

FLUID PROPERTIES OF AUTOMOTIVE ENGINE COOLING SYSTEM

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**This report is submitted in
fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering**

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DECLARATION

I declared that this project report entitled “Fluid Properties of Automotive Engine Cooling System” is the result of my own work except those that were cited in the references.

Signature :

Name of Supervisor :

Date :

SUPERVISOR'S APPROVAL

I hereby declared that I have read this project report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

Signature :

Name of Supervisor :

Date :

DEDICATION

To my beloved father, Idris Bin Husin and
Loving mother, Roiyati Binti Mohamad

ABSTRACT

Car cooling system is one of the most important components in the automotive engine system. The function of this cooling system is to control engine temperature from overheat. A typical car can produce enormous amount of heat ignite by the combustion of fuel in cylinder to drive the wheels. If it is not controlled, it can destroy an engine in a minute. A few components that influence cooling system are; i) size of radiator, ii) type of coolant, iii) speed of fan, and iv) radiator fin. This factor will affect the rate of temperature released to the surrounding. The experiment was performed to study the major properties of coolant that influence cooling system and to differentiate properties behaviour between various type of coolant. The result stated that the coolant with 88.86% water and 11.42% antifreeze is the best because of the factor that influence the heat transfer and ability to increasing the boiling point and lowering the freezing point.

ABSTRAK

Sistem penyejukan kereta adalah salah satu komponen yang paling penting dalam sistem enjin kenderaan. Fungsi sistem penyejukan ini adalah untuk mengawal suhu enjin daripada terlalu panas. Enjin kereta boleh menghasilkan sejumlah besar haba yang menyala oleh pembakaran bahan api dalam silinder untuk memacu roda. Jika ia tidak dikawal, ia boleh memusnahkan enjin dalam masa yang singkat. Beberapa komponen yang mempengaruhi sistem penyejukan adalah; i) saiz radiator, ii) jenis penyejuk, iii) kelajuan kipas, dan iv) sirip radiator. Faktor ini akan mempengaruhi kadar suhu yang dilepaskan ke kawasan sekitarnya. Ujikaji di makmal dilakukan untuk mengkaji sifat-sifat utama penyejuk yang mempengaruhi sistem pendinginan dan membezakan kelakuan sifat antara pelbagai jenis penyejuk. Hasilnya menyatakan bahawa penyejuk dengan 88.86% air dan 11.42% antibeku adalah yang terbaik kerana faktor yang mempengaruhi pemindahan haba dan keupayaan untuk meningkatkan titik didih dan menurunkan titik beku.

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TABLE OF CONTENT

DECLARATION	
SUPERVISOR'S APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENT	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS	ix
INTRODUCTION	1
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT	2
1.3 RESEARCH STATEMENT	3
1.4 SCOPE OF RESEARCH	3
1.5 GENERAL METHODOLOGY	4
2 LITERATURE REVIEW	8
2.1 ENGINE	8
2.2 COOLING SYSTEM	9
2.2.1 FUNCTION OF COOLING SYSTEM	10
2.3 COOLING PART	10
2.3.1 Coolant	10
2.3.2 Reservoir	12
2.3.3 Thermostat	13
2.3.4 Radiator	15
2.3.5 Radiator Fan	16
2.3.6 Heater Core	17
2.3.7 Hoses	18
2.4 FLUID PROPERTIES	19

2.4.1	Density	19
2.4.2	Conduction	20
2.4.3	Thermal Conductivity	21
2.4.4	Heat Transfer	22
2.4.5	Ideal Gas Law	23
3	Methodology	24
3.1	Experiment	25
4	RESULT AND ANALYSIS	27
4.1	INTRODUCTION	27
4.2	RESULTS AND DISCUSSION	29
4.2.1	COOLANT COMPOSITION OF 100% WATER	29
4.2.2	COOLANT COMPOSITION OF 94.33 % WATER AND 5.57 % ANTIFREEZE	32
4.2.3	COOLANT COMPOSITION OF 88.86% WATER AND 11.42% ANTIFREEZE	36
4.2.4	COOLANT COMPOSITION OF 83.29% WATER WITH 16.71% ANTIFREEZE	40
4.3	LIMITATION	44
4.4	COMPARISON	45
5	CONCLUSION AND RECOMMENDATION	47
5.1	CONCLUSION	47
5.2	RECOMMENDATION	47
CHAPTER 6		48
6	REFERENCE	48
7	APPENDIX	52

