UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS OF THE CAR VENTILATION SYSTEM AND ENHANCEMENT USING SOLAR POWER

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

by

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DECLARATION

I hereby, declared this report entitled “PSM Title” is the results of my own research except as cited in references.

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APPROVAL

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

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(Dr. Ahmed Salem Saeed bin Ghooth)

ABSTRAK

Ventilasi adalah satu system penting untuk diaplikasikan di ruang tertutup supaya udara dapat disebarkan dan diganti dengan bantuan kipas. Semasa kereta diletakkan di tempat meletak kereta yang terbuka pada hari yang panas, kepanasan didalam kabin kereta tidak apat dielakkan. Situasi ini berlaku disebabkan radiasi solar yang dapat menembusi cermin lutsinar tetapi tidak dapat keluar darinya, menyebabkan haba terkumpul di dalam kabin kereta. Tujuan pembelajaran ini dilakukan adalah untuk mereka bentuk suatu system ventilasi yang dapat mengeluarkan haba yang terkumpul di dalam kabin kereta. System yang dicipta akan memerlukan tenaga elektrik untuk beroperasi, maka penggunaan tenaga solar diaplikasikan dimana ia menukarkan radiasi solar kepada tenaga elektrik dengan menggunakan modul fotovoltaik. Reka bentuk akan berasaskan suhu di dalam kabin kereta yang diukur menggunakan termogandingan suhu. Suhu didalam cabin kereta boleh meningkat sehingga 57˚C. suhu tinggi yang terperangkap di dalam kabin kereta menyebabkan ketidakselesaan kepada pemandu dan penumpang kereta memasuki kereta. Makanya, satu system ventilasi direka bentuk untuk mengurangkan suhu di dalam kereta. Kerja eksperimen dilakukan untuk membandingkan suhu sebelum dan selepas system ventilasi dipasang. purata suhu yang dapat dikurankan selepas system ventilasi dipasang adalah 6.25˚C. selain daripada memberikan keselesaan, pemasangan sistem ventilasi ke kereta yang di letakkan di bawah matahari dapat mengelakkan kerosakan kepada komponen getah di dalam kereta. Memandangkan fotovoltaik digunakan, ia dapat menjimatkan tenaga elektri kerana radiasi solar adalah percuma.

ABSTRACT

Ventilation is an important system needed to apply in a closed space so that air can circulate and removed with the help of blower or fans. While parking a car under the open sun on a sunny day, heating of the car cabin cannot be avoided. It happens because solar radiation can come in to the car cabin through transparent glass, but cannot escape from it, hence results to heat trapped inside the car cabin. The purpose of this study is to design a ventilation system that can remove the heat trapped inside the car cabin. Such system needs electrical energy to operate the system, hence the utilization of solar power which convert solar radiation into electricity by using photovoltaic module. The design is based on the temperature inside the car cabin that is measured using thermocouples. The temperature inside the car cabin could increase up to 57˚C. The high temperature that trapped inside could cause discomfort when the driver or passenger enter the car. Hence, a proper ventilation system is designed to reduce the temperature. Experimental work is done to compare the temperature before a ventilation system installed and after a ventilation. An average reduction of 6.25˚C could be reduced after ventilation system is installed. The additional benefit other than provide comfort, the installation of a ventilation system inside the car cabin when it is parked under the open sun area could also avoid damage of rubber parts inside the car cabin. Since, photovoltaic is used, it saves electricity cost because solar radiation is free.

DEDICATION

To my beloved parents, I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. I am really thankful for their sacrifice, patience, and understanding that were inevitable to make this work possible. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams. Lastly, I would like to send my gratitude to any person that contributes to my final year project whether its directly or indirectly. I would like to acknowledge their comments and suggestion, which was crucial for the successful completion of this study

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Last but not least, I appreciated the assistance of my classmate for their wonderful support during the completion of this project. I really hope my report will provide beneficial information and ideas to everyone who is interested in the topic of "Analysis of The Car Ventilation System and Enhancement Using Solar Power". Any comments and critique are welcomed to overcome my weaknesses.

Thank you.

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LIST OF ABBREVIATIONS, SYSMBOLS AND NOMENCLATURE

PV	-	Photovoltaic
A	-	Area
C_v	-	Specific heat capacity with constant volume
E	-	Sun Total Power
g	-	Gravity
h	-	Height
m	-	Mass
$\dot{m}$	-	Mass Flow Rate
P	-	Pressure
ΔP	-	Difference in Pressure
$\dot{Q}$	-	The amount of heat / heat radiation
R	-	Radius
S	-	Irradiance
T	-	Temperature
ΔT	-	Difference in temperature
$\dot{V}$	-	Volume Flow Rate
W	-	Weight
ε	-	Emmissivity
σ	-	Stefan BoltzmannConstant
π	-	Ratio of Circle Circumference to it's Diameter

CHAPTER 1

INTRODUCTION

In chapter 1, the introduction contains some subtopics which are the background of the study, problem statement, objectives, scope and organization of the thesis.

