SUPERVISOR'S VERIFICATION

I hereby admit that have read this report and from my point of view this report is enough in term of scope and quality for purpose for awarding Bachelor of Degree in Mechanical Engineering (Thermal-Fluid)

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STUDY OF OPTIMIZING HX1 CAR AIR CONDITIONING HEAT EXCHANGER BY USING CFD METHOD

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This report presented to fulfill the requirement in term to obtain

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DECLARATION

"I admit this report has been written by me myself except for some quotation that has been noted well for each of them"

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Date	: …...............................

DEDICATION

This report is dedicated to my beloved parents, my father Dr. Hj. Abdullah @ Sudin Ab Rahman and my mother, Hjh Pauziah Yaacob.

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ABSTRACT

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In cars, power supply is limited to fuel and dry cell. This definitely influences the use of air conditioning in cars. Added with global warming effect, power efficient heat exchanger is a must in the system to avoid pollution and fuel inefficiency. Thus optimum flow in the heat exchanger plays a vital role in minimizing the air conditioning system's energy consumption to save the environment**.** This study is about optimizing HX1 car air conditioning heat exchanger by using CFD method. By using a heat exchanger in car air conditioning refrigeration cycle the efficiency of the air conditioning system with respect to the power supplied can be increased. However the heat exchanger must be in a state where the performance is at its optimum to decrease fuel and power consumption. In doing so, a simulation via CFD using SolidWorks Simulation Premiumwill be conducted to investigate the heat transfer rate of the refrigerant. Based on the result of the simulation, further improvement will be done to the heat exchanger in terms of its dimension, design and flow distribution. Scheduling and time framework will be based on the project's Gantt chart

ABSTRAK

Di dalam kereta, bekalan kuasa adalah terhad kepada bahan api dan sel kering. Ini pasti akan mempengaruhi penggunaan penyaman udara di kereta. Ditambah dengan kesan pemanasan global, kuasa penukar haba yang cekap adalah menjadi satu kemestian di dalam sistem untuk mengelakkan pencemaran dan ketidakcekapan bahan api. Oleh itu, aliran optimum dalam penukar haba memainkan peranan penting dalam mengurangkan penggunaan tenaga sistem penghawa dingin untuk menyelamatkan alam sekitar. Kajian ini adalah untuk mengoptimumkan HX1 penukar haba penyaman udara kereta dengan menggunakan kaedah CFD. Dengan menggunakan penukar haba di dalam kitaran penyejukan penghawa dingin kereta, kecekapan sistem penghawa dingin berkenaan dapat dipertingkatkan. Walau bagaimanapun, penukar haba itu mestilah berada dalam keadaan prestasi optimum untuk mengurangkan penggunaan bahan api dan kuasa. Untukmelaksanakannya, simulasi melalui CFD menggunakan “SolidWorks Simulation Premium”akan dilakukan untuk menyiasat kadar pemindahan haba bahan pendingin. Berdasarkan keputusan simulasi tersebut, penambahbaikan akan dilakukan kepada penukar haba dari segi pengagihan ukuran, reka bentuk dan aliran.Jadual dan rangka kerja masa akan berdasarkan carta Gantt projek

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a	=	Acceleration, (m/s^2)
c_p	=	Thermal Capacity, ($J/kg.K$)
F	=	Force, (N)
k	=	Thermal Conductivity, ($W/m.K$)
m	=	Mass, ()
p	=	Pressure, (N/m^2)
T	=	Temperature, ($°C$)
T_C	=	Cold Temperature, ($°C$)
T_H	=	Hot Temperature, ($°C$)
u	=	Velocity in x-direction, (m/s)
v	=	Velocity in y-direction, (m/s)
W	=	Width, (m)
ρ	=	Density, (kg/m^3)

CHAPTER 1

INTRODUCTION

1.1 Background Study

Air condition is somewhat a technology to control certain properties of air for the convenience of a person in a certain enclosed area. Mainly consist of HVAC which means heating, ventilating and air conditioning. Either used to cool the air, or heat it and also control the flow and humidity by an effective application of vaporization and condensation.

1.2 Problem Statement

Heat exchangers are widely used in industry both for cooling and heating large scale processes. Heat exchanger commonly applies in heating, ventilation and air conditioning (HVAC) systems, radiators, boilers and others. Heat exchanger can be added in the car air conditioning systems. With the existence of heat exchanger, it will increase the pressure drops in the air conditioning systems.

