UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION ON THE USE OF AIR FLOW INDICATOR IN VEHICLE AIR CONDITIONING SENSOR AS DUST PARTICLE ACCUMULATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Engineering Technology (Bachelor's Degree of Mechanical Engineering Technology(Maintenance Technology)) (Hons.)

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirement for degree of Bachelor of Engineering Technology (Bachelor's Degree of Mechanical Engineering Technology (Maintenance Technology)) (Hons). The member of the supervisor is a follow:

……..

(Mr. Harris Fadzilah Bin Zainudin)

ABSTRAK

kajian ini telah dijalankan terhadap pembangunan alat pemantauan petunjuk untuk melaksanakan penyelenggaraan terhadap sistem penghawa dingin kenderaan. Untuk memanjangkan jangka hayat sistem penghawa dingin dalam kereta, penyelenggaraan yang sistematik perlu dilaksanakan. Peningkatkan kenderaan pada masa kini telah menyebabkan kualiti penapis udara pada sistem penyejukan kurang cekap . Kapasiti habuk yang tinggi di dalam penapis udara adalah punca utama aliran udara yang rendah terhadap sistem pengudaraan untuk kabin. Oleh itu, alat petunjuk udara dipasang pada kabin aliran udara untuk mengukur dan memantau aliran udara sebagai kaedah alternatif untuk mengesan aliran yang menghasilkan selepas aliran udara melalui penapis. Pemilihan sistem kawalan dan peranti pegesanan telah dilakukan berdasarkan kepada kebaikan dan kepekaan terhadap persekitaran yang dikaji . Peranti petunjuk adalah tempat di kabin kenderaan. Keputusan kadar aliran udara direkodkan dan dinilai supaya angaran untuk penukaran perangkap habuk dalam sistem penapis udara kenderaan dapat dilakukan. Berdasarkan keputusan perbandigan yang telah dijalanakan menunjukan 99.25 peratus ketepatan terhadap pembangunan alat pemantau pentunjuk yang dihasilkan. Pada masa yang sama keputusan ujian terhadap penapis udara yang baru telah memberikan keputusan yang menunjukan penigkatan aliran udara yang baik.

ABSTRACT

This study reflects on the development of an indicator monitoring device, to perform condition based maintenance on vehicle air condition system. Due to prolong lifetime of air condition system inside the car, systematic maintenance needs to be conducted. Increasing of vehicle nowadays gives a prime cause to filter quality. The capacity of the dust trap inside the filter is a prime cause of low air flow from the ventilation system to cabin. Hence, an air flow device attached on air flow cabin to measure and monitor air flow as an alternative method to detect flow that produce after air flow through the filter. The selection of microcontroller and sensing device were done based on each advantages and sensitivity to the applied environment. Indicator device was place on vehicle cabin. Based on the accuracy result 99.25% shown that indicator can be used as measuring air flow velocit device. On other hand result shown clean air filter has hight speed of air flow velocity compare to used air filter.

DEDICATION

This thesis is dedicated to my parents for their love, endless support and encouragement.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CBM	-	Condition Based Maintenance
R&D	-	Research and Development
MAF	-	Mass Air Flow
I/O	-	Input and output
USB	-	Universal Serial Bus
PLC	-	Program Logic Control
SOC	-	System On a Chip
GPU	-	Graphic Processing Snit
PC	-	Personal Computer
DRAM	-	Dynamic Random Acess Memory
SD	-	Secure Digital
m/s	-	meter per second
PCB	-	printed circuit board

CHAPTER 1
INTRODUCTION

1.1 Introduction to Air conditioning

Air condition is the system of air that related to temperature and humidity to performed more comfortable condition. Air conditioning is a device that be used to reduce the temperature at certain area by decrease temperature from high to low temperature. The cooling system is work through a refigration cycle. In general air condition also can be refers to heating system that generate hight temperature in certain area.

Recent years the effect of global warming have cause climate condition on health increase. Previously, air condition was apply in hot climate, but the demand of usage at moderate climate has been increase (El-Agouz and Kabeel, 2014)

1.2 Introduction to filter

A particulate air filter is a device that composed of fibrous materials which is to remove solid particle such as dust, pollen, mold, and bacteria from air. A chemical air filter consists of an absorbent or catalyst for the removal of airborne molecular contaminants such as volatile organic compounds or ozone. Air filters are used in applications where air quality is important, especially in ventilation systems and in engines

Filter have the function of preventing impurities from entering inside of compartment area. Air filter for passenger car come in two different designs, panel

filter and round filter. This type of filter is suitable for any specific case mainly depend on basic rules of filter technology (MSI-motor-service). Air filter are shown in figure 1.1.

