Faculty of Mechanical Engineering

THE EFFECT OF DIRT ON AN ENGINE COOLING SYSTEM

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Project report submitted in fulfilment of the requirement for the Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

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DECLARATION

"I hereby declare that the work in this whole report is my own except for the summaries and quotations which have been duly acknowledged"

Signature: ……

Author: Nur Kamal Hisyam Bin Mohamad Nazri

Date: ……

APPROVAL

I have checked this report and the report can now be submitted to JK-PSM to be delivered back to supervisor and to the second examiner.

Signature :.....

Name of Supervisor: MOHD HAFIDZAL BIN MOHD HANAFI

Date :.....

DEDICATION

To my beloved father Mohamad Nazri Bin Mohd Noor,

My beloved mother Ayu Yusnita Binti Razali,

My beloved sisters,

Nur Aimi Balqis, Nur Aini Batrisya,

&

My supportive friends,

Tengku Azeruddin, Arif Sufian

ABSTRACT

This report analytically focus on study the automotive engine cooling system and the effect of dirt on engine cooling system. The function of automotive cooling system is to cooling the engine after running for a long time. The engine will generate huge amount of heat and must be cool to avoid an engine damage. As the vehicle goes through the muddy and dusty road, the dirt will accumulate on the surface of the radiator and it will affect the performance of the engine. From the experiment result, it shows that increase of the area covered by dirt on the surface of the radiator will proportion increase of the temperature inlet and outlet of the radiator. It also show that mud as covering material, will have the higher temperature of inlet and outlet of the radiator compared the silt. Using brush as a cleaning method, the temperature will decreased to the preliminary condition which is good to the engine.

ABSTRAK

Laporan ini secara analitik menumpukan pada kajian sistem penyejukan enjin automotif dan kesan kotoran pada sistem penyejukan enjin. Fungsi sistem penyejukan automotif adalah untuk menyejukkan enjin selepas berfungsi untuk masa yang lama. Ia akan menghasilkan sejumlah besar haba dan mesti menjadi sejuk untuk mengelakkan kerosakan enjin. Radiator yang selalu dipasang di hadapan enjin digunakan untuk memindahkan haba dari cecair (dipanaskan akibat pembakaran enjin) ke udara yang mengalir melalui sirip radiator. Walau bagaimanapun jika kenderaan itu melalui jalan berlumpur dan berdebu, kotoran akan berkumpul di permukaan radiator dan ia akan menjejaskan prestasi enjin. Daripada eksperimen yang telah dilakukan menggunakan pelantar ujian, ia menunjukkan bahawa peningkatan kawasan yang diliputi oleh kotoran pada permukaan radiator akan meningkatkan kenaikan suhu masuk dan keluar radiator. Ia juga menunjukkan bahawa lumpur sebagai bahan penutup, akan mempunyai suhu yang lebih tinggi dari salur masuk dan keluar radiator berbanding lumpur. Menggunakan berus sebagai kaedah pembersihan, suhu akan menurun kepada keadaan permulaan yang baik kepada enjin.

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LIST OF ABBREVIATIONS AND SYMBOLS

HVAC	Heating Ventilation Air Conditioning
EMF	Electromotive force
RPM	Revolution per minutes
Kpa	Kilo Pascal
Km	Kilo Meter
min	Minimum
max	Maximum
Cm	Centimetre
mm	Millimetre
ft	Foot
lb	Pound
kW	Kilo Watt
C_c	Coolant heat capacity
T_{ci}	Temperature coolant inlet
T_{co}	Temperature coolant outlet
T_{ao}	Temperature air outlet
T_{ai}	Temperature air inlet
A_a	Area air
A_c	Area coolant
ρ_c	Density coolant
ρ_a	Density air
$C_{p,a}$	Specific heat of air
$C_{p,c}$	Specific heat of coolant
ε	Thermal efficiency
Q	Heat transfer rate
°C	Celsius
m^3	Cubic metre
s	Second

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

An automotive engine generates a huge amount of heat once it is running. It should be cooled continually to avoid engine damage. The maximum temperature attained throughout combustion is approximately equal to the melting point of platinum, and therefore the temperature even of the exhaust gas is higher than that of the melting point of aluminium [1]. Generally, this is typically done by using water mixed with a liquid solution which called antifreeze that passes through special cooling passages.

