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DEVELOPMENT OF EXHAUST GAS LEAK DETECTOR TOOL BY USING COMPRESS AIR AND SMOKE METHOD

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A thesis submitted
in fulfillment of the requirements for the degree of
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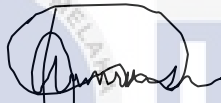## DECLARATION

I Declare That This Research Entitled "Development Of Exhaust Gas Leak Detector Tool By Using Compress Air And Smoke Method" Is The Result Of My Own Research Except As Cited In The References. The Research Has Not Been Accepted For Any Degree And Is Not Concurrently Submitted In Candidature Of Any Other Degree.

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Date : 28 /1/2022

APPROVAL

I Hereby Declare That I Have Checked This Thesis And In My Opinion, This Thesis Is Adequate In Terms Of Scope And Quality For The Award Of The Bachelor Of Mechanical Engineering Technology (Automotive Technology) With Honours.

Signature :

Supervisor Name : *Mrs Ezzatul Farhain Binti Azmi*

Date : 28/01/2022

DEDICATION

This project is wholeheartedly dedicated to my beloved mom, who have been my source of inspiration and gave me strength when I thought of giving up. To my brothers, sisters, supervisor, and classmates who shared their words of advice and encouragement to finish this project.

ABSTRACT

This project presents the design of exhaust gas leak detector tools. The difficulty to discover exhaust gas leak is more complex compared to lubricant leak. Leak of lubricant can be discovered by verifying the moisture in the leak area compared with exhaust gas has no smell, which means a small leak would be impossible to detect. The main purpose is to design a detector tool by using air and smoke method. The objectives of this project are (1) to design a low-cost tool to detect exhaust gas leak, (2) to fabricate a safety tool to detect the exhaust gas that is efficient, convenient and safe and (3) to analyze the effectiveness of this tool for mechanic to find the location of exhaust gas leak area. Exhaust Gas Leak Detector (ExGLD) is a tool that uses blower fan motor to create compress air from the outside of the tool to suction flowing into the ExGLD. The compress air pushes the smoke into the exhaust system. The smoke created from the combination of fire cracker smoke. The smoke and compress air work together in this process and eventually, the smoke will come out from the leakage area in the exhaust pipe if there is leakage detected. Leaks are most commonly seen in the exhaust pipe, muffler, manifold, and catalytic converter. The dimension of the ExGLD was done by drafting drawing from CATIA V5. The main part of the ExGLD is smoker box that dimension of the length is 400 mm, the height of the smoker box is 150 mm and the width of the box is 150 mm. The ExGLD designed compact, lightweight and easy to bring to anywhere. Acrylic sheet was used for the smoker box wall. Based on the project, the new tools have created to develop the gas leak detector for new era that can help technician or mechanic to find the exactly location of exhaust leakage. The blower speed reading for speed 1 is 11.95m/s, speed 2 is 15.68m/s and speed 3 is 18.85m/s. The blower speed reading was used to collect data for detection leakage size and the distance. The lowest reading of anemometer at 2 mm size of leakage hole size. The higher reading of anemometer is at 5 mm leakage hole size. This result show that by using blower speed 1, 2 and 3 at the Exhaust Gas Leak Detetctor (ExGLD) tool the leakage of 5 mm size can be easily see compare to leakage 2 mm. As the result the pressure of blower speed that comes out from leakage hole increase when the leakage size increase. Besides that, the length 1.2meter and 2.4meter does not affect the quantity of the compress air that coming out through the leakage hole. The velocity or the speed of air that coming out from the leakage hole is depend on the size of the leakage. Therefore, the ExGLD tool function to find the exactly location of the leakage hole area at the exhaust system.