LIST OF TABLES

Table 1: Gantt Chart for FYP 1 and FYP 2	4
Table 3: Coolant temperature with 94.33% water and 5.57% antifreeze	52
Table 2: Coolant temperature with 100% water composition	52
Table 4: Coolant temperature with 88.86% water and 11.42% antifreeze	53
Table 5: Coolant temperature with 83.29% water and 16.71% antifreeze	53

LIST OF FIGURES

Figure 1: Circulation of coolant in engine.....	2
Figure 2: The engine component	8
Figure 3: The cooling system	10
Figure 4: The antifreeze coolant.....	12
Figure 5: The coolant reservoir.....	13
Figure 6: The thermostat	15
Figure 7: The radiator	16
Figure 8: The radiator fan	17
Figure 9: The heater core component.....	18
Figure 10: The hoses for cooling system	19
Figure 11: The conduction process	21
Figure 12: Experimental set-up	28
Figure 13: Schematic diagram of experiment.....	28
Figure 14: Coolant temperature with 100% water composition.....	29
Figure 15: First segment of 100% water composition graph	30
Figure 16: Second segment of 100% water composition graph	30
Figure 17: Third segment of 100% water composition graph	31
Figure 18: Fourth segment of 100% water composition graph.....	31
Figure 19: Fifth segment of 100% water composition graph	32
Figure 20: Sixth segment of 100% water composition graph	32
Figure 21: Coolant temperature with 94.33% water and 5.57% antifreeze.....	33
Figure 22: First segment of 94.33% water and 5.57% antifreeze composition.....	33
Figure 23: Second segment of 94.33% water and 5.57% antifreeze composition graph	34
Figure 24: Third segment of 94.33% water and 5.57% antifreeze composition graph	34
Figure 25: Fourth segment of 94.33% water and 5.57% antifreeze composition graph	35
Figure 26: Fifth segment of 94.33% water and 5.57% antifreeze composition graph	35

Figure 27: Sixth segment of 94.33% water and 5.57% antifreeze composition graph.....	35
Figure 28: Coolant temperature with 88.86% water and 11.42% antifreeze	36
Figure 29: First segment of 88.86% water and 11.42% antifreeze composition graph.....	37
Figure 30: Second segment of 88.86% water and 11.42% antifreeze composition graph	37
Figure 31: Third segment of 88.86% water and 11.42% antifreeze composition graph	38
Figure 32: Fourth segment of 88.86% water and 11.42% antifreeze composition graph	38
Figure 33: Fifth segment of 88.86% water and 11.42% antifreeze composition graph	39
Figure 34: Sixth segment of 88.86% water and 11.42% antifreeze composition graph.....	39
Figure 35: Coolant temperature with 83.29% water and 16.71% antifreeze	40
Figure 36: First segment of 83.29% water and 16.71% antifreeze composition graph.....	40
Figure 37:Second segment of 83.29% water and 16.71% antifreeze composition graph	41
Figure 38: Third segment of 83.29% water and 16.71% antifreeze composition graph	41
Figure 39: Fourth segment of 83.29% water and 16.71% antifreeze composition graph	42
Figure 40: Fifth segment of 83.29% water and 16.71% antifreeze composition graph	42
Figure 41: Sixth segment of 83.29% water and 16.71% antifreeze composition graph.....	42
Figure 42: Result plagiarism from Turnitin software	53

LIST OF ABBREVIATIONS

PVC

Polyvinyl Chloride

RPM

Rotation Per Minutes

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Engine of a vehicle produces heat during combustion process. Engineers have to come out with a solution to cool down the engine by inventing a liquid called the coolant or also known as the antifreeze. Coolant are circulated around the engine block. It is generally a mixture of glycol and water where it is used to maintain or control the raising temperature of the engine. Researchers that had studied the properties of the coolant indicated that an ideal coolant has high thermal capacity and low viscosity. Coolant is also a non-toxic, chemical inert, and it will not cause corrosion in the cooling system. And the most important thing is, the cost to buy a coolant is super affordable.

