UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN INVESTIGATION OF CAR CABIN TEMPERATURE REDUCTION USING DIFFERENT NUMBER OF SOLAR CAR VENTILATOR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning System) with Honours.

by

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TAJUK: **AN INVESTIGATION OF CAR CABIN TEMPERATURE REDUCTION USING DIFFERENT NUMBER OF SOLAR CAR VENTILATOR**

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APPROVAL

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

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ABSTRAK

Tesis ini memberikan keterangan tentang penyiasatan mengenai pengurangan suhu di dalam kabin kereta apabila menggunakan kipas pengedar udara berkuasa solar. Udara panas yang terperangkap di dalam kabin kereta boleh mencapai sehingga 70℃ jika diletakkan dalam keadaan tempat terbuka untuk beberapa jam berdasarkan suhu iklim Malaysia. Terdapat beberapa produk dan penyelidikan telah dibuat sebelum ini untuk mengatasi dan mengurangkan kesan udara panas yang terperangkap. Tujuan kajian ini adalah untuk membandingkan dan menganalisis keberkesanan pengurangan suhu dengan menggunakan jumlah ventilator kereta solar yang berbeza. Eksperimen untuk pengumpulan data dijalankan di kawasan terbuka di Ayer Keroh, Melaka di mana sebuah kereta Proton Saga berada dalam keadaan parkir dari 11.00 pagi hingga 4.00 petang. Eksperimen ini diuji dalam 5 keadaan yang telah ditetapkan bagi menguji dan membandingkan keberkesanannya. Hasil daripada eksperimen yang dijalankan, data menunjukkan bahawa dengan menggunakan alat pengudaraan kereta berkuasa solar yang sedia ada, suhu kabin kereta dapat dikurangkan hingga 49.8°C. Namun begitu, dengan menggunakan seunit alat pengudaraan kereta berkuasa solar yang diubah suai, suhu kabin kereta boleh dikurangkan sehingga mencapai sehingga 46.5 °C. Terdapat kira-kira 3.3 °C perbezaan antara kedua-dua keadaan. Walau bagaimanapun, suhu kabin kereta boleh dikurangkan sehingga 41°C apabila 4 unit ventilator kereta solar yang diubah suai digunakan. Semua data dikumpulkan pada keadaan kereta yang sama dalam julat waktu yang sama. Dari data yang dikumpulkan, terdapat hasil yang berubah-ubah bergantung pada keadaan yang telah ditetapkan dan faktor suhu sekitar. Walau bagaimanapun, objektif utama penyelidikan ini adalah untuk membandingkan keberkesanan alat pengudaraan kereta berkuasa solar yang sedia ada dengan alat pengudaraan kereta berkuasa solar yang diubah suai telah tercapai.

ABSTRACT

This thesis presents the description of the investigation about temperature reduction inside the car cabin using the solar car ventilator. The trapped hot air inside the car cabin can reach until 70°C if being parked in open condition for the several hours based on to the Malaysian climate temperature. This condition will cause a lot of problems as health disease and also to the car life expectancy. As the result from this condition, there were several products and researched have been made to overcome and reduce the effect of the trapped hot air. One of the product have been developed by the previous researcher is solar car ventilator. The purpose of this research is to compare and analyse the effectiveness of the temperature reduction using different number of solar car ventilator. The presentable in the market solar car ventilator have been upgrade by changing the size of solar panel and reposition it at the better condition to maximize the amount of the solar energy that can be absorb by the solar panel. The project was being held in an open space area in Ayer Keroh, Malacca by using a car model Proton Saga in the parking condition from 11.00 am to 4.00pm. The experiment being tested in 5 predefined condition where are by using an existing solar car ventilator without any modification, using a unit of the modified solar car ventilator, 2 unit of modified solar car ventilator, 3 unit of modified solar car ventilator and 4 unit of modified solar car ventilator. The result from the experiment shows that by using the existing solar ventilator, the car cabin temperature can be reduced until 49.8°c. Other than that, by using a unit of modified solar car ventilator, the car cabin temperature can be reach until 46.5°c. There is about 3.3°c of difference between both conditions. Anyhow, the car cabin temperature can be reduced until 41°c when 4 unit of modified solar car ventilator be used. All the data were being collected at the same car condition in the same range of time. The main objective of this research is to compare the effectiveness of the existing solar car ventilator with the modified solar car ventilator has been achieved.