ABSTRAK

Projek ini membentangkan reka bentuk alat pengesan kebocoran gas ekzos. Kesukaran untuk mengetahui kebocoran gas exzos lebih kompleks dibandingkan kebocoran pelincir. Kebocoran pelincir boleh ditemui dengan mengesahkan kelembapan di kawasan kebocoran dibandingkan dengan gas exzos tidak mempunyai bau, yang bermakna kebocoran kecil akan menjadi mustahil untuk dikesan. Tujuan utama projek ini adalah untuk mencipta alat pengesan dengan menggunakan kaedah mampatan udara dan asap.Objektif projek ini adalah seperti berikut. (1) untuk mencipta alatan yang berkos rendah untuk mengesan kebocoran gas ekzos, (2) menyediakan alatan yang boleh mengesan kebocoran gas ekzos yang menjimatkan masa, mudah dan selamat dan, (3) menganalisis keberkesanan alatan ini untuk memudahkan mekanik mencari lokasi sebenar kebocoran gas di ekzos. Exhaust Gas Leak Detector (ExGLD) adalah alat yang menggunakan motor dengan bilah kipas untuk membuat mampatan udara dari luar alatan yang digunakan untuk menyedut udara yang mengalir ke ExGLD. Udara mampatan mendorong asap ke sistem ekzos. Asap yang dihasilkan adalah daripada penggunaan mercun asap. Asap dan udara mampatan bekerjasama dalam proses ini dan akhirnya, asap akan keluar dari kawasan kebocoran di paip ekzos sekiranya terdapat kebocoran yang dikesan. Kebocoran paling sering dilihat pada paip ekzos, exzos, manifold, dan catalytic converter.Dimensi ExGLD dilakukan merangka lukisan dari CATIA v5.Bahagian utama dari ExGLD adalah kotak asap yang panjangnya 400 mm, tinggi kotak asap 150 mm dan lebar kotak asap 150 mm. ExGLD yang direka ringkas, ringan dan senang dibawa ke mana sahaja. Kepingan persepek akan digunakan untuk dinding kotak asap. Berpandukan perkara tersebut, alat baru yang akan dibuat untuk mencipta alat pengesan kebocoran gas untuk era baru dapat membantu juruteknik atau mekanik untuk mencari lokasi tepat kebocoran ekzos. Bacaan kelajuan blower untuk kelajuan 1 ialah 11.95m/s, kelajuan 2 ialah 15.68m/s dan kelajuan 3 ialah 18.85m/s. Pembacaan kelajuan blower digunakan untuk mengumpulkan data untuk saiz kebocoran pengesan dan jarak. Pembacaan paling rendah anemometer pada saiz 2 mm saiz lubang bocor. Bacaan yang lebih tinggi anemometer adalah pada saiz lubang kebocoran 5 mm. Hasil ini menunjukkan bahawa dengan menggunakan kelajuan blower 1, 2 dan 3 pada alat Detektor Kebocoran Gas Exhaust (ExGLD) kebocoran saiz 5 mm boleh mudah dilihat dibandingkan dengan kebocoran 2 mm. Sebagai hasilnya tekanan kelajuan pembuluh yang keluar dari lubang kebocoran meningkat apabila saiz kebocoran meningkat. Selain itu, panjang 1.2meter dan 2.4meter tidak mempengaruhi kuantiti udara kompres yang keluar melalui lubang bocor. Halaju atau kelajuan udara yang keluar dari lubang kebocoran adalah bergantung kepada saiz kebocoran. Oleh itu, alat ExGLD berfungsi untuk mencari lokasi tepat kawasan lubang kebocoran di sistem exhaust.
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ExGLD	-	Exhaust Gas Leak Detector
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
CNG	-	Compress Natural Gas
CDC	-	Centres for Disease Control
RPM	-	Revolution Per Minutes
CC	-	Cubic Capacity
ECU	-	Engine Control Unit
LED	-	Light Emitting Diode
UV	-	Ultra Violet
DVVT	-	Dynamic Variable Valve Timing
EM	-	Exhaust Manifold
MM	-	Milimeter
IPU	-	Air Polution Index
CATIA	-	Computer Aided Three-Dimensonal Interactive Application
PVC	-	PolyVinyl Chloride
LPG	-	Liquefied Petroleum Gas
SMS	-	Short Massage Service

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CHAPTER 1

INTRODUCTION

1.1   Background

The internal combustion engine is one invention that has had a profound impact on
every aspect of human life. It is still the dominant driver of industry and transportation
around the world, more than a century after its development. Vehicles that rely on a
combustion engine as their primary source of power will be harmed. Cars that are expected
to age will be prone to damage such as exhaust system leakage. Almost every year, a lot of
death due to inhalation of poisonous gases that leaks from the vehicle exhaust system (Che
Soh et al., 2010). Leaks in the exhaust system can be extremely harmful due to harmful
exhaust fumes to enter the vehicle's interior instead of being released by the tail pipe.

Gas leakage is a serious issue that may currently be found in many areas, including
homes, businesses, and vehicles such as compressed natural gas (CNG), buses, and cars. It
is observed that due to exhaust gas leakage, dangerous accidents occur (Khan, 2020). If the
damage of the leaking gas exhaust system does not be resolved immediately, it may cause
various hazards such as exhaust gas poisoning which can cause the driver or passenger to
experience fast drowsy (micro-sleep). The leakage of exhaust gas can be dangerous for
drivers and passengers if the accumulation of smoke in the cabin is faster than the car's
ventilation system to release it. Exhaust gas contains toxic gases such as carbon monoxide,
nitrogen oxides, phosphorus, metals such as lead, and unburned fuels (hydrocarbons).

The worst effect is that it can cause death due to inhalation of carbon monoxide which
is a very poisonous gas. The leakage of exhaust gas can also harm a vehicle's fuel

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consumption and performances, it makes the vehicle produces a lot of noises, and damage the catalysts (Oke et al., 2011). Therefore, in order to repair the leakage on the exhaust system, it is slightly complicated as the mechanics need to detect where is the exact location of leakages occur.

