PERFORMANCE INVESTIGATION OF VEHICLE AIR CONDITIONING SYSTEM UNDER DIFFERENT HEAT LOAD

NURUL NABILA BINTI JAMALUDDIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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NURUL NABILA BINTI JAMALUDDIN

A report submitted

in fulfilment of the requirements 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 Heat Load” 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 : DR. MOHAMAD FIRDAUS BIN SUKRI

Date : ……

To my beloved father and mother

ABSTRACT

This study deals with the performance investigation of vehicle air conditioning system under different heat load. The effect of different heat load on system temperature, system pressure, compressor work, cooling capacity and coefficient of performance was investigated. The heat load is simulated using electrical bulbs with the power range between 300 to 900 watt. In addition, R134a was used as refrigerant. The heat greatly affect the performance of air conditioning system. Meanwhile, the speed of compressor, speed of blower fan and ambient temperature is fixed. Measurements were taken during the 10 minutes experimental period for evaporator inlet temperature of air which 30℃. The data has been analysed in statistically and graphically by using Refprop. It seems that the result has risen up and fall regularly almost every parameter in this experiment which is not corresponding with the previous research due to some error. The result shows that the performance of the vehicle air conditioning system increase about 9.86% in 34℃ to 37℃ when the evaporator inlet temperature of air increased (heat load increase). Therefore, the best coefficient of performance of vehicle air conditioning system with different heat load is 4.57 at 37℃.

ABSTRAK

Kajian ini berkaitan dengan penyiasatan prestasi sistem penghawa dingin kenderaan di bawah beban haba yang berbeza. Kesan beban haba yang berlainan pada suhu sistem, tekanan sistem, kerja pemampat, kapasiti penyejukan dan pekali prestasi disiasat. Beban haba disimulasikan menggunakan mentol elektrik dengan jarak kuasa antara 300 hingga 900 watt. Di samping itu, R134a digunakan sebagai penyejuk. Haba sangat mempengaruhi prestasi sistem penghawa dingin. Sementara itu, kelajuan pemampat, kelajuan kipas blower dan suhu ambien tetap. Pengukuran telah diambil dalam tempoh percubaan selama 10 minit untuk penyejatan suhu masuk udara yang 30 ℃. Data telah dianalisis secara statistik dan secara grafik dengan menggunakan Refprop. Nampaknya hasilnya telah meningkat dan jatuh secara kerap hampir setiap parameter dalam eksperimen ini yang tidak sepadan dengan penyelidikan terdahulu akibat beberapa kesilapan. Hasilnya menunjukkan bahawa prestasi sistem penghawa dingin kenderaan meningkat sekitar 9.86% dalam 34 ℃ hingga 37 ℃ apabila suhu penyejat masuk udara meningkat (kenaikan beban haba). Oleh itu, pekali prestasi terbaik sistem penyaman udara kenderaan dengan beban haba yang berlainan adalah 4.57 pada 37 ℃.

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HVAC	= Heating, ventilation and air conditioning
ASHRAE	= American Safety of Heating, Refrigerating and Air Conditioning Engineers
A/C	= Air Conditioning
AC	= Alternate Current
SOP	= Standard Operating Procedure
COP	= Coefficient of Performance

LIST OF SYMBOLS

Qe = cooling capacity of the evaporator (kJ)

Wc = power of the compressor (kJ)

h_1 = enthalpy on compressor (kJ/kg)

h_2 = enthalpy discharge of compressor (kJ/kg)

h_3 = enthalpy on condenser exit (kJ/kg)

h_4 = enthalpy on evaporator inlet (kJ/kg)

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Air conditioning is a part of the heating, ventilation, and air conditioning system (HVAC). Automobile air conditioning (A/C) is used to cool the air in the vehicle. In 1933, a company in New York City in the United State was the first offer of air conditioning in the cars. Then, the first air conditioning system in the world was developed by Packard Motor Car Company in 1939. Nowadays, automotive air conditioning system has competed for each other because the A/C was a very important role in human comfort and to some extent safety throughout vehicle driving in varied weather conditions. Therefore, it has become an important element for the vehicles of all categories worldwide. Based on American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), air conditioning system is used to create and maintain the temperature, humidity, motion, and cleanliness of the air. Besides that, air conditioning also controlled and provides a comfy atmosphere to the passengers and driver of a vehicle throughout summer and winter. In addition, the air conditioning also provides comfort to passengers that express satisfaction with the surrounding environment.

HVAC system known as heating, ventilation and air conditioning system is designed in an automobile to provide comfort to users. The air conditioning system transfers the heat inside the vehicle to the outside of the vehicle. There are four main components of the air

conditioning system that be shown in Figure 1.1 which are condenser, evaporator, expansion valve and compressor.