DEDICATION

With wholeheartedly, I would like to dedicated this study to my beloved parents and siblings as my source of inspiration and give me strength through my giving up, who continuously provide their moral, spiritual and emotional support.

To my honoured and beloved supervisor

Puan Noor Saffreena binti Hamdan

Thank you so much for every single thing that has been done, for all knowledge sharing and guidance to complete this thesis project.

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CHAPTER 1
INTRODUCTION

1.1 Project Background

In the era of the modernization, most of the people drive the cars since it was being an important transportation to travel the people from one place to another destination. Most of the problem that faced by the car users today is hot temperature inside the car cabin after being parked in an open area for a few hours which the car were totally exposed to the sunlight. (Gaurav Kumar Jaiswal et al., 2012) This condition will cause the temperature inside the car cabin can easily rise up approaching to 60°C. Even in fairly overcast day, the temperature inside the cabin also can be rise up to 55°C. (R. Saidur, 2009) Getting on a car that have been exposed to the solar radiation for several hours are hard since the hot temperature inside the car cabin will cause the passenger feel very uncomfortable at the first 10 minutes (M.Bouzidi., 2004). There were also a lot of works were being reported about the thermal comfort inside a car (C. Bureau, 2003) (R.B Farrington, 1999) (Nebojsa 1. Jaksic and Cem Salahifar, 2003).

The greenhouse effect, open burning, releases of gaseous to the air results the global warming and the thinning of the ozone layer. All of this matter will cause the extreme heat of the solar radiation in the surrounding. Those solar radiation will heats up the equipment inside the car. The equipment will absorb the heat and will cause the harder process to cool down the compartment inside the car within the short period of time. The window glasses itself became a heat source inside the car.

Hence, the amount of heat energy being absorbed inside the car being can be determine by the temperature of glass. The amount of heat that will swallow in can be detect by using preliminary heat transfer analysis involving the convection and radiation process from the glass into the interior of the car and also the surrounding air (Nebojsa 1. Jaksic and Cem Salahifar, 2003). There is lot of method to minimize the heat absorb into the car cabin as the use of windows tinted, sunshade and solar reflector. But reducing the heat gain inside the car compartment by using a ventilator also known as an effective mechanism to lower down the penetrate temperature (R.B Farrington, 1999). Therefore, this study aims to compare the effectiveness to reduce the car cabin temperature by using multiple number of solar car ventilator.

1.2 Problem Statement

The numbers of the car on the road nowadays have increasing rapidly. The problems occur when there is only limited space of the roofed car park. When the car was being parked at the open space, the trapped hot air will cause a bad effect to car and also to the users especially during the hot day. The hot air temperature that trapped inside the car will cause damage or aging to the compartment and accessories inside the car. Besides that, the higher temperature inside the car cabin after being parked for a several hours will force the users to lower down the window and open the door widely to remove the heat. This practice are not to practical to apply since it will takes time and also will expose to unsafe condition as snatch and being robbed.

Other than that, there were also a lot of incident that cause from the trapped hot air inside the car cabin which some of cases is the explosion of the car perfume bottle and electronic equipment that being kept inside the car. The possibility of the explosion happen maybe can be reduced if the trapped hot air can be removed from the car cabin.

The hot car cabin temperature also will affect the health problems since the compartment and accessories inside the car are made from rubber and vinyl material. Those material will produce air pollution inside the cabin when it being heat up by the high surrounding temperature. Some of people will start up the blower at high and run the air conditioner system at maximum to cool down the temperature when they enter the car. The effect from this behavior is the car will consume more power and fuel to work at maximum capacity (Nebojsa 1. Jaksic and Cem Salahifar, 2003). This will added the pollution to the air as the results from the combustion of the engine. The air conditioning system that forced to work at maximum power capacity also will affect the main component of the system such as the air conditioner compressor which will shorten the life span of the component. If the temperature inside the car cabin can be lower down or being reduced, the car air conditioning can be operate effectively at the lower cost, less maintennce and also prolong the life span of the system component. As a result, the integrated of the air flow system in the car cabin is really necessary need to be improved to remove the heat and reduce the temperature inside the car cabin.