1.1 Background of The Study

Background of the study describe the following important subtopics, such as ventilation, thermal comfort, greenhouse effect,photovoltaic and Stefan Boltzman law.

1.1.1 Ventilation

Ventilation is a process to bring air to indoors, circulated and removed it through proper design. Ventilation is an important subject to provide fresh air to an enclosed space for it to reach thermal comfort and overcome some pollutant in a sick building. Ventilation system also can work as pathway to remove unwanted air in closed space.

As a human, we have our comfort factors. Comfort is a feeling of human body when tends to accept the thermal of surroundings. Thermal comfort has become a worldwide issue as it is relevant to everyday life. Most people would want their surrounding relevance to human comfort.

1.1.2 Thermal Comfort

As a human, thermal comfort factors are important. Comfort is a feeling of human body when tends to accept the thermal of surroundings. Thermal comfort has become a worldwide issue as it is relevant to everyday life. Most people would want their surrounding relevance to human thermal comfort.

1.1.3 Greenhouse Effect

The presence of radiatively active gases on the earth results in raising of global mean surface temperature that making our planet habitable by life nowadays. The increasing carbon dioxide and other trace gases, which are largely due to human activity, increase the radiative heating of the troposphere and surface. Heat tapped inside an enclosed space were a common thing to occur in a space with transparent mirror under open sun area. The heat trapped due to solar radiation through the transparent mirror that is radiated to the area inside the enclosure space cannot be released due to the greenhouse effect. Hence, any heat radiation entered through glass cannot be released without any forced exerted. Green house effect can be defined as the rise of temperature in the enclosed space due to radiation of some product which emitted heat with long waves that disable to pass through the transparent mirror.

1.1.4 Photovoltaic

The heat provided from solar radiation can be converted to produce electrical energy. Photovoltaic (PV) is a device used, where solar radiation is converted into direct current electricity using semiconductor that exhibit the photovoltaic effect. Photovoltaic can be considered as a free flow of electricity. Hence the solar radiation would not be a waste because it can be used as a renewable energy to generate electrical power.

1.1.5 Stefan Boltzmann Law

Stefan Boltzmann law is a formula used to calculate heat energy that is radiated from the black body depending on its temperature. With varying temperature as the manipulated data, we can use the Stefan Boltzmann constant to calculate the energy radiated from the body, which will become the manipulated variable to measure the temperature inside the car cabin.

1.2 Problem Statement

A car is what most people use to transport from one place to another. Hence we could not run away from parking the car in any space available. In Malaysia, which it is a hot and humid country throughout the year would be a downfall to car user park's their car in open space in broad daylight. It is always desirable to consider discomfort that we feel which needs an intensive energy operation to overcome the undesired conditions. Saving environment and overall cost for car uses is an essential challenge problem. An alternative, inexpensive method to achieve desirable comfort is to remove heat generated due to greenhouse effect inside the car cabin during parking is proposed.

A car that is parked under the sun results to heat trapped inside the car. Whenever we are entering the car under this situation feeling of discomfort to the driver and passenger is the must condition. The heat trapped inside the car cabin due to greenhouse effect lead to warmed up in the enclosed space. This relates to the human discomfort which the hot air trapped inside the car cabin. The heat tapped can also result in damage of the dashboard and any rubber in the car. The damage will be hard to repair and costly. Hence, a car need ventilation system to remove unwanted heat when it is parked under an open sun area.

1.3 Objectives

The main objectives of this project are to

i. Investigate ventilation system to overcome trapped heat inside the car cabin
ii. Utilization free cost solar energy

1.4 Scope of Work

The area under consideration is inside of the car (car cabin). The car that parks under open sun area. The temperature of the car cabin is measured different use of the window that are all closed and slightly opened. The measured temperature is effective parameter to design the ventilation system. By using the solar radiation principle, a photovoltaic size will be determined depending on the ventilation system. The solar energy will be used to operate the ventilation system to be designed. Hence, this system will save cost on electricity and car can be cooled faster since the heat tapped were removed to achieve human comfort.