There is other type of coolant that is used as the cooling agent which is water. Based on the observation, many people use water as a coolant substitution. This is mainly because it is cheaper and easier to find compare to the coolant. Unfortunately, water has a lot of down sides such as the corrosive behaviour, which can shorten the engine life. Water also does not posses antifreeze capability as compared to coolant.

Therefore, coolant is an important substance to maintain the temperature of the engine. One of the most conducted research in this area is how to reduce the taken time for the engine to cool down with the help of the coolant. Without the coolant, almost all conventional engines for modern cars and motorcycles will overheat and increase the tendency to break.

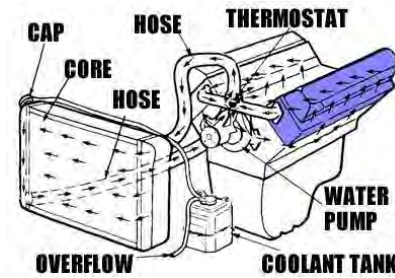


Figure 1: Circulation of coolant in engine

1.2 PROBLEM STATEMENT

Based on the scenario of a local manufactured car, the radiator fan keeps on rotating because the engine temperature is too high. In order to lower down the temperature, the fan has to suck air into the radiator fin and push the hot air out from the radiator. It will cool down the coolant inside the radiator. Therefore, the selection of good coolant is critical in order to regulate the temperature of engine during operation. The burning of engine fuel inside the cylinder increases the temperature up to 4500°F which can absolutely damage the engine without proper cooling system.

1.3 RESEARCH STATEMENT

Based on the problem statements described in the previous section, the objectives of the research are:

- i. To determine the major properties of coolant that influence the vehicle cooling system
- ii. To differentiate the properties behaviour between various type of coolant.

1.4 SCOPE OF RESEARCH

The scope of this project involves the experimental testing in laboratory environment to study the fluid properties of the coolant.

1.5 GENERAL METHODOLOGY

Table shows the Gantt generated for the following FYP 1 and 2

Task	Duration														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FYP 1															
Introduction to FYP	█														
Initial Work and Brainstorming		█													
Article and Gantt chart Submission			█												
Introduction and Methodology				█											
Research on Coolant					█										
Progress Report Submission						█									
Literature Review							█	█	█						
Literature Review Submission										█					
Conceptual Project											█	█	█		
Presentation														█	
FYP 1 Submission															█
FYP 2															
Experiment	█	█	█	█	█	█	█								
Result and Analysis								█	█	█	█				
Conclusion and Recommendation												█	█	█	
Presentation															█
FYP 2 Submission															█

Table 1: Gantt Chart for FYP 1 and FYP 2

The actions that need to be carried out in order to achieve the objectives of this project are listed as below:

1. Literature Review.

Journals, articles, books, and videos are studied as research materials for the project.

2. Observation, Surveys and Data Collection.

The car behaviour when the cooling system that is not functioning well is observed.

Automotive mechanic is referred to illustrate the cause of the problem.