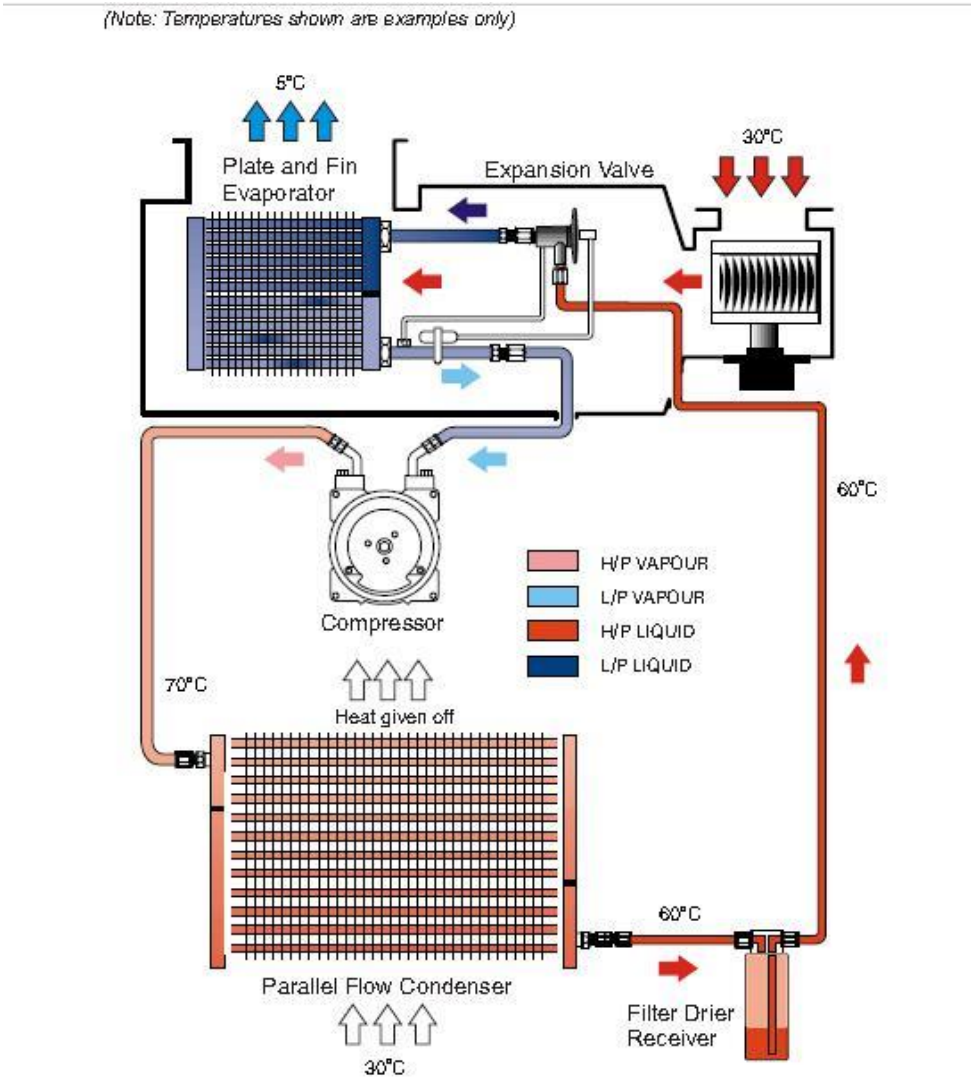

Figure 1.1: Four main components of the air conditioning system

Hence, the main of this project is to investigate the performance of vehicle air conditioning system with different heat load due to give thermal comfort for the passengers besides to reduce the fuel consumption of the vehicle.

1.2 PROBLEM STATEMENT

Due to extreme weather conditions in Asia, automotive air conditioning has played an important role in the automotive system by giving human comfort and to some extent of human safety during vehicle driving in various atmospheric conditions. It has become an essential part of the vehicles of all categories throughout the worldwide. The basic operation of the air conditioning system has resulted in the thinning of the ozone layer where the gas released by the air conditioning system such as Nitrous Oxide (NO) that can increase from time to time which are harmful to the environment. This probably due to the growing global flows and concerns that should be reinforced and secure.

There are several problems arise from the recent of air conditioning system. First of all, the problems that face by the passengers is do not feel comfortable in high temperature because of peak weather. In that time, the temperature inside the cabin of the car is high because of the heat from surrounding will enter the condenser and mixed with the heat that release by the passengers at the evaporator make the. So that, the air conditioning will used at a low temperature with high speed of the blower that make the compressor must work harder that gives effect to the fuel consumption of the vehicle.