The antifreeze passes through the engine extract heat around the combustion chamber and dissipates the heat inside the radiator. The radiator is used to transfer heat from the fluid (heated due to engine combustion) to the air flowing through the fins of the radiator. The air flowing is driven by a mixture of the forward motion of the automobile and from a fan enclosed during a shroud connected to the radiator [1]. The radiator acts as a reservoir that stores water for the engine cooling system. Therefore, the basic needs of the radiator are to supply a sufficiently large cooling space for transmission of heat from the fluid (antifreeze) to the air. The fluid passes through the chambers inside the engine block to absorb the heat and spread it far away from other main components [2].

As shown in Figure 1.1, the radiator is regularly placed in front of the engine to increase the stream of air in the cooling of the motor [3]. However, if the vehicles through on the untarred road, a ton of dust and mud would obstruct a large proportion of the radiator fins area. Subsequently, the engine could be overheated, which may influence the performance [3]. These dust accumulations reduce heat removal. Unfortunately, there are only a few published literature on the measurement of dirt on the radiator and its impact on the engine performance. Present studies take on the critical looks at the effects of dirt on the radiator performance.

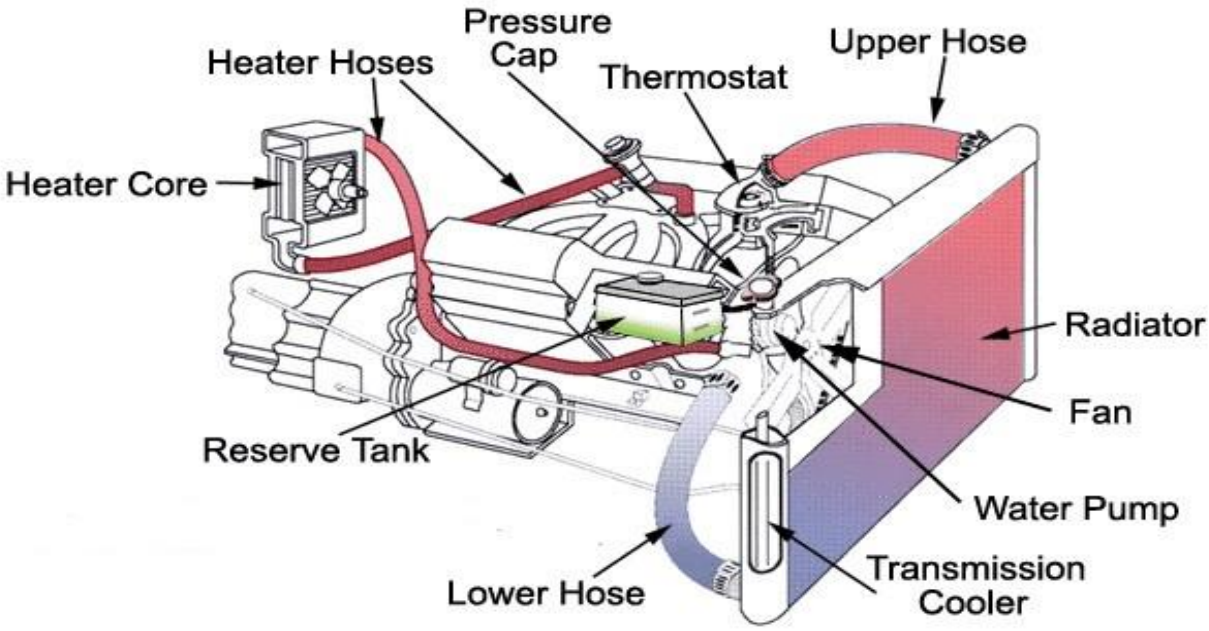


Figure 1.1: Main component on the automotive cooling system [18].