3. Experimental Testing

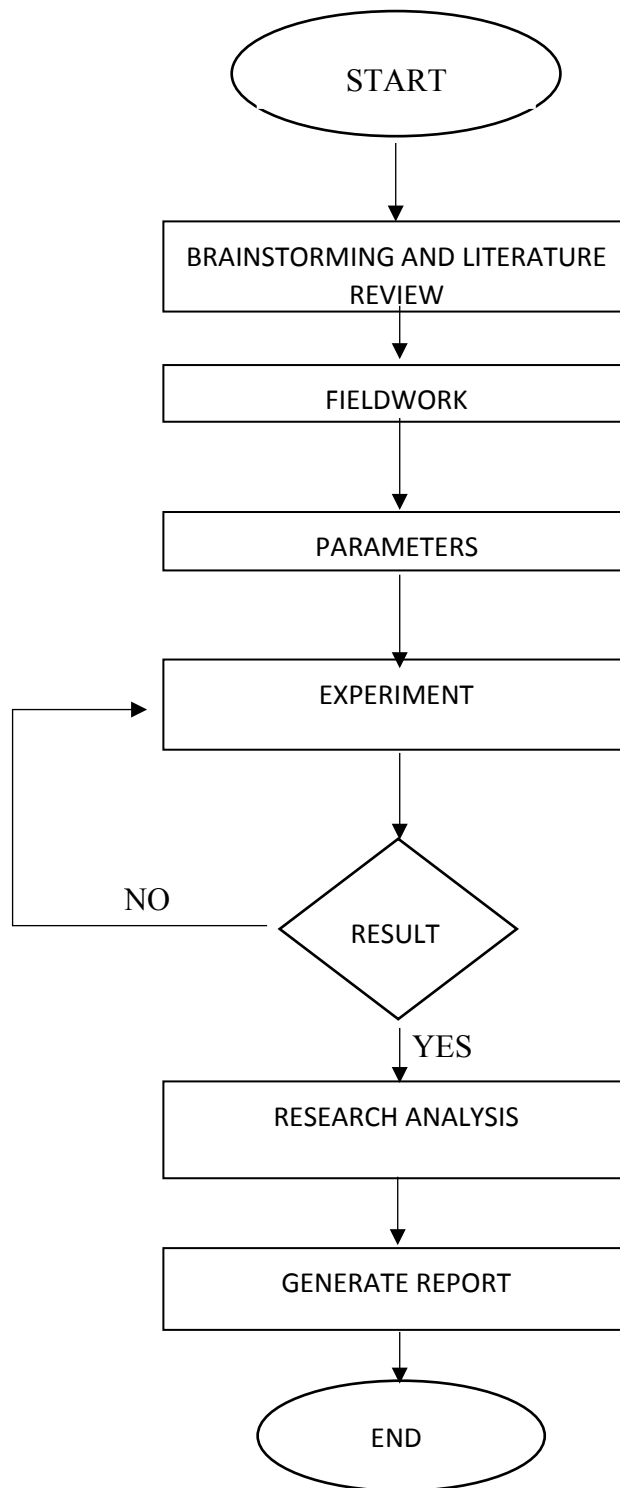
Experiment is conducted to collect data.