Figure 1.1: Dust particle on filter at cabin system

1.3 Sensor

In the recent years sensor devolvement became a fast growing discipline. Worldwide market offer a thousand types of sensor, it offer in many application and for every measurable quantity, also offer for many type application, manufacturer today compete with each other in explore new technology in sensor development, the quality of sensor also has been developed for high accuracy detection. According to (Jon s. Wilson,2005), this decade on 21st century has been labelled as 'sensor decade' it because all application in this decade will be related of to a sensor application, our life nowadays was surrounding by sensor to control system in our daily life. Sensor has turning into a developing innovation that overcomes in the worldwide in which we live (John Veletilo,).

1.4 Problem statement

Increasing of vehicle nowadays has contribute an impact to air quality in cabin system found decline by gradually caused by the vehicle exhaust to close with vehicle intake system. Pollution will get into the system via the ventilation system. The past study has shown that cabin system is some of the causes disruptions in the health of passengers, via higher toxic limited surpassing ventilation system. (komsas Galatsis).

Air filter is the main equipment that has the function to prevent airborne contamination and abrasive from entering into air cabin system. Without proper filtration these contamination can cause serious demage and appreciably shorten ventilation life (Douglas Vidler). Air filter generally know that it is important equipment in cabin air system, air filter will screen a contamination than it will give permission to clean air to move in passenger area.

The past research has shown 88% of dirt contaimenance that enter HVAC system through the air intake system (J Schell, n.d.) it is importance to make sure that air filter constantly in efficient condition. The proper maintenance on air filter is importance, in other hand it can help to prolong life of cabin air system, such as filter to extend desire functionality and keep the ventilation system can be used longer. Test that has been direct by world biggest expendable air-filter maker, Owens corning fiberglass corp, demonstrate that air channel should be changed at least once a year and about once a month during peak heating and cooling period.

This study will focus on develop a method for measure the flow rate and temperature over cabin filter by using sensor device. To prolong life of ventilation system and its equipment from having a shortage demage, an indicator for measure ability of filter will be design. The air filter indicator will sesnse a output at ventilation air system. Sensor will measure flow rate of air than transmit it to microcontroller to give an feedback and display a data about the efficiency of filter.

1.5 Objectives.

i. To develop indicator in detecting the flow of vehicle air conditioning.
ii. To test and analyse the newly developed indicator

1.6 Scope

i. Developing indicator in detecting the flow of vehicle air conditioning using Arduino and air wind sensor.
ii. Testing the newly developed indicator using vehicle air conditioning systems with different filter condition.
iii. Analyzing the newly develop indicator based on test results.

CHAPTER 2
LITERATURE REVIEW

2.1 Condition Based Maintenance

Maintenance generally is defined as technical and managerial action be taken during usage period to maintain or restore required functionality of the equipment or asset. Maintenance policies can be classified on various policies. Maintenance can be divide into three types breakdown maintenance (corrective maintenance), preventive maintenance, and condition based maintenance (Jong-Ho-shin). For breakdown maintenance an action will be taken when the problem is occur than task for corrective is apply, while predictive maintenance normally check a equipment and functionality of system periodically based on schedule in order to prevent an abnormality of the equipment.(Hong-Bae-jun)

Condition based maintenance (CBM) may be related to the preventive maintenance in the sense of goal is to avoid of any abnormality of equipment than can cause the system fail to perform its desire function, however CBM have some different approach from preventive maintenance, CBM actually focusing on predicting of degradation the product or equipment, which is based on the assumption of the abnormality will not take place immediately, and some times that has a kind of degradation from normal to abnormalities. CBM not only method of focusing on fault detection and diagnostics of the component but CBM also can degradation monitoring and failure prediction. (Jong-Ho-shin). Condition Based Maintenance (CBM) also can be used to cut the uncertainly of maintenance activity and it carried out permitting to the requirement showed by the equipment condition.

By applied CBM it will became an advance way to identify the problem of product or equipment before that equipment becoming fail to perform it desire function .(Hong-Bae-jun). CBM is a maintenance action based on information that be collected through the condition monitoring of the physical asset, by implement CBM in identify health of physical asset it can reduce maintenance cost by reducing the number of unnecessary schedule of preventive maintenance operation. (Jardine, Lin & Banjevic, 2006). Three step a concept of Condition Based Maintenance are show in figure 2.1.

Figure 2.1: Three steps in a CBM program.

1. Data Acquisition: to collect relevant data about health of physical item
2. Data Processing : this step present on amylase data collection to understanding health of physical item
3. Maintenance Decision Making: make a decision to apply maintenance strategy.