1.2 PROBLEM STATEMENT

Engine overheating is one of the main concern in any vehicle where the temperature of the cooling system should not increase to the maximum level. However, as the vehicle goes through dusty and muddy roads, the dirt may deposit on the radiator and these accumulate of dirt will block the air flows, and subsequently, reduce the efficiency of the cooling system. As the temperature in the cooling system increased, it will cause the engine to be overheating and this will break and seize the overhead cam.

1.3 OBJECTIVE

The objective of this projects are as follows:

i) Investigate the effects of dirt (mud and silt) on the radiator performance.

1.4 SCOPE OF PROJECTS

This study will conduct an experiment on a radiator (Perodua Kancil 850 model), focusing on its performance before and after dirt accumulation. Two type of dirt (mud and silt) will be used and only a part of the radiator will be covered with dirt. The study manipulates percentage or the amount the dirt's on the radiator in addition to different the flow rate and coolant temperature. There will be only one type of coolant in this study which is a mixture of 50 % of water and 50 % of ethylene glycol.

1.5 GENERAL METHODOLOGY

The clarifications and detail for the methodology that will be executed in order to accomplish the objective in this project will be discussed in chapter 3. Generally, the flow of this project is as follows:

(a) Literature review

Collecting data from the previous journal, website, books, article, videos and any related material about the project.

(b) Experiment setup

All the test component will be prepared along the measurement devices such as thermocouple and data logger to conduct the experiment.