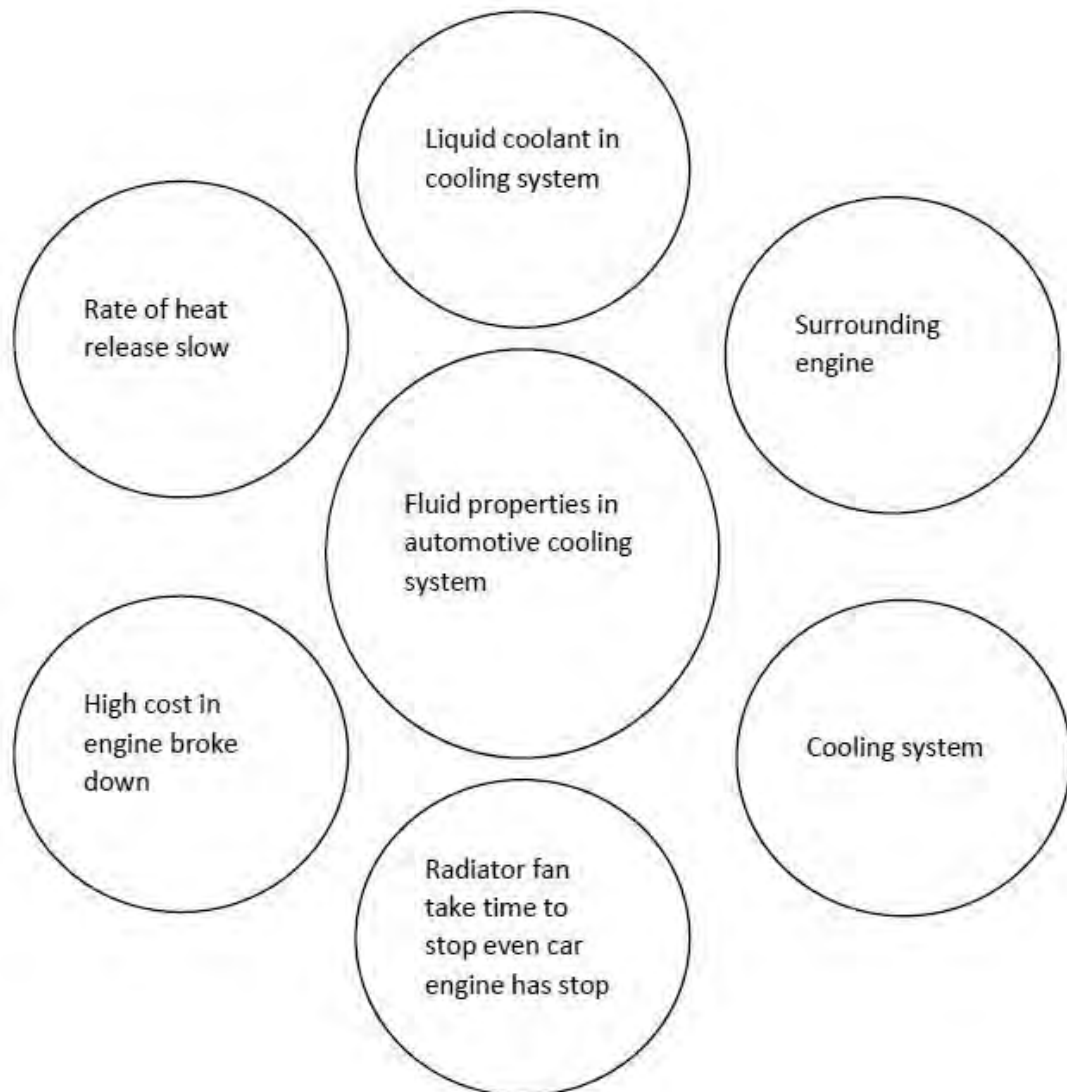
4. Analyse the results and provide the recommendation for improvement.

Analysis is presented on how to reduce the time for the automotive engine to cool down. All solutions are proposed based on the analysis of the project.

5. Report Writing.

A report will be written and submitted at the end of this project.





CHAPTER 2

2 LITERATURE REVIEW

2.1 ENGINE

A modern vehicle design consists of many integrated systems that are required to function properly. Cooling system is one of the subsystem that works to support the operation of vehicle powertrain system. Automotive engine was invented in 1878 by Karl Benz [1]. The components of the engine consist of cylinder block, piston, cylinder head, connecting rod, crankshaft, oil sump, crankshaft, valve, spark plug, injector, push rod, manifold, piston rings, gasket, piston pin, and engine bearing. The function of the engine is to propel the car by converting the chemical energy to mechanical energy [2]. The process of converting energy happened when the mixture of fuel and air exploded inside the combustion chamber. This explosion causes the piston to move which can be translated as mechanical energy.