1.5 Organization of The Thesis.

Chapter 1 explains the introduction to the thesis, and give some information to what is done on the thesis. Chapter 2 is designed to survey past works published in the open literature that are inline with the theme of current research. The design of previous inventor is presented in the chapter. Chapter 3 demonstrates the methodological approach that is adopted to achieve the objectives. Details on the work procedure, materials and apparatus are explained. Chapter 4 presents the result and the findings of the study, the result from the experiment and optimization of car ventilation are presented in tables, figures, drawings and graphs and are discussed elaborately in the chapter. Several observations are also projected from the findings. Chapter 5 summarizes the outcomes of this experiment and concludes the final

design of the car ventilation. The chapter also outlines the optimization process and project several recommendations for further development and improvement on the design. Suggestion for future inventor are also provided to open the door for the application of the car cabin ventilation system in Malaysia.

CHAPTER 2

LITERATURE REVIEW

Based on the Malaysian climate, we can see that it is hot and humid throughout the year. Unlike other 4 season country, this study would more important to Malaysia. In chapter 2, Literature review explains deeper about subtopic from the background of the study, previous study done on this project and summary of this chapter.

2.1 Ventilation

Basically, ventilation is a process to circulate air, which is to bring air to indoors or removed air to outdoors through proper design. Ventilation is important to provide fresh air to an enclosed space, controlling airborne toxic and contiminated air from enclosed space and replacing it with clean air. Ventilation is divided into two types, natural ventilation and mechanical ventilation.

2.1.1 Natural Ventilation

Natural ventilation is air flow through open windows, doors, grilles and other penetration that is driven by natural produced pressure.

2.1.2 Mechanical Ventilation

Mechanical or forced ventilation is air movement into or out of encosed space by intentional means such as fan, blowers or intake and exhaust vents.

2.2 Thermal Comfort

Thermal comfort can be defined as a condition of mind which expresses satisfaction with the surrounding thermal environment (ASHRAE, 1992). There have been a complex relationship between physiological and psychological variation of each person and condition of their mind. Maintaining thermal comfort for occupants of a building or a space is one of the important goals of HVAC (heating, ventilation, and air-conditioning) design engineers. Environmental satisfaction has been divided into many categories including satisfaction with floor space (Sundstrom, 1986); workspace, control of noise distractions and also with temperature and air-quality (O'Neill, 1992). Standard ISO 7730 (ISO, 2005) has stated the combined effect of four environmental parameters and two personal factors can determine the level of thermal comfort in the space:

Table 2.1 Factor affecting thermal comfort

Environmental factors	Personal factors
• Air temperature • Mean radiant temperature • Air velocity • Humidity	• Metabolic rate • Clothing insulation

2.2.1 Human Thermoregulation

In order to maintain normal body temperature, metabolic activities of the body must be continuously dissipated and regulated. Insufficient heat loss leads to overheating or known as hyperthermia, and excessive heat loss results in body cooling known as

hypothermia. According to Hardy et al., 1952, skin temperature greater than 45˚C or less than 18˚C causes pain. 1hile according to Fanger, 1967, skin temperatures associated with comfort at sedentary activities are 33 to 34˚C and decreases with increasing activity. An internal temperature less than 28˚C can lead to serious cardiac arrhythmia and death, while with a temperature greater than 46˚C can cause irreversible brain damage. Therefore, careful regulation of body temperature is critical to comfort and health.

2.2.2 Standard Values for Thermal Comfort.

Table 2.2 Standard value for thermal comfort

Factors	Ranges
Dry bulb temperature	24˚C to 26˚C
Relative humidity	30% to 60%
Air velocity	0.12 m/s to 0.35 m/s

While mean radiant temperature can be calculated using the following equation.

$$T^4_{\ met} = T^4_{\ g} + C\, V^{1/2}(T_g - T_a)$$

Where;

T_g = global temperature (K) (measured using global temperature tool)

V = air velocity

C = 0.247×10^9 (SI unit) or 0.103×10^9 (English unit)

Proper selection of the thermal comfort principle is important in selecting heating and cooling system in order to provide thermal comfort.

2.3 Greenhouse Effect

The Sun powers Earth's climate, radiating energy at very short wavelengths, predominately in the visible or near-visible (e.g., ultraviolet) part of the spectrum. Approximately one-third of the solar energy that hits the upper side of Earth's air is reflected straight back into space. The remaining two-thirds are occupied by the surface and, to a lesser extent, by the atmosphere. To balance the absorbed incoming energy, the Earth must, on average, radiate the same amount of energy back to space. Because the Earth is a lot more frigid than the Sun, it radiates at much longer wavelengths, primarily in the infrared portion of the spectrum. Much of this thermal radiation emitted by the land and ocean is absorbed by the atmosphere, including clouds, and reradiated back to Earth. This phenomenon is called the greenhouse effect. The glass walls in a greenhouse reduce airflow and increase the temperature of the air inside. Analogously, but through a different physical process, the Earth's greenhouse effect warms the surface of the planet. Without the natural greenhouse effect, the average temperature at Earth's surface would be beneath the freezing point of water. Thus, Earth's natural greenhouse effect makes life as we know it possible. However, human activities, primarily the burning of fossil fuels and clearing of forests, have greatly intensified the natural greenhouse effect, causing global warming.