There are many of advantages and disadvantage of Condition Based Maintenance (CBM). A lot of report advantages of CBM has been reported from previous history in industry, CBM give an early warning before the failure occur on physical item and increase accuracy in predict failure to physical item. CBM also can be present while the machine or physical item is running, this mean an accurate diagnose of physical item will be more accurate compare to others approach. (Shin & Jun, 2015). In addition CBM can allow to implement a better planned maintenance, reduce unnecessary inspection, and reduce time based maintenance.

Beside that they are some several limitations in implement CBM. Cost for investment to implement CBM is still considered high. In term of monitoring equipment also need some high budget to purchase it. High skill of manpower also

must be consider in implementing CBM, because cost for give an training also expensive. They are some of technology and technical system still in their initial stages, so that mean they are some limitation in ensuring condition of physical equipment. (Shin & Jun, 2015).

2.2 Sensors

At the beginning of 21st century has been considered as the "Sensor Decade." With dramatically revolution in sensor R&D and application over the past 15 year, Nowadays the technology of sensor are used in varied application technology of sensor are used in varied application. A sensor stands as a device that be used in convert physical into electrical signal. The technology of sensor denotes part of the interface between the physical site and the site of electrical device, such as a computer. Recent year sensor becoming very importance element in various device, sensor can be limit the performance, range and capability.

Sensor is a device that related to the circuit in used to measure various physical properties such as temperature, force, pressure, flow, position, light intensity, etc. this properties act as the boost to the sensor, and provide similar measurement of physical properties. Sensor control in many applications in daily life at this world which we were live (john Vatelino). This mean all things in modern equipment today has be control by a sensor to make life became effective. In "sensor decade" the complexity of advancing technology, the every-increasing world population, and the emergence of terrorist-related activities have heightened the need of sensor. Depending upon particular application, fabrication, the design, testing, and eventual use of sensors require a wide variety of both technical and nontechnical expertise. As a result, sensor have becoming an emerging technology that prevails in the world. In a real world, for example, vehicles, the capacity of an electronic control system to convey accurately and successfully to the vehicle operation is critical to the operation of the car. Since the vehicle has been working in concert with an outside world of significant complexity, the requirement for reliable, effective, and accurate sensor is greatly high.

In order to appreciate the need, diversity, and complexity of sensor required in an automobile, it is interesting know on several potential areas of automobile in which sensor are used, it can be seen that the sensor function may range from a simple sensing of oil pressure, water temperature, and fuel level to the intensive control engine and transmission to optimize economy and performance while minimizing potential dangerous emission effluents.

Vehicle system have a various type of sensor that be used to ensure the performance of vehicle achieve the desire specification. Sensor is critical in automobile performance and it relate to vehicle system. The requirement of the sensor can be seen as parameter indicator such as accuracy and operating in temperature range.

2.2.1 Flow sensor

Flow sensors are variously applied in observing and control application, to quantify air and fluid stream. The term of flow can be characterized in numerous routes, for example, mass flow, volume flow, laminar flow, turbulent flow. Generally in automotive industry mass flow rate is the most importance. Information about the flow rate at which air mass flow in vehicle system is essential to control accurate flow rate to flow at some of the system in vehicle. If the system does receive accurate flow rate, an adjustment to flow rate is need to allow the system achieve their efficiency. (Turner & Watson, 2009). To monitor flow of fluid in vehicle flow sensor is need. flow sensor is a typical obtained by measuring the velocity in structure.

2.2.2 Thermal anemometer

Thermal anemometer use the principle that the amount of the heat remove from heat temperature sensor by a flowing fluid can be related to that fluid's velocity. These sensor typically use a second, unheated temperature sensor to compensate for variation in their temperature. Hot wire sensor are available as single

point instrument for test purpose, or multi arrays for fixed installation. These sensor are better at low airflow measurement than differential pressure types, and are commonly applied to air velocity from 50 to 12,000 feet per minutes. (Wilson, 2005)

Mas airflow (MAF) sensor are used on many automotive system, this sensor are used in measure air flow in certain area. This is necessary to enable the automotive management system to calculate and

$$w = Q + \frac{dQ_i}{dt}$$

Where

W = power generated by jouling heated given $I^2R_w = R_w = R_w(T_w)$

Q = Heat transfer rate to surrounding

Q_i = Thermal energy stored in hot wire (C_wT_w)

R_w = Resistance of wire

C_w = Heat capacity of wire

T_w = Temperature of wire

2.2.3 Differential Pressure sensor

This type of sensor technologies can be use either for air flow or liquid flow measurement. A variety of application-specific sensor used for both air flow and pressure measurement. Differential pressure sensor apply based concept that the pressure drop across the meter is proportional to the square of flow rate. The flow rate is found by measuring the pressure differential and taking the square root.

This type of device are similar to flowmeter, this device have primary and secondary element. The primary component is cause change of kinetic energy, to generate the differential the differential pressure in the system. For secondary