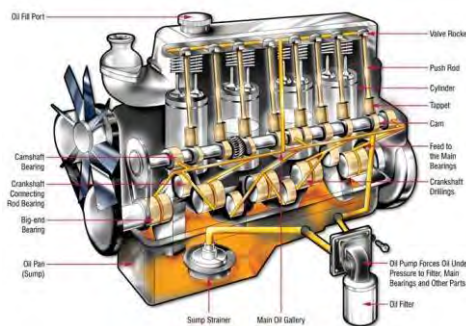


Figure 2: The engine component

2.2 COOLING SYSTEM

The combustion process of the engine is not only helps to move the car, but also leads to produce massive amount of heats that can damage the engine. Cooling system was invented to regulate the temperature of the engine. The fuel burns inside the cylinders can reach the temperature above 4500°F (2500°C) [3]. In even a more efficient engine, only 20 to 25 percent of this heat energy is used to drive a car. The remaining of 30 to 35 percent must be carried away by the cooling system to keep the engine oil from evaporating and the engine components from become jam or melt. The first honeycomb radiator was designed by Wilhelm Maybach for Mercedes 35hp. It was the first successful cooling system for a vehicle. Later on, engineers came out with improved design of radiator that was suitable with a larger engine capacity. In general, there are three type of cooling systems which are the air cooling, oil cooling and liquid cooling. These three types of cooling are used to remove the heat from the engine block and engine head. With air as the coolant, the heat is removed by using the fin that attached to the cylinder wall. By using water as the coolant, the heat is removed by the fluid that filled the internal cooling passages. Both of these fluids have various advantages and disadvantage. For the air-cooled system, this system is noisier because there is no water jacket to absorb the combustion sound. It uses fins to increase the heat transfer rate. For the water-cooled system, it usually uses a single loop where the water pump circulates the coolant to the engine block, and then to the engine head. The coolant then flows to radiator or heat exchanger and back to the pump [4].

Conventional car uses liquid cooling system. This is because this type of cooling is more efficient than air cooling. Oil cooling is usually used in the motorcycles engine. This system consists of reservoir, radiator fin, fan, coolant, hose, thermostat, heater core.

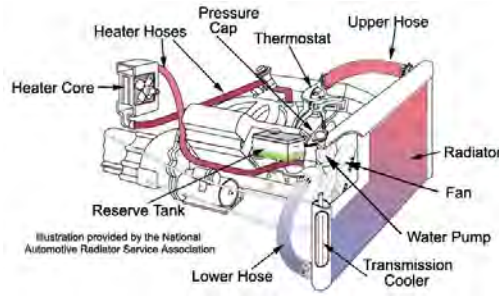


Figure 3: The cooling system

2.2.1 FUNCTION OF COOLING SYSTEM

Generally, the function of cooling system is to control the engine temperature. It removes excess heats produced by the internal combustion engine to keep the engine in safe temperature range [5]. In cold winter, the cooling system provides an interior cabin heat to warm up the car.

2.3 COOLING PART

2.3.1 Coolant

The main component in cooling system is coolant. Coolant is a liquid that is used as a heat transporter. Commonly called as antifreeze, it is a special formulated liquid that flows around the cylinder through the hollow passages in metal engine block called water jacket. Coolant absorbs heat from combustion and release the heat to atmosphere. Coolant is

generally consisting of a 50-50 mixture of glycol and water. Glycol is an organic compound, which is mainly used in polyester fibres and ion as a raw material in antifreeze formulation. Ethylene glycol is a common chemical used in many commercial and industrial applications including antifreeze coolant [6]. Ethylene glycol helps keeping the engine from freezing in the winter and acts as a coolant to reduce overheating in the summer. A spring-loaded radiator cap keeps the cooling system under about 14 pounds per square inch (97kPa) of pressure, which raises the boiling point of a 50-50 mixture of water and antifreeze from 226°F (108°C) to 263°F (128°C). The freezing point of the same mixture would be -34°F (36°C). Antifreeze concentrations of up to 70 percent can be used and produce a boiling point of 274°F (134°C) and freezing point of -85°F (-65°C) in a 14-psi pressurized system. More than 70 percent antifreeze will raise the freezing point rather than lowering it [7]. However, ethylene glycol is a toxic material that can cause birth defect, reproductive damages or even death if ingested and requires very specific handling. Ethylene glycol antifreeze has a sweet odour and flavour, and that makes it dangerously appealing to animal and child. An alternative antifreeze is based on propylene glycol. Propylene glycol antifreeze is significantly less toxic than ethylene glycol. Another method of removing heat that is commonly used is by substituting water as coolant. It is used as a method of heat removal from component and industrial equipment. The advantage of using water is inexpensive and non-toxic. It also has high specific heat capacity, density, and thermal conductivity. This allows water to transmit heat over greater distance with much less volumetric flow and reduce temperature difference. In contrast, water also accelerates corrosion of metal part. When the corrosion occurs, it may cause the crucial component like thermostat to break down and affects the cooling system performance. Another disadvantage is water has low boiling point and high freezing point as compared to antifreeze coolant.