN	KKM

KPM	PDRM

Figure 2.2: The major Client of the Pioneer Coachbuilder

2.3 Definition of HVAC

Heating, Ventilation and Air Conditioning is the short terms of HVAC. It is the mechanical system that provide heat and cooling indoor space either for building or transportation. HVAC system is the technology that control the ambient environment such as temperature, humidity, air flow, and air filtering. They are the systems that keep human warm and comfy in the winter and feeling cool and fresh in the summer. They also are the systems that filter and clean indoor air to keep human healthy and maintain humidity levels at optimal comfort levels. HVAC usually used in residential or in transportation. This experimental study is focus on HVAC system for transportation which is in Automotive HVAC. Below are the different between HVAC



circulating system in residential and transportation.

Figure 2:2:Basic of HVAC system for residential building unit (www.google.com)

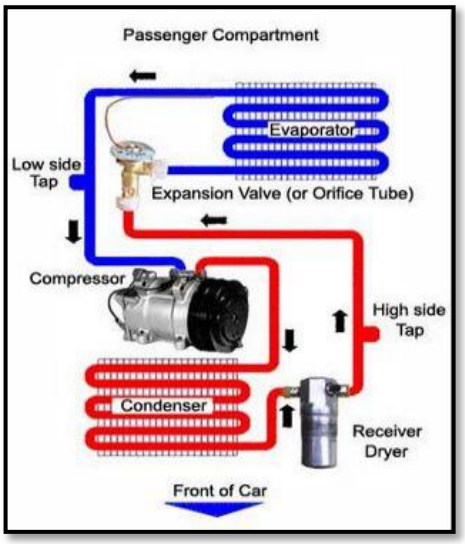


Figure 2:3: Basic of HVAC system for Automotive (www.google.com)

There are minor different between this two especially in their component. based on the figure 2.3 above shows that. automotive does not use boiler, it is because engine already give heat and it became the heater for the system.

2.4 Component of Automotive HVAC system.

Some mechanical components are compulsory in a refrigerant scheme involving 4 main components. The 4 major components of a refrigerant system is:

i. Compressor
ii. Condenser
iii. Evaporator
iv. Expansion valve.

In the selection of any refrigerant system components, there are numerous factors that need to be carefully considered, such as:

i. Compressor design
ii. Selection of refrigerant
iii. Selection of cooling medium
iv. Type of condenser
v. System efficiency and maintainability
vi. System type

2.4.1 Vapor-compression cycle.

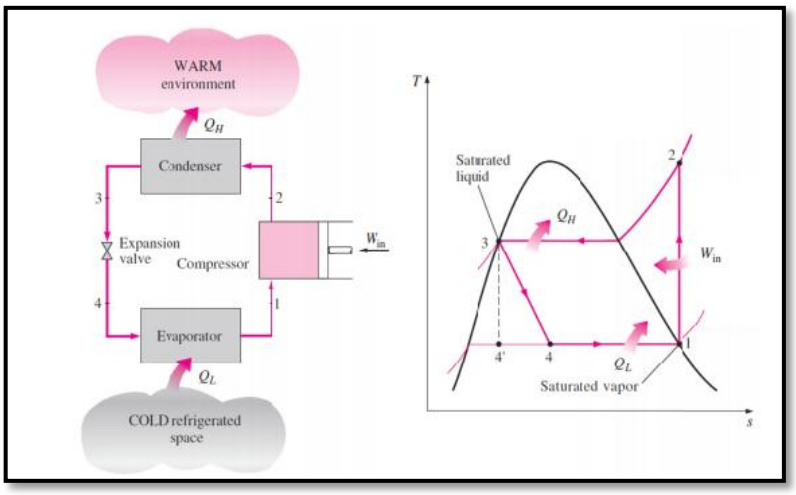


Figure 2:4: Schematic of a basic VCR cycle(Bagheri, 2016)

Air conditioning systems basically operate on a vapor compression cooling cycle with 4 major components which is compressor, condenser, evaporator and expansion valve. A basic VCR cycle schematic is shown in the figure 2.5. The compressor is the most energy-consuming component in this type of cooling cycle, sucking the refrigerant from the evaporator and compressing it. Compressor pumps high pressure and high temperature gas into the condenser after it has been