The gas molecules in the atmosphere contains 99.5% of nitrogen, oxygen and argon. While another 0.5% contains greenhouse gases such as, Carbon Dioxide (CO_2), Sulfur hexafluoride (SF_6), Methane (CH_4), and Nitrous oxide (N_2O). The generation of energy from non-renewable sources such as fossil fuel oil, coal, nuclear and natural gases results in greenhouse gas emissions. It also absorb infrared radiation which acting as barrier for escaping heat to the space.

2.3.1 Solar Radiation

The sun radiates considerable energy onto the earth. Putting that diffuse, rarely over 950 W/m_2 energy to work has led to the creation of many types of devices to convert that energy into useful forms, mainly heat and electricity.

At the core of the sun is where the intense nuclear activity happens where a huge amount of radiation is generated. This is when the light energy is formed in the form of photons. The photons carry non-visible light and visible light. The example of non-visible light is ultraviolet and infrared, while visible light is a white light. It takes about 1 million years for the photon to push out to the surface of the sun. After the photons reach the surface of the sun, it rushed through the space with the speed of 670 million miles/hour which result to reach space in about 8 minutes.

Some of the of the sun direct radiation is scattered by nitrogen, oxygen and other molecules to pass through the earth atmosphere. It is small compared to the wavelength of the radiation by aerosol, water droplets, dust and other particles with diameters comparable to the wavelength.

2.3.2 Peak Sun Hours

Peak sun hours are the time where solar radiation is at its peak. It is considered as the best time to conduct solar radiation to become energy. Peak sun hours is also the hottest time of the day. With the location of Malaysia that near the equator where sun is directly overhead, its result to Malaysia receiving 4-6 hours of peak sun hours.

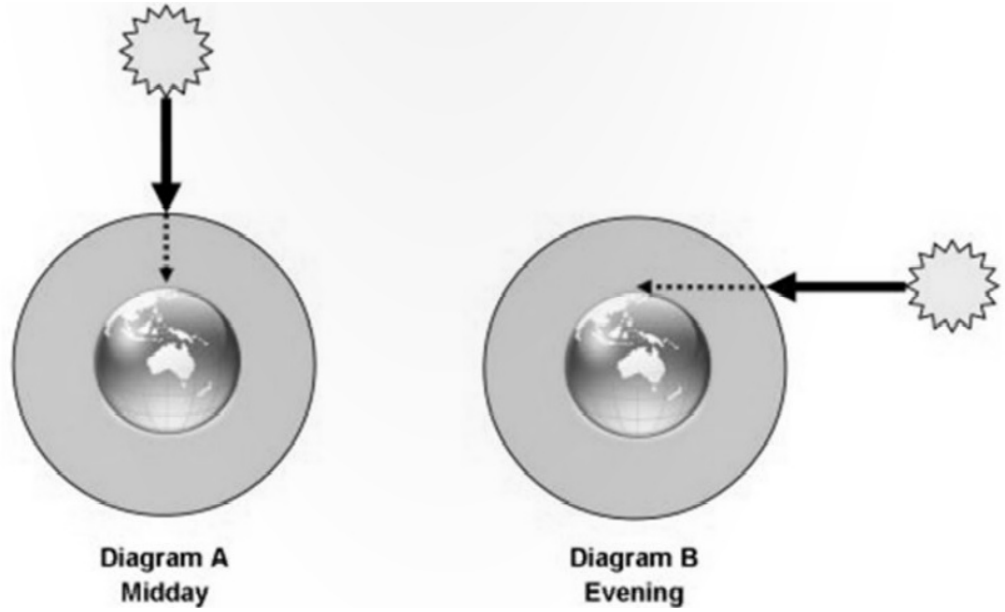

Figure 2.1 Location of sun in the daylight

Table 2.3 Peak hours

Diagram A	Diagram B
• Sun is overhead. • The photon has to travel through the thin layer of atmosphere. • Intensity of photons higher.	• Sun is setting. • Photons have to travel through a thicker layer of atmosphere. • Intensity of photons lower.

2.4 Photovoltaic (PV)

Photovoltaic panels convert the sunlight directly into electricity. Photovoltaic cellsmay look similar to solar panels but works in a different way. Solar panel are use to produce hot water or steam while photovoltaic use to produce electricity. A typical example is solar powered calculator. This type of device only needs a small amount of electrical power to work and can even be used in a room with artificial light (bulbs / fluorescent light).
Although we see photovoltaic cells powering small devices such as calculators they have a more practical application especially in the third world. Photovoltaic cells