

**PERFORMANCE INVESTIGATION OF VEHICLE AIR CONDITIONING SYSTEM UNDER
DIFFERENT AMBIENT CONDITION**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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SYSTEM UNDER DIFFERENT AMBIENT CONDITION**

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**A report submitted
In fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled “Performance Investigation of Vehicle Air Conditioning System Under Different Ambient Condition” is the result of my own work except as cited in the references.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature :

Supervisor's Name :

Date :

DEDICATION

To my beloved father and mother.

ABSTRACT

This study investigate the performance of vehicle air conditioning system under different ambient condition. An ambient temperature play an important role in affecting the performance of vehicle air conditioning system. This is because the impact of the global warming that is happening today due to increased of fuel consumption will cause increased an ambient temperature, even affecting the vehicle's air conditioning system. The objective of this study is to determine the best coefficient of performance of air conditioning systems between three different ambient temperatures which are 28°C, 33°C and 38°C by taking into account several parameters such as system temperature, system pressure, cooling capacity and compressor work. The compressor speed and blower inlet air temperature are kept constant where at 1500 rpm and 30°C respectively. The experiment was conducted by using a test rig that consist of actual componenet used in Proton Wira passenger car. During the experimental works, the test rig should be stabilized of around 10 minutes before the data is taken for another 10 minutes with time interval of 20 seconds. The recorded data are temperature and mass flow rate. The results showed that an ambient temperature at 33°C produced higher COP at 4.97.

ABSTRAK

Kajian ini menyiasat prestasi sistem penyaman udara kenderaan di bawah keadaan ambien yang berbeza. Suhu ambient memainkan peranan penting dalam memberikan kesan terhadap prestasi sistem penyaman udara kenderaan. Hal yang demikian kerana kesan pemanasan global yang berlaku pada masa kini disebabkan oleh peningkatan penggunaan bahan bakar akan menyebabkan berlakunya peningkatan suhu ambien, malah mempengaruhi sistem penyaman udara kenderaan. Objektif kajian ini adalah untuk menentukan pekali prestasi terbaik sistem penyaman udara antara tiga suhu ambien yang berbeza iaitu 28°C, 33°C dan 38°C dengan mengambil kira beberapa parameter seperti suhu sistem, tekanan sistem, kapasiti penyejukan dan kerja pemampat. Kelajuan pemampat dan suhu udara masuk blower tetap di mana masing-masing 1500 rpm dan 30°C. Eksperimen dijalankan dengan menggunakan rig ujian yang terdiri daripada komponen sebenar yang digunakan di dalam kenderaan penumpang Proton Wira. Semasa eksperimen dijalankan, rig ujian perlulah distabilkan sekitar 10 minit sebelum data diambil untuk 10 minit lagi dengan selang waktu 20 saat. Data yang direkodkan adalah suhu dan kadar aliran jisim. Keputusan menunjukkan bahawa suhu ambien pada 33°C menghasilkan COP yang lebih tinggi pada 4.97.

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LIST OF ABBREVIATION

VCRC	Vapor Compression Refrigeration Cycle
COP	Coefficient of Performance
CO ₂	Carbon Dioxide

LIST OF SYMBOL

Q_c	Condenser Heat Rejection (kJ/s)
Q_e	Cooling Capacity (kJ/s)
W_c	Compressor Work (kJ/s)
Q_a	Heat Absorb by Air (kJ/s)
\dot{m}	Refrigerant Mass Flow Rate (kg/s)
T	Temperature ($^{\circ}\text{C}$)
N	Compressor Speed (rpm)

CHAPTER 1

INTRODUCTION

1.1 Background

Air conditioning system in a car is needed especially in Malaysia as the weather in this country is hot and always humid. Many factors can affect the thermal comfort inside a cabin compartment of a typical land vehicle. One of the factors is ambient condition.

Ambient condition is a state where it involves the humidity at surrounding, air movement and temperature. It affects the efficiency of the air conditioning system due to the fact that heat load of the air conditioning system significantly depends on the surrounding condition. Apart from that, vehicular thermal comfort is vital as a result of driver and passenger should feel comfortable when in the vehicle and can improve health and safety during driving. There are several factors affecting the thermal comfort such as air temperature, air speed and humidity.

The air conditioning system in the vehicle needs to work stronger due to the increased of an ambient conditions to provide the ideal temperature in the cabin compartment. The inclusion of heat and its transfer rate into the vehicle system depends on the ambient temperature difference where if the ambient temperature is lower then it causes more cooling to be done by the heat exchanger while high ambient temperatures causes reducing of compressor efficiency. This indicates that ambient condition can affects the performance of the air conditioning system in the vehicle.