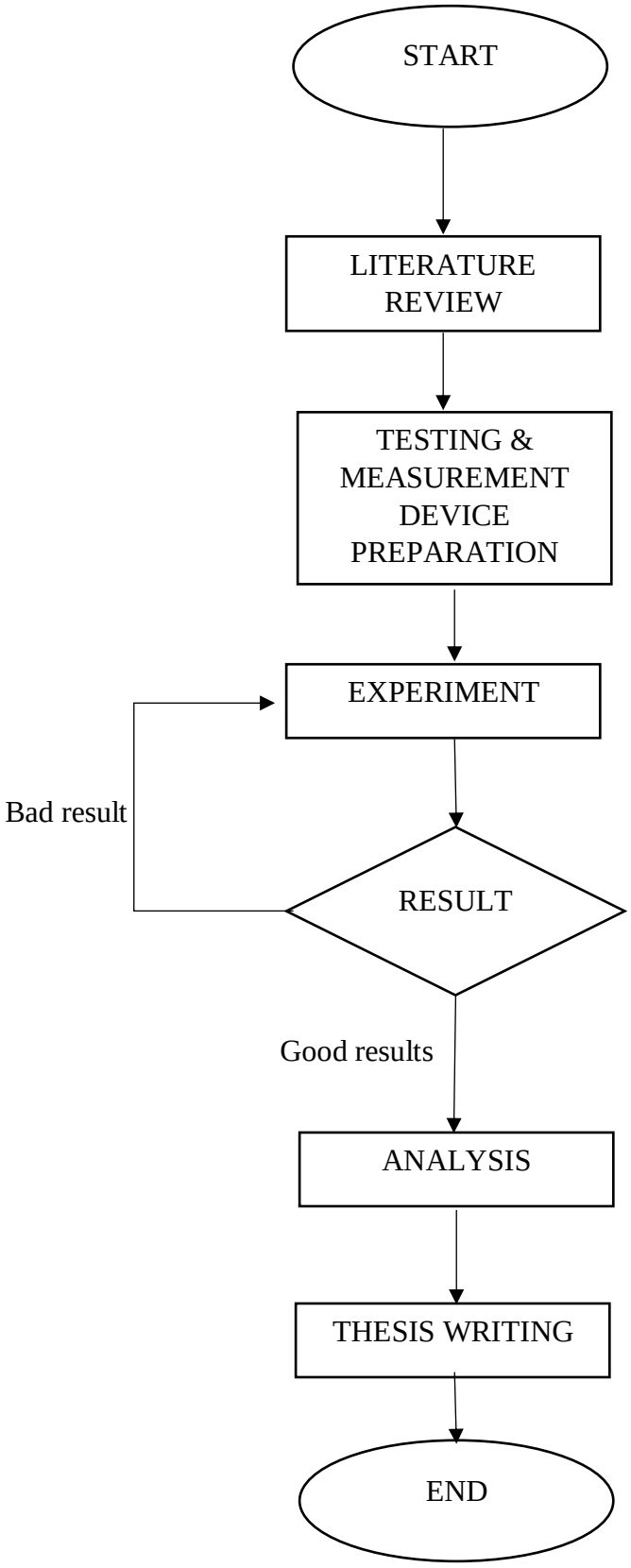
(c) Experiment & analysis

The experiment will be the focused on the temperature of the automotive coolant by collecting data in two different conditions (a) pre-test and (b) post-test. The pre-test is referred to a clean condition before any dusts are placed on the radiator (heat exchanger) surface. While, the post-test is the condition with the addition of dust. The temperature at the inlet and outlet of the radiator will be measured by using several thermocouple. The temperature data will be analysed to investigate the effect of dirt on radiator performance.

(d) Thesis writing

At the end of the project, a thesis will be written that include all the data and analysis of the experiment.

The methodology of this study is simplify in the flow chart as shown in Figure 2.



CHAPTER 2

LITERATURE REVIEW

This chapter will discuss on the past literatures that discussed on automotive cooling system and its performance. This include any factors that influence the efficiency and overall engine performance.

2.1 INTERNAL COMBUSTION ENGINE SYSTEM

The purpose of an internal combustion engine is to create mechanical power from the chemical energy of the fuel. The internal combustion engines, as distinct from external combustion engines, this vitality is discharged by copying or oxidizing the fuel inside the motor. The fuel-air blend before combustion and the burned product after ignition are the real working fluids. The work transfers that provide the desired power output occur directly between these working fluids and the mechanical parts of the engine[4].

An atmospheric engine that was introduced by Otto [4], has utilized the pressure rise due to the ignition of the fuel-air. It charges early in the outward stroke to accelerate a free piston and rack assembly, so that its momentum would generate a vacuum in the cylinder. Atmospheric pressure pushed the internal cylinder, with the rack connected through a roller clutch to the output shaft.

In the past, a German architect Diesel [4] has sketched out in a patent on another type of internal ignition motor. His idea of starting combustion by injecting a liquid fuel into air heated exclusively by compression permitted a multiplying of efficiency over another

internal ignition engine. A lot more expansion extension ratios, without explosion or knock, are now possible[4].

An engine produces a high amount of heat while running. This can raise the engine temperature to an abnormal state and can break the engine component. For the security of engine parts, it needs to keep running at a much lower temperature, which is known as engine working temperature [5]. Most susceptible to overheating are the base of the cylinder head, the upper belt of the cylinder liner, the piston crown, the upper compression ring, and the exhaust valve cap.

The stresses from moving the thermal field in these elements, due to the periodic nature of the work of the internal combustion engine, may offer rise to fatigue crack propagation with specific mechanisms, which is more hazardous than crack propagation mechanisms in static thermal fields [6]. It influences the combustion temperature in the engine, by directly affecting its performance and emissions [7]. The engine cooling system keeps the engine running at its working temperature by evacuating excess heat [8]. As shown in figure 2.1, it show that all the part of the internal combustion engine such as piston, engine block, connecting rod and crankcase.

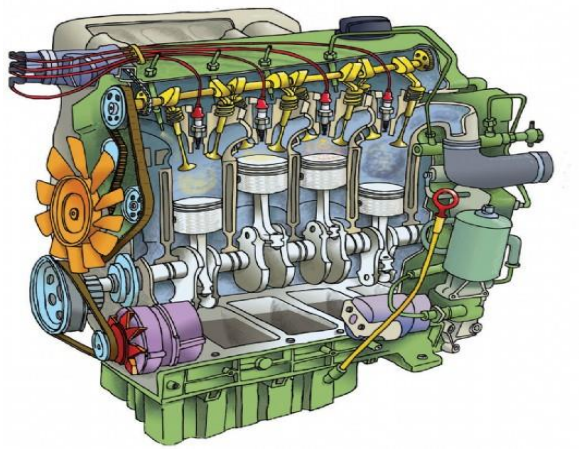


Figure 2.1: Part of Internal Combustion Engine [19].