The development of this project is creating exhaust gas leak detector tool because a lot of people died due to the harmful of the carbon monoxide flow inside the vehicle cabin. This happened because of the leaked exhaust gas from exhaust system will flow the poison gas into the vehicle cabin. It will take a long time to solve this problem. Sometime mechanic cannot even solve the exhaust gas leak because they didn't find the exact location of the leaking area. The fabrication of exhaust gas leak detector by using compress air with smoke will make the work of the mechanic much easier and save time. This tool can guarantee the safety of mechanic during fixing the leaking exhaust gas problem compared to the conventional method.

1.2   Problem Statement

In repairing cars, the most important role is to diagnose the problem accurately and quickly. It was not an easy job to find an accurate location of malfunction component. Special tools are needed to regulate the process of repairing the car. Successful diagnosis depends on how mechanic finds the root causes the problem by using the particular tools. The difficulty to discover exhaust gas leak is more complex compared to lubricant leak. Leak of lubricant can be discovered by verifying the moisture in the leak area compared with exhaust gas has no smell, which means a small leak would be impossible to detect.

An exhaust gas leak leads in case of death. One such silent killer coming out of vehicle exhaust is carbon monoxide (CO). CO exposure causes serious complications including brain damage and heart problems or even sudden death in severe cases (Thranya

Arumugamad, 2020). CO is a dangerous gas that is colorless, unscented and tasteless (Shantonil Nag, 2016). The number of sudden death incidents due to excessive CO inhalation has recently increased (Che Soh et al., 2010).

According to the Centres for Disease Control and Prevention (CDC), Americans die every year from accidental CO poisoning that is not caused by fires. There are more than 20,000 emergency room visits, and over 4,000 hospitalizations (Brazier, 2017). Sudden death cases while sleeping in a vehicle has raised alarming among Malaysian and authority. Specifically for a car driver and passengers who stop taking a rest without turn off the car engine and poisoned by carbon monoxide (Masek et al., 2019). Three Malaysians die in suspected carbon monoxide poisoning in their vehicle. The carbon monoxide was supposed to have seeped into their vehicle due to a faulty air conditioning system.

A common procedure to detect exhaust leak is either run the engine, press the throttle pedal at certain revolution per minutes (rpm) to perceive sound of leaking or need to touch all the parts of the exhaust pipe to find the area of leaking. The method used is not systematic and takes a long time to solve the problem. By creating this exhaust gas leak detector tool, mechanic can easily detect the exhaust gas leak in exhaust system and solve it to prevent the unwanted gas flows in into the car cabin and harms the driver and passenger. Thus, this project aims to develop new tools to detect exhaust gas leak.

1.3   Research Objective

The objectives of this project have been identified and should be achieved to produce a successful exhaust gas leak detector. The objectives of this project are as follows:

a)   To design a low-cost tool to detect exhaust gas leak.

b)   To fabricate a safety tool to detect the exhaust gas that is efficient, convenient and safe.

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c) To analyze the effectiveness of this tool for mechanic to find the location of exhaust gas leak area.

1.4   Scope of Research

This research is creating a new effective tool for mechanic to find the exhaust gas leak area easily. This tool has three speeds of fan blower where it functions to drag and compress air. The compress air will flow into the smoker box. The smoker box function is to create smoke by smoke bomb. By lighting up the smoke bomb, the smoke will be come out and the smoke will be compress by air into the exhaust pipe to exhaust system to find the leak location. The smoke will come out from the leaking area and mechanic will observe to find the smoke. This method will make mechanic job scope will be easier and save time.

The scope of the project has been focusing on exhaust system prototype using PVC pipe. This prototype had been using because the cost is cheaper than actual exhaust system. The total length of the exhaust prototype is around 3 meters. The appearance of the exhaust prototype is similar to actual exhaust system which have catalytic dummy at the middle and angle elbow. The diameter of catalytic dummy is 80 mm and the diameter of angle elbow is 40 mm. The total diameter of the exhaust system is 40 mm.

This exhaust prototype is differing from others because at the end of the PVC pipe have been put a stopper. The present of the stopper will make the leaking hole be more focus because the compress air will not blow out from the pipe but it is still remained in the pipe. If there a leakage hole, the compress air will come out at the hole, so we can detect the leakage easily.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

This chapter is about the research of exhaust leak tools, existing product, study of Carbon Monoxide, safety precaution for checking vehicle, other tool product with the same method leak identifies and vehicle exhaust system. Last but not least, this chapter discusses symptoms and causes of an exhaust leak, a common method of gas detector, and existing product of gas detector that found in Malaysia market.