1.2 Problem Statement

One of the energy used to produce internal combustion engine is the fossil fuel. As a result of elevated fuel consumption, it causes pollution to air and global warming. Global warming takes place when the ozone layer serves to absorb most sun's ultraviolet radiation and block the damaging ultraviolet achieving the surface of the earth that will reduce the ozone layer. This ozone layer is placed above the atmosphere that is a blanket of gases that covers the planet Earth and is maintained by means of its gravity. The gas that accountable for the global warming is the carbon dioxide which carbon dioxide can be discovered in the vehicle air conditioning system.

As a way to reduce this pollution problem, an ambient temperature cannot be control but the vehicle can be operate at specified ambient temperature where at that condition the efficiency is the best. If the consumer know the best operating time of the air conditioning system, the journey or travel activity can be planned during its best operating time. This ambient temperature plays an important role in reducing global warming and provide thermal comfort for drivers and passengers in the vehicle. Besides that, ambient temperature is differ based on the condition of place and relates with the condenser where higher ambient temperature cause the higher condensing temperature and contributes to the higher consumption. So, this experiment is conduct to ensure which condition of the ambient temperature is the excellent in reducing pollution, operates in efficient way and the most important is to maximize the coefficient of performance for the vehicle air conditioning system.

1.3 Objectives

The objectives of this study are:

- a) To determine the system temperature, system pressure, cooling capacity and compressor work at different ambient condition.
- b) To justify the best coefficient of performance of the air conditioning system.

1.4 Scope of Project

In this study, there are three scope of projects that should be considered and one of it is the method use for this project. The experiment method for this study is a procedure that have been carried out to collect the data and doing the analysis to get the required result based on different ambient condition. Besides that, experiment is the handy way to learn more due to the fact it take a look at the understanding about the ongoing experiment and it's primarily based on the hands-on things to do to gain result or progress of the project.

Second is the variables covered that includes the variables fixed, manipulated variables and control variables. In this vehicle air conditioning system, the main variable that need to be manipulate is the ambient temperature as it as it will test the overall performance of air conditioner when the compressor is driven using engine power in the car. Variables fixed is something that want to remain constant or not change during the experiment which can be describe as the operation of air conditioning system in a car using internal combustion engine. The control variables is the variables that should be calculate in this experiment which encompasses within the objectives to be achieved. From the manipulate variables, the changes can be observed and easy to figure out the conclusion that will give result about the performance of air conditioner.

Lastly, the validity result. This result will show among the different condition, which one is the best to obtain the best coefficient of performance of the air conditioning system whether in morning, afternoon, evening and night. When the results are obtained, awareness of the amount of energy released by the air conditioner can be portrayed at different times. It is to ensure that the energy produces enough to accommodate the car users with a certain amount without wasting energy.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This literature review is organized into several sections. The first section briefly reviews the air conditioning system and actual VCRC system as a basic principle of a typical air conditioning system. Second is the main components included in the air conditioning system. Then, the working principles followed by the thermodynamic analysis. Next, the effect of an ambient condition to the efficiency of vehicle air conditioning system and finally, the summary of chapter 2.

2.1.1 Impact of using the Vehicle Air Conditioning System to the Environment

Air conditioners in the vehicle illustrate many implications to the environment where the air conditioners emit high amounts of energy and can cause additions to climate change. Vehicles burn more fuel and produce more greenhouse gases where greenhouse gases is the gas that absorbs infrared radiation emitted from the earth surface and re-emitted in all directions by atmosphere that cause warm to the earth surface and lower the atmosphere (Russell and John, 2006).

The fuel produced by the car is also routed to the environment without any filtering that gives poor air quality which will cause in increasing the respiratory ailments like asthma and can increase the risk to get cancer. When the usage of fuel is lower, the impact for the environment can be reduce by control the use of air conditioners by not wasting the excess energy provided to passengers when generating the air conditioning system.

2.1.2 Basic Air Conditioning System

Air conditioning in the vehicle is an accessory that can provide comfort to passengers. The air conditioner can not only cool the temperature in the vehicle but also be able to treat ventilation for temperature and humidity. There are two basic types of air conditioners system used in the vehicle. The only difference is the type of device that can reduce the refrigerant pressure but the way and the concept it works together is the same with each other (Mike and John, 2000).

The first type of system is to use the expansion valve system. Expansion valve system used to control the pressure and temperature levels in the air conditioner to determine the amount of refrigerant that enters the evaporator.