2.2 ENGINE COOLING SYSTEM

The use of engine cooling system is to keep up the ideal coolant temperature for optimum engine operation. According to Tasuni [9], the water pump will enhance the cooling effect. Water pump is one of the important components in the cooling system as it maintains the circulation of coolant throughout the system. Many researches have been conducted to study the water pump characteristic of an engine cooling system [9]. The experiments usually used a real engine cooling system as a test rig.

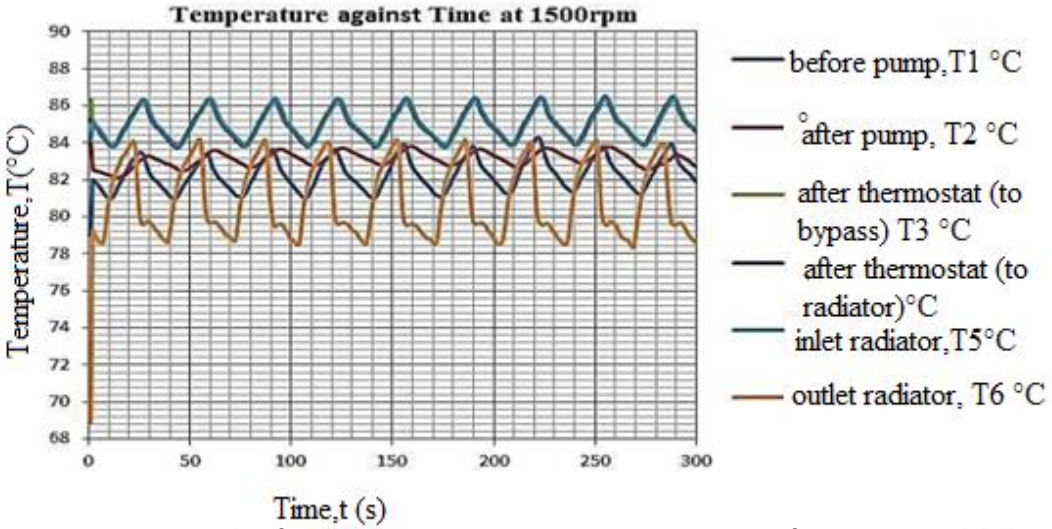


Figure 2.2: Graph of temperature against time at 1500rpm of engine speed [9].

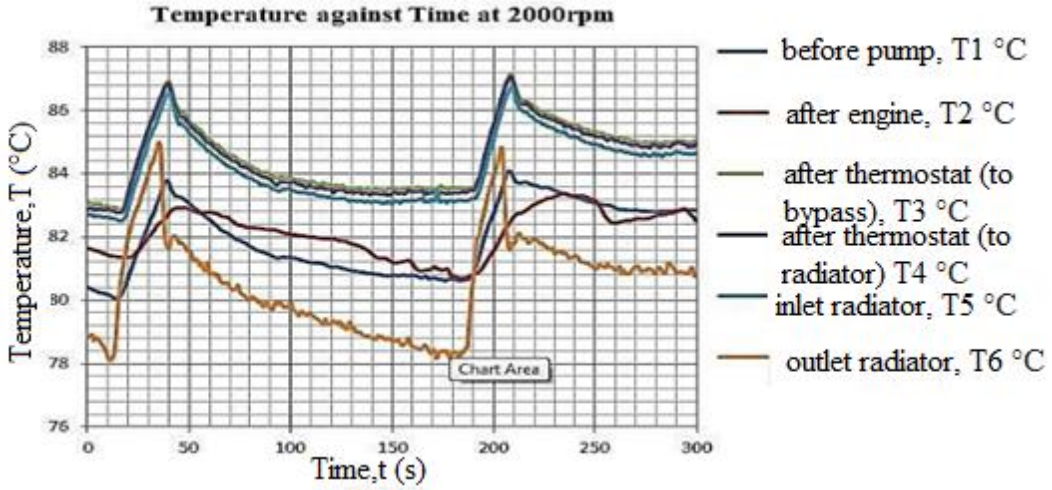


Figure 2.3: Graph of temperature against time at 2000rpm of engine speed [9].