'Saya/ Kami* akui bahawa telah membaca

karya ini dan pada pandangan saya/ kami* karya ini

adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan

Ijazah Sarjana Muda Kejuruteraan Mekanikal (Automotif)'

Tandatangan: .....

Nama Penyelia I: .....

Tarikh: .....

Tandatangan: .....

Nama Penyelia I: .....

Tarikh: .....

FABRICATING A CAR'S RADIATOR

HERMAN ANAK EDMEADES

Laporan ini dikemukakan sebagai

memenuhi sebahagian daripada syarat penganugerahan

Ijazah Saujana Muda Kejuruteraan Mekanikal (Automotif)

Fakulti Kejuruteraan Mekanikal

Universiti Teknikal Malaysia Melaka

MAY 2008

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya telah jelaskan sumbernya"

Tandatangan: .:.....

Nama Penulis: HERMAN ANAK EDMEADES

Tarikh: 7 MEI 2008

To God, my family and everyone who knows me

ACKNOWLEDGEMENT

The writer wishes to thank the supervisor, Dr. Yusoff bin Sulaiman for his guidance, teachings and motivations during the duration of this project.

The cooperation from the lab management, especially to Mr. Junaidi, Mr. Razmi, Mr. Nazri (FKP) and all the technicians who has help during the experimental and fabrication work is mostly appreciated.

Appreciation also goes out to everyone who has helped me in this project directly or indirectly and especially to Mohd. Firdaus bin Zakaria. The writer hopes that this report can be reference to the future students in UTeM.

ABSTRACT

Vehicle need to have a radiator in order to dissipate the excessive heat produced by the combustion of fuel inside the engine's cylinders. In order to fit into a car's hood, the radiator and fan system must have a compact size but still capable of transferring massive amount of heat energy from the engine to the surrounding air without the engine being overheated. Therefore the design and method of fabrication of a radiator is getting more and more technologically advance in order to cope with the demand of a lighter, corrosion resistance and sufficient radiator.

ABSTRAK

Kebanyakkan kenderaan moden memerlukan sebuah radiator untuk membebaskan lebihan tenaga haba yang dihasilkan oleh pembakaran bahan api di dalam silider enjin. Untuk memuatkan radiator di dalam bonet hadapan kereta, system radiator dan kipas perlulah memiliki dimensi yang padat tetapi masih mampu untuk membebaskan lebihan tenaga haba dari enjin tanpa menyebabkan enjin menjadi terlampau panas. Perminataan terhadap kereta bersaiz kecil juga menyebabkan radiator masa kini harus lebih ringan. Oleh itu, rekaan serta kaedah fabrikasi radiator menjadi semakin untuk menghasilkan radiator yang lebih ringan, tahan karat dan efisen.

CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

Q_{max}	=	Maximum Heat Transfer Rate, kW
Q	=	Actual Heat Transfer Rate, kW
m_h	=	Mass Flow Rate of Hot Fluid (water), kg/s
m_c	=	Mass Flow Rate of Cold Fluid (air), kg/s
$c_{h,p}$	=	Specific Heat of Hot Fluid (water), kJ/kg.°C
$c_{c,p}$	=	Specific Heat of Cold Fluid (air), kJ/kg.°C
$t_{h,i}$	=	Inlet Temperature for Hot Fluid (water), °C
$t_{h,o}$	=	Outlet Temperature for Hot Fluid (water), °C
$t_{c,i}$	=	Inlet Temperature for Cold Fluid (air), °C
$t_{c,o}$	=	Outlet Temperature for Cold Fluid (air), °C
ε	=	Thermal Effectiveness
c_{min}	=	Smaller Value of Heat Capacity Rate Value Between Air and Water, kW/°C
c_h	=	Heat Capacity Rate for Hot Fluid (water), kW/°C
c_c	=	Heat Capacity Rate for Cold Fluid (air), kW/°C
NTU	=	Number of Transfer Units

A_s	=	Total Heat Transfer Surface Area, m^2
A_{finned}	=	Total Heat Transfer Surface Area for Fins, m^2
$A_{unfinned}$	=	Total Heat Transfer Surface Area for Tubes, m^2
U	=	Total Heat Transfer Coefficient, W/ m^2.°C
U_i	=	Inner Heat Transfer Coefficient, W/m^2.°C
U_o	=	Outer Heat Transfer Coefficient, W/m^2.°C
h	=	Convective Heat Transfer Coefficient, W/m^2.°C
h_i	=	Inner Wall Convective Heat Transfer Coefficient, W/m^2.°C
h_o	=	Outer Wall Convective Heat Transfer Coefficient W/m^2.°C
k	=	Thermal Conductivity, W/m.°C
Nu	=	Nusselt Number
D_h	=	Hydraulic Diameter, m
A_i	=	Inner Wall Surface Area, m^2
A_o	=	Inner Wall Surface Area, m^2
A_c	=	Cross Sectional Area of Tube, m^2
p	=	Perimeter of the Tube, m
R	=	Total Resistance for Tube

CHAPTER I

INTRODUCTION

1.1 Project Summary

The final year project is a compulsory subject that has to be taken by every UTeM students in order to obtain their respective degree. Two semesters are given to student to complete this subject. The code for this subject BMCU 4973 and BMCU 4983 is part of the syllabus that is included in the UTEM degree program. This project is about analyzing and fabricating a car's radiator under the supervision of Dr. Yusoff bin Sulaiman. This report consists of five chapters; literature review, methodology, result, discussion and conclusion.