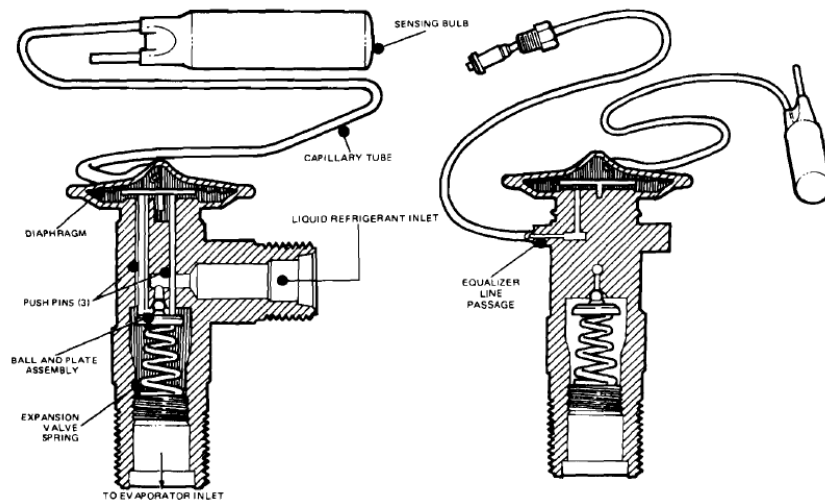


Figure 2.1: Expansion Valve (Mike and John, 2002).

The second type of the system is to use the fixed orifice tube system. The fixed orifice tube function is similar to the expansion valve which is to control the amount of refrigerant that goes into the evaporator but it has a fixed size and cannot change the rate of refrigerant inclusion into the evaporator as can be made by expansion valve where expansion valve can adjust the rate of refrigerant enter to the evaporator because if too much refrigerant enters the evaporator, the evaporator will be too cold and there may be freezing.

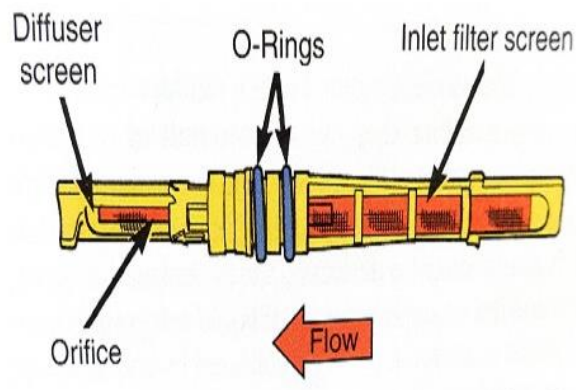


Figure 2.2: Orifice Tube (Mark, 2018).

2.2 Main Components of Air Conditioning System

Air conditioning systems have five of the main components that work with each other to provide thermal comfort to the occupant. The components are:

2.2.1 Compressor

Compressor is the most important component and located beside the engine of the vehicle (Khiril, 2015). Compressor also known as the heart of the air conditioning system as it works to compress the refrigerant gases. In addition, the compressor also controls temperature production and moves the hot temperature to the condenser.

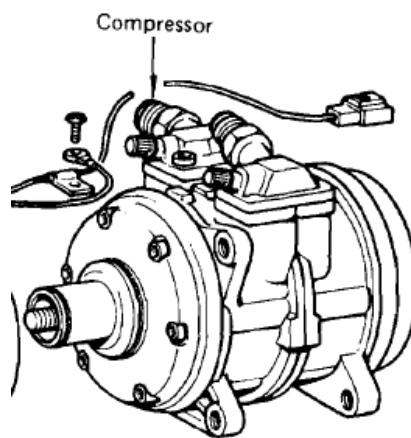


Figure 2.3: Compressor (Mike and John, 2000).

2.2.2 Condenser

Typically, the condenser is located at front of the vehicle radiator and is known as a mini radiator. Condenser works to convert hot gas to cold. When the hot gas comes out of the compressor and enters the condenser, the condenser will turn into a liquid and move to the air conditioner dryer or accumulator (Khiril, 2015).

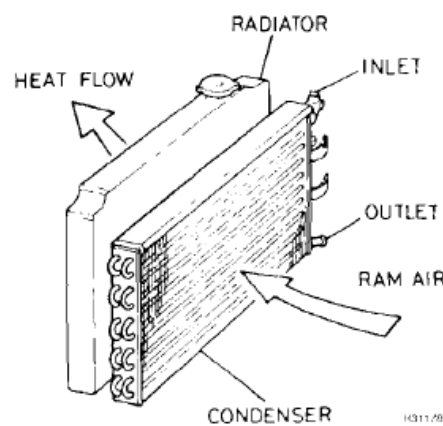


Figure 2.4: Condenser (Mike and John, 2000).

2.2.3 Dryer or accumulator

Dryer or accumulator depending on the type of vehicle used. These components located in the engine compartment (Mike and John, 2000). Dryers are available in vehicles using the expansion valve while the accumulator is in the vehicle using the orifice tube. The function for this dryer is similar to the accumulator function which both filters the dust, remove the moisture and liquid from entering the air conditioner system as when the liquid enters the compressor designed only to handle gas and non-liquid, the compressor will be damaged.