In cars, power supply is limited to fuel and dry cell. This definitely influences the use of air conditioning in cars. Added with global warming effect, power efficient heat exchanger is a must in the system to avoid pollution and fuel inefficiency. Thus optimum flow in the heat exchanger plays a vital role in minimizing the air conditioning system's energy consumption to save the environment**.**

1.3 Objectives

The objectives of this project are:

i. Profiling the current HX1 in term of pressure loss, velocity and flow.
ii. Compare the pressure loss, velocity and flow profile between HX1 with HX2

1.4 Scope

This project is to study the effect of heat exchanger on car air conditioning system and to conduct a simulation via CFD to find the HX1 pressure loss, velocity and flow. The simulation will be validated with different type of heat exchanger (HX2) while having intent to improve the design. A comparison will be made to determine the level of effectiveness of the heat exchanger HX1, HX2 and the improved design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Heat exchanger is a device built for efficient heat transfer from one medium to another, whether the media are separated by solid wall so that they never mix, or the media are in contact**.** Heat exchanger widely used in refrigeration, air conditioning, power plants, space heating, and natural gas processing. One common example of a heat exchanger is the radiator in car, which the heat source, being a hot engine-cooling fluid, water transfers heat to air flowing through the radiator.

2.2 Refrigeration Cycles

Refrigeration cycles are used as the base theory on how to work any air conditioning system. It can be simply described as a reversed Carnot cycle where a Carnot cycle is an ideal cycle consists of four totally reversible processes. It is used as a guideline for most power producing devices to analyze its performance and efficiency. Whereas the Carnot cycle can totally be reversed, the processes can also be reversed resulting in the reverse of energy transfer direction and interactions. A refrigerator, heat pump and any air conditioning system that operates on a reversed Carnot cycle is called a Carnot refrigerator or Carnot heat pump.

Although the reversed cycle is ideal, most of the air conditioning system operates on an actual cycle that is quite different from the ideal cycle. The performance and efficiency is considerably lower and there are a lot more surrounding factors that must be calculated.

As there are four main components in a power cycle, there are also four main components in the refrigeration cycle. These components are

- Compressor
- Condenser
- Evaporator
- Throttling valve (expansion valve)

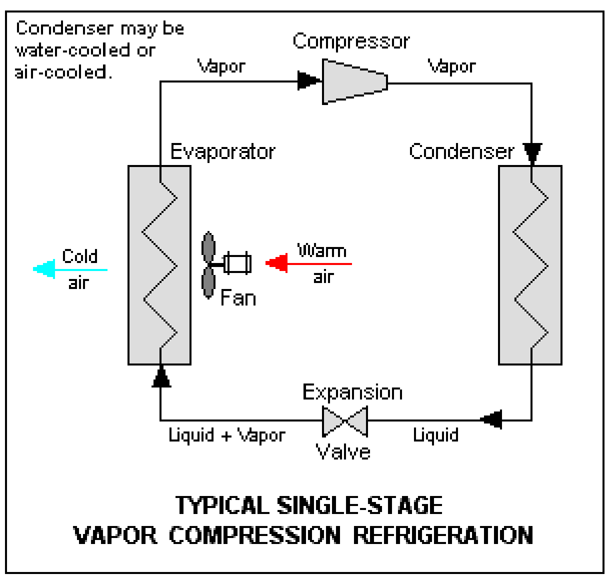

Figure 2. 1 :Schematic of a single stage compression refrigeration cycle

(source:*http://en.wikipedia.org/wiki/Heat_pump_and_refrigeration_cycle)*

These are the basic components of the cycle according to Figure 2.1. But in a contemporary refrigerant or cooling system, there are much more components added to ensure the efficiency of the system. Actual systems are much more complex and diverse. Depending on the function of the system, the verification and modification done are angled toward suitability and effectiveness. The most common function of a reverse Carnot cycle is to refigerate food and beverages, cool down systems as in automotive, electronics and also cooling the surrounding also known as an air conditioning system[1].

An air conditioning system is then divided into a few more categories. For instance, an air conditioning system for a whole building is operates rather differently compared to a single unit air conditioning for one room. It can also be differentiated by the source of power such as electrical, solar photovoltaic and thermal. Above all, these systems are also different than an air conditioning system in an automobile. Where weight and power is the main factor of efficiency added with a small cooling area.