2.2   Study of Carbon Monoxide

Currently, in Malaysia the number of sudden death due to excessive Carbon Monoxide (CO) inhalation has recently increased. The cases of death occurred due to the habit of citizen and awareness for instance, air conditioning switches remain on while they are sleeping in the car (Bernama, 2020). The condition where there is a gas leakage in the cabin especially CO, will result to sudden death. Basically, when there has excessive CO concentration occur in the cabin, the driver will feel sleepy. As a result, excessive sleep in the car with the air conditioning on could lead to sudden death.

New Straits Time, (2008) was reported there a case where a young couple died due to Carbon Monoxide (CO) inhalation in Johor Bharu Malaysia. The cases of young couple died occurred after lethal doses of the gas speeded into the car's inner chamber through its extractor exhaust system, which was found to had been modified. There is no sign of trauma was shown in the examination of the body.

Second cases that involve the hazardous CO gas occur in Kulai. According to (Arkib, 2000) the accident involved a family with three children. As reported in the newspaper, the leakage of CO managed to flow through the ventilation system when the engine of the car was left in the running condition for about 3 hours (Che Soh et al., 2010).

Next cases are a couple died due to inhaled an excessive amount of CO which leaked from the air conditioning unit. The couple slept in the car without switch off the engine and shutting off the air conditioning system (Shantonil Nag, 2016) . Last but not least, there a case where a person tried to kill himself by using gas Carbon Monoxide supplied from the car exhaust. He uses a pipe attached to the exhaust system. This case showed the illustration that CO gas is poisonous and can be represent a serious danger when introduced into a vehicle cabin (Arkib, 2008).

All cases that had been reported in Malaysia were occurred due to the CO leakage in a car cabin. Carbon Monoxide is a colourless, odourless, and tasteless gas. CO gas is a poisonous and potentially lethal. Carbon Monoxide (CO), is the by product by the incomplete combustion (Che Soh et al., 2010). It is the by product from the combustion of the flammable fuels like natural gas, propane gas, heating oil, kerosene, coal, charcoal, gasoline, or wood burn with insufficient oxygen. The entire death case can be avoided and prevented by installing gas leakage detector in the user's car.

CO leakage occurs in two conditions. First, the exhaust system has been altered for a certain reason. Basically, the exhaust system is long in the standard car but had been modified to short. This condition leads to the leakage of Carbon Monoxide easily in the extractor exhaust system. Second, the air conditioning system in a car operates by filtering air from outside before it is used. However, it recommended switching off the air condition

while the car is stop. Air conditioners may gather Carbon Monoxide (CO) while the engine idles.

2.3   Safety precaution is important during inspection vehicle

The technician's manual way of inspecting the leakage on a vehicle's exhaust contributes to the technician's significant danger of health and safety (Roslin et al., 2016). Safety in this regard should be from external and internal forces in form of risks to life, tools and equipment and the workshop environment. When workshop technicians actively and subconsciously protect themselves, others, tools, equipment, and the environment, teaching and learning will undoubtedly be a rewarding experience (Omeje, 2017).

Example danger of health and safety that will harm the technician with effects on the respiratory system, skin cancer , and blood system are among the dangers. The risk mention as below :-

    i.   Respiratory Affect

One of the dangerous gases released by the exhaust system is carbon dioxide. The abnormal amount of carbon monoxide (CO) has been linked to major health effects. According to the study, technicians who were exposed to high levels of CO (for a long time) when inspecting leaks in vehicle exhaust pipes had respiratory symptoms throughout their lives. Beside that , technician were at possibility of developing issues due to adverse respiratory effects (Ratterman et al., 2011). The exhaust fumes might irritate the eyes and respiratory tract. Long-term exposure to diesel fumes can cause coughing and shortness of breath. If this type of gas is inhaled over an extended period of time, the risk of lung cancer may increase.

ii.   Skin Cancer

One of the dangers that technicians in the automotive repair sector face is skin cancer. Thermal and chemical burns commonly occur in the automobile repair sector as a result of contact with heated surfaces, such as heated metal like exhaust pipe, tail pipe, catalytic and exhaust manifold. Common inspection to detect the exhaust leakage, technician need to idle or press the throttle pedal to check the leakage at the exhaust system. Exhaust component or a hot melt chemical with a rapid temperature change. As a result, if the dermal layer of the skin is injured, scarring will occur (Ford, 2014). Malignant alterations in the form of a large ulcer have occurred in areas of previously damaged, chronically inflammatory, or scarred skin in some cases, typically associated with chronic burn wounds. Figure 2.1 shows that the major risk that technician need to face during inspection process on the car with the exhaust leakage problem.

Figure 2.1 Technician check the exhaust leak

Figure 2.1 shows that technician find the location of the exhaust leakage by common method such as feel and touch the air coming from leaking area. This common method is high risk because it will harm technician by skin burn. Other risk is technician exposed to the exhaust gas from the tail pipe and can effect technician respiration.