In recent years, the fuel consumption of vehicles has received attention from the customer, the automotive industry, regulatory bodies and academia that are responsible for the operation of air conditioning. There has been much argument on the effect of air conditioning system on the fuel efficiency of a vehicle. The factors such as wind resistance, aerodynamics, engine power, and weight must be considered to find the best coefficient of performance air conditioning system. This system has a greater impact on fuel consumption which burns additional fuel to the mechanical air conditioning device and carries additional air conditioning loads throughout the vehicle all the time.

Besides, when more uses of fuel the more harmful gas such as hydrocarbons that reacts with nitrogen dioxide and sunlight to form ozone, which can affect human health such as it can cause chest pains and coughing also making it difficult to breathe. Carbon monoxide also another exhaust gas that particularly dangerous and people suffering from heart disease because it interferes with the blood's ability to transport oxygen.

1.3 OBJECTIVE

Objectives are the guidance of any project, so the objectives of this study are as follows:

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

1.4 SCOPE OF PROJECT

The scope of this project is to focus on the performance of the vehicle air conditioning system with different heat load based on the objective and to solve the problem faced as much as it can. The air conditioning system will be observed using analytical methods. Thus, all the data will be obtained from the experiment with different heat load that is done in the laboratory by following the procedure and safety in the lab.

In this project focus will be a focus on the coefficient of performance air conditioning system where it will be different heat load. The heat load will be manipulated the heat in watt which the values are 300 watt, 600 watt and 900 watt. Besides that, the speed of the compressor being fixed at 1500 rpm and the surrounding temperature about 28℃ to 29℃.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, reviews of the previous researches project that are related to this project will be discussed. The information will become an additional source for the project in becoming more successful. To have a brief understanding of the research related to the project, a few literature previews had been done. This chapter will describe the related literature reviews.

2.2 AIR CONDITIONING SYSTEM

Automotive air conditioning system has become the main role in a vehicle based on human comfort and some safety during driving vehicle in varied atmospheric conditions. Therefore, in this study will to investigate the performance of vehicle air conditioning system with different heat load.

2.2.1 Definition of Air Conditioning System

Air conditioning system is the system that controls the humidity, ventilation and temperature of a building or vehicle in warm conditions. Besides, air conditioning is defined in the automotive sector as a system for the maintenance of occupants of cars, buses and trucks that limited to air cooling, air heating and occasionally dehumidification.

2.3 VAPOR COMPRESSION REFRIGERATION SYSTEM AND VAPOR ABSORPTION REFRIGERATION SYSTEM

Vapour compression refrigeration system (VCRS) widely used method for automotive air conditioning system. Refrigeration is defined as lowering the temperature by remove heat from one space to be cool and reject heat elsewhere, it also as known as the air conditioner or heat pump. The basic schematic diagram is shown in Figure 2.1(a). VCRS have involve four components: compressor, condenser, expansion valve/throttle valve and evaporator. It is a compression process that aimed at increasing the refrigerant pressure because it flows from the evaporator. The high pressure of refrigerant will flows through a condenser before the initial low pressure is reached and the evaporator is returned.

Meanwhile, Vapour Absorption Refrigeration System (VARS) used ammonia, water or lithium bromide as refrigerant where the refrigerant will condense in a condenser and gets evaporated in an evaporator. At the evaporator, the refrigerant will produce the cooling effect while releasing the heat to the atmosphere through the condenser.

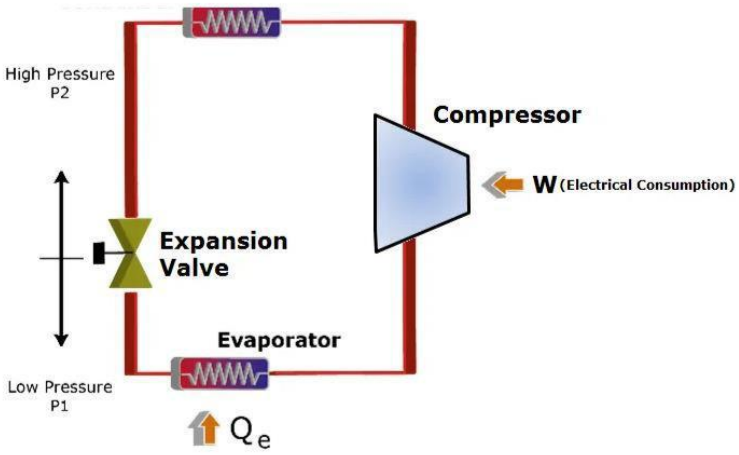

Figure 2.1 (a): Basic schematic diagram of VCRS (Araner, 2018)