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STUDY OF HEAT EXCHANGER EFFECT IN A CAR AIR CONDITIONING SYSTEM

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This report is presented in
Partial fulfilment of the requirements for the
Degree of Bachelor of Mechanical Engineering (Thermal Fluid)

Faculty of Mechanical Engineering
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APRIL 2009

"I hereby, declare this thesis is result of my own research except as cited in the references"

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To my beloved family

ACKNOWLEDGEMENT

Firstly, I would like to express my greatest gratitude and appreciation to my supervisor of this Project Sarjana Muda, En. Faizil bin Wasbari for his guidance, support and practical advices throughout the entire project. Many thanks as well to the Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM) for the opportunities given and facilities offered. I would also like to extend my thanks to En. Razmi for his assistance and guidance contributed towards the success of this project.

Above all else, I could not execute this project smoothly without my dear partner's help, Mr. Lim Swee Meng who encouraged me towards the completion of this research. Lastly, a special thanks to each and every individual who have helped me throughout the efforts of this report be it in the form of encouragement and advice.

ABSTRACT

Suction-liquid heat exchangers are most often used in the vapor compression cycle to exchange energy between the cool gaseous refrigerant leaving the evaporator and warm liquid refrigerant exiting the condenser. These device improve refrigeration system performance and it is a proven refrigeration system component for greater efficiency. This research study about the heat exchanger effect in term of Coefficient of Performance (COP) in a car air conditioning system. Air conditioning system of Proton Wira is used for the experiment. The experimental with and without the presence of a suction-liquid heat exchanger in the car air conditioning system are presented and analyzed. A comparison of COP that are calculated from the experimental result between the system with and without the presence of heat exchanger is enclosed. An increase of the coefficient of performance has been found using the suction-liquid heat exchanger. The suction-liquid heat exchanger improved COP of the refrigeration system up to 24%.

ABSTRAK

Penukar haba terbina dalam sering digunakan dalam kitar penyejuk mampatan wap untuk menukarkan tenaga di antara bahan penyejuk gas yang keluar daripada penyejat dengan bahan penyejuk cair panas yang keluar dari pemeluwap. Alat ini menambahkan kecekapan keseluruhan sistem dan juga merupakan satu komponen yang telah terbukti dapat menambah kecekapan dalam sistem penyejuk. Kajian ini dilakukan untuk mendapatkan