1.3 Objective

The aim of this project is to investigate if the different number of solar ventilator being use will affect the rate of temperature reduction in the car cabin. In order to achieve the aim, there were 3 objectives being set. There are:

- To measure the temperature of car cabin using existing solar car ventilator.
- To modify the solar source on the existing solar car ventilator.
- To compare the effectiveness of the system before and after modification.
- To compare the amount of temperature can be reduce using different number of ventilator.

1.4 Scope Of Project

This project will focus on standard sedan car since this type of car are economy and being use more on the road. The study area of this project is at an open area in Ayer Keroh, Malacca. The temperature will be taken for every single hour from 11.00 am until 4.00 pm by using the Graphtec Midi Logger. The reading will be repeatedly taken for five days with different condition where the temperature will be taken when using 1 unit of the solar car ventilator until 4 units. The ventilator will be attached at the window with the same position even different condition. The size of solar panel also being increase by using the solar panel with the size 13.0 cm x 16.5 cm.. The solar panel was placed on the rooftop of the car to absorb better sunlight. The systems were fully powered by solar energy where it will not cause any affects at all the car battery power. The project aims to compare the effectiveness of the system by using different number of ventilator that being attach to reduce the car cabin temperature.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the course of the most recent couple of decades, sunlight based design which utilized this sun based vitality has begun to turned out to be prevalent again because of the conservation issues. These days, extensive advancement has been made in advancing the sun based sustainable power source. Numerous individuals trusted that sunlight based vitality has contributed and will keep on adding to the national and worldwide vitality use systems. Sun powered vitality is utilized in different pieces of modern and business areas, for example, horticultural, transportation, correspondence and others. In the transportation business, there were a few advancement have been by utilizing the sun based vitality as sun based vehicle and sun powered ventilation system for a vehicle. ASHRAE Handbook understanding, ventilation air is the air used to create a dignified quality of indoor air (ASHRAE, 2005). The ventilation system is divided into three types consisting of regular ventilation, mechanical ventilation, and hybrid ventilation. This paper will focus more on its usefulness in a car's ventilation arrangement. Ventilation is an air supply and evacuation without restriction as per a space. It is the deliberate stream through the quality of a space in less complex words. It is connected by allowing air from the outside to fill in, to maintain the thermal condition of the inside space, to dispose of upsetting smell and over the top dampness.

2.2 Ventilation system of a car

The ventilation systems of car are being divided by two parts where it is ventilation of car engine and ventilation of car cabin.

2.2.1 Car engine

The cooling system serves three important functions. Initially, it expels abundant heat from the engine, second, it keeps the working temperature of the engine where it works most productively, and finally, it transports the engine as fast as possible to the right working temperature. As an engine, a radiator, a water pump, a cooling fan, hoses, and a thermostat, the cooling system consists of six main parts. A portion of the fuel vitality is transformed into heat during the combustion process. This heat is exchanged for the water pump to flow the coolant through the engine. Hoses transport the hot coolant to the radiator, where the heat is transferred to air that the cooling fan pulls past the engine. Then the refrigerant is returned to the water pump and recycled. The engine operates a little differently when an engine is cold, like the first thing in the morning. The engine is intended to heat up quickly to increase efficiency. When the engine reaches the right working temperature, it is intended to maintain the engine at a stable temperature, which is the thermostat's purpose. The thermostat is like a valve opening and closing as a temperature element. The thermostat isolates the engine from the radiator until a specific minimum temperature has been achieved. The engine would reliably lose heat to the radiator without a thermostat and take more time to heat up. The thermostat changes stream to the radiator to maintain a stable temperature when the engine has achieved the ideal working temperature. Sometimes the coolant is extremely hot, that the thermostat opens the whole way, making the engine completely dependent on the radiator to stabilize its temperature.

The engine will remain cool for whatever length of time there is sufficient air stream through the radiator. If the air flow rate is too low for some reason, the radiator will not fulfill its responsibilities and the engine may overheat. In this condition, the engine will then transfer more heat to the coolant if the coolant flow rate is increased, which will intensify the circumstance. The limitation of the thermostat flow will help to increase the pressure in the cooling system, making boiling in the water pump more difficult for the coolant. It does little, however, to allow the radiator to keep the engine cool.