Literature reviews are emphasized on the design and function of a car's radiator and fan. The components, material used and function for the radiator are enclosed in this part of the report. The methodology section will explain the method and the experiment that has been carried out to complete this project. For this project, the experiment was carried out in the first semester and the fabrication for the radiator begun the following semester.

1.2 Objective

- To fabricate a radiator and compare the performance with a manufacture radiator.

1.3 Scope

- Conduct experimental work on manufactured radiator to gain the inlet and outlet temperature for both fluid.
- Design a suitable configuration of a typical automotive radiator.
- Conduct numerical modeling.
- Fabricate using suitable materials.
- Test in a wind tunnel and compare the result with the manufactured radiator

1.4 Gantt Chart

Gantt chart for both of the semesters is shown in the next page:

Table 1: Gantt chart for First Semester

Activities	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Title Selection																
Literature Review																
Experimental Work																
Presentation																

Table 2: Gantt chart for Second Semester

Activities	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mechanical Design																
Numerical Modeling																
Methodology																
Fabrication																
Testing																
Presentation																

CHAPTER II

LITERATURE REVIEW

2.1 General Function of a Car's Radiator

A radiator in general is a device that removes unwanted thermal heat from a device so that overheating does not occur. It is also known as a heat exchanger that operates either in a closed system or an open system. The use of radiators can be normally seen in automotive vehicles, large machines (compression coolers, heavy duty pumping sets, off-highway construction equipment and etc), trains, cooling system, factories and buildings. In term of a car, the radiator is the sole cooling system that operates to remove the excessive heat from a car's engine. If the radiator fails to function properly overheating could occurs and this could lead to a major engine breakdown. A car's radiator is usually pair up with a fan that supplies the necessary movement of air so that the engine can be cool while stationary or working hard. This fan gets its power from the engine via a fan clutch or a simple fluid coupling, as part of the water-pump drive from the crankshaft pulley.

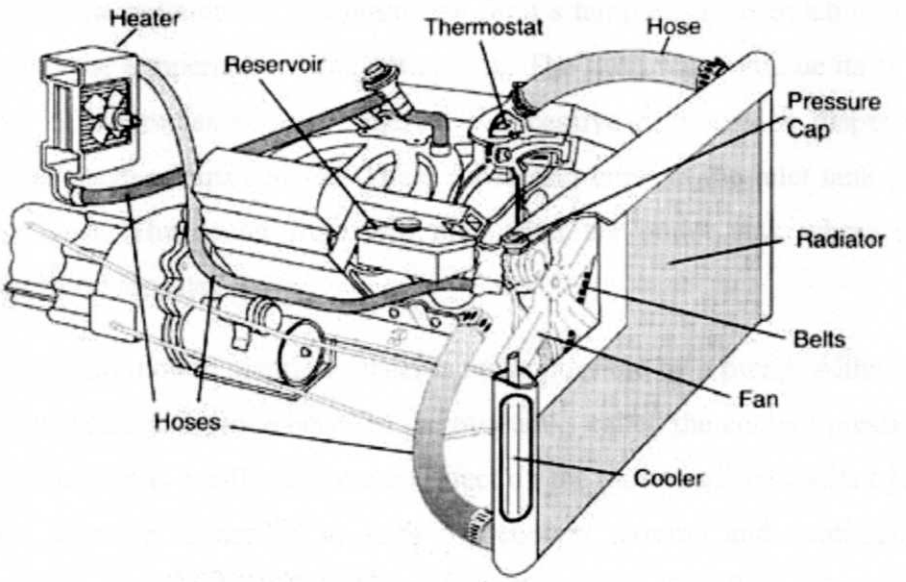

Figure 1: Cooling system of a vehicle (Source: www.narsa.org)

The thermal energy that has been generated will be dissipated to the surrounding air by means of heat transfer. Car's radiator often uses force convection as the main heat transfer mechanism but there are also other types of heat transfers method such as conduction and radiation that is present in the design. However the amount of heat that is removed is notably done by force convection as the movement of the car will generate a lot of bulk movement of air. Combine with the flow of air generate by the radiator's fan, the air's flow rate through a radiator is normally high enough to cool the coolant which flow through the radiator's tubes adequately.

Normally there will be a medium which will be the heat transfer agent for a radiator. This medium can be in the form of liquid or gas and acts as the cooling agent for the radiator. This cooling agent is usually called coolant and usually water is used. The flow of the cooling agent can be seen as a close cycle. First, the fluid will flow from the outlet tank into water jackets or crevices that exist on components. The difference in temperature between the fluid and the surface area of the components will cause heat transfer to occur at these areas. This fluid will then flow into the radiator via the inlet hose into the