2.3 Car air conditioning

Automobile air conditioning systems started to come into wide use from the late twentieth century. There has been much debate on the effect of air conditioning on the fuel efficiency of a vehicle. Air conditioners use significant power, nevertheless the drag of a car with closed windows is less than if the windows are open. Various factors such as wind resistance, aerodynamics and engine power and weight have to be factored into finding the true variance between using the air conditioning system and not using it when estimating the in actual fuel consumption. Other factors on the impact on the engine and an overall engine heat increase can have an impact on the cooling system of the vehicle. Hence a lot of study has been done to find the optimum that suites a certain car.

In an automotive air conditioning system, the components are not too different from the basic reverse Carnot cycle. A few things may be added to make it more efficient and suitable for the system to operate in a limited space and power[2]. The components of that system are elaborated later in sections below.

2.3.1 Compressor

Figure 2. 2 : Compressor

(Source: *http://www.gasgoo.com/showroom/shxinjing/auto-products/1079202.html*)

A compressor is the main part of an air conditioning system as show in the Figure 2.2 is a belt driven pump that is fastened to the engine. It compresses and transfers refrigerant gas. The A/C system is split into two sides, a high pressure side and low pressure side; defined as discharge and suction. Since the compressor is basically pumped, it must have an intake side and discharge side. The intake or suction side draws in refrigerant gas from the outlet of the evaporator. After the refrigerant is drawn into suction side, the compressor compresses it and sends to the condenser where it can then transfer the heat that is absorbed from the inside the vehicle**.**

2.3.2 Condenser

Figure 2. 3: Condenser

(Source: *http://www.ecvv.com/product/2382590.html*)

After the refrigerant absorbs heat from the air, it is brought to the condenser. This is the area in which heat dissipation occurs. The condenser as in Figure 2.3 looks like a radiator because it is designed to radiate heat as also a radiator. Condenser must have good air flow anytime the system is in operation. On rear wheel drive vehicle, this is usually accomplished by taking advantage or existing engine's cooling fan. On front wheel drive vehicles, condenser air flow is supplemented with one or more electric cooling fan. As hot compressed gaseous refrigerant flows into top of the condenser, they are cooled off. As the refrigerant cools, it condenses and exits the bottom of the condenser as high pressure liquid.

2.3.3 Evaporator

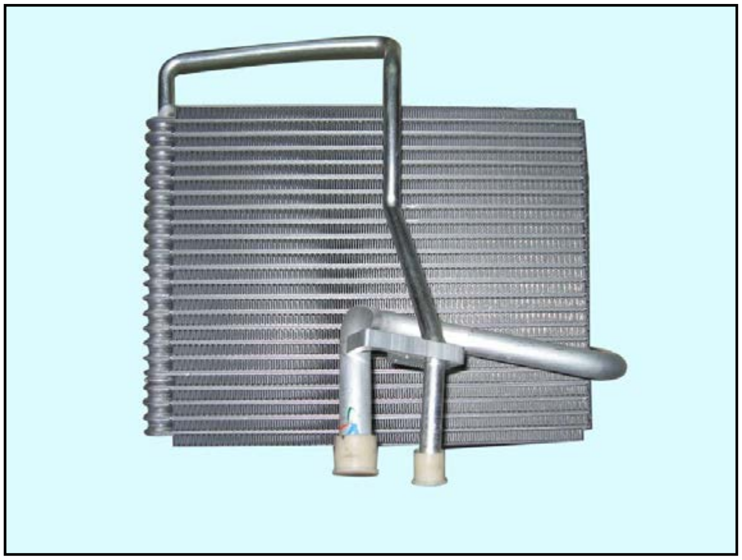

Figure 2. 4 : Evaporator

(Source: *http://www.elephanttrade.com/ExporterList*)

Located inside the vehicles, the evaporator shows in Figure 2.4 serves as the heat absorption component. The evaporator provides several functions. It's primarily duty is to remove heat from the inside the vehicle. A secondary benefit is dehumidification. As warmer air through the aluminum fins of the cooler evaporator coil, the moisture contained in the air condenses on its surface. Refrigerant enters the bottom of the evaporator as low pressure liquid. The warm air passing through the evaporator fins causes the refrigerant to boil (refrigerants have very low boiling points). As the refrigerant begins to boil, it can absorb large amount of heat. This heat is then carried off with the refrigerant to outside the vehicles. Factors that are important in the design of evaporators include the size and length of the tubing, the number and size of the fins, the number of return bends and the amount of air passing through and past the fins.