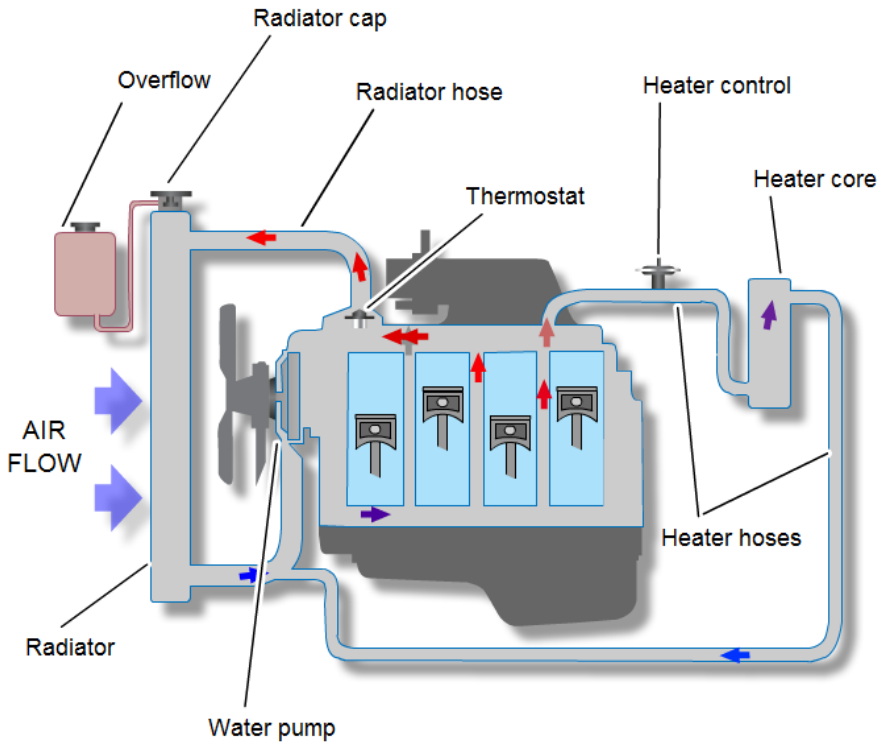

Figure 2.1 : Car engine cooling system

2.2.2 Car cabin

The ventilation inside the car cabin were divided into two conditions where the car is in moving condition and car in static condition.

2.2.2.1 Car moving condition

The ventilation system for a car being generated as well the engine start up. When the car was in moving condition, the car will use the air conditioning system to ventilate the air inside the car cabin. The systems use two types of the air that is fresh air and recirculated air. The amount of the air either fresh or recirculated air can be control by a damper.

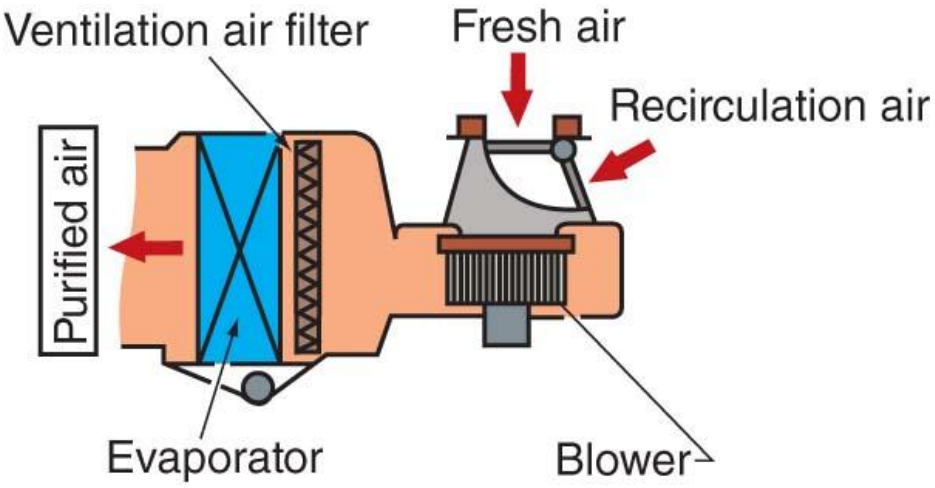

Figure 2.2: Ventilation of car cabin

The car air conditioning system use the refrigerant as a medium to transfer heat from inside the car cabin to the outside until reach the comfortable condition. This system involved a few types of component as compressor, condenser, dryer, expansion valve and evaporator.

The coolant is in the air conditioning system. The compressor starts the system's high-side where the refrigerant is compressed into a high-pressure state making it liquefy. It passes to the condenser through the high pressure lines. The condenser, which is like a small radiator, puts the fluid outwardly from the vehicle in contact with natural air, which keeps the heat from the fluid. It then flows into the air conditioning system's expansion valve or orifice tube where it is restricted and gasses into the air conditioning system's low pressure side. Then it flows into the receiver dryer to remove and collect unwanted moisture and impurities containing a desiccant bag. Then the clean gaseous refrigerant travels into the evaporator through the tubing. In its gaseous state, the refrigerant can now absorb heat from the air that passes through the evaporator fins, leaving the cooler air behind. Fans blow into the cabin of the car this cooler dry air. In the air conditioning system suction hose, the refrigerant travels back to the compressor to get compressed back into the high-pressure gas and restart the process.

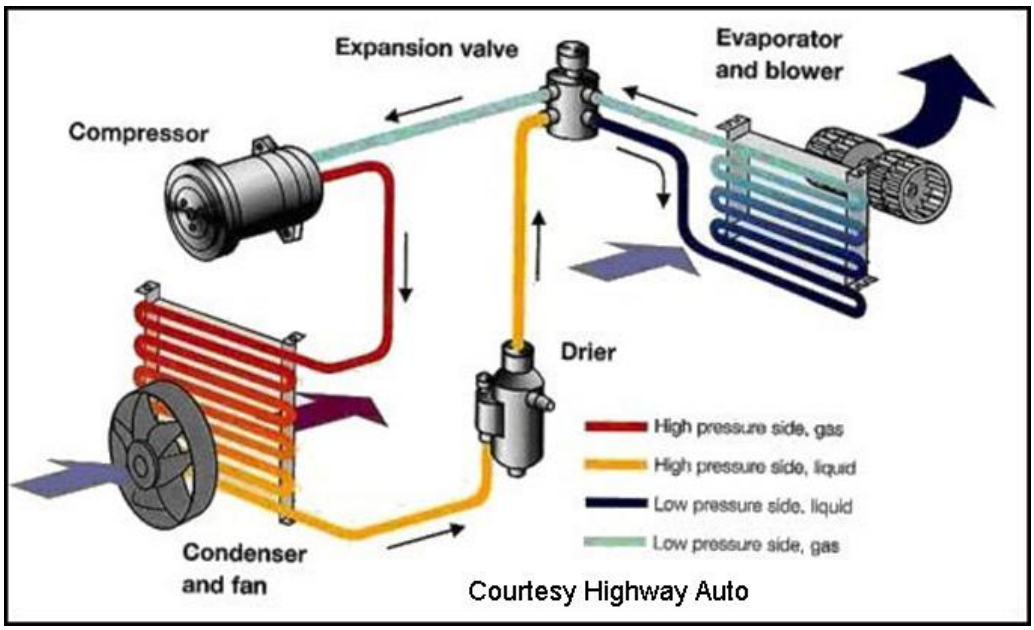

Figure 2.3: Car Air Conditioning System

2.2.2.2 Static / parking condition

During a car parked at an exposed area where the thermal heat in the interior space of a car is generated directly perpendicular to sunlight will raise the temperature of the interior space drastically. After entering a prolonged soaked car, the thermal accumulation will cause the driver or passengers an uncomfortable environment in the early 10 minutes. The temperature inside the car can easily rise to 60 ° C and it can easily reach 55 ° C even in fairly cloudy days (R. Saidur, 2009). The equipment inside the car will absorb heat and make it difficult to cool the car compartment in a short time. There was no or only a limited air flow inside the car cabin during this condition. The air is mostly only trapped and heated by the solar energy that is absorbed into the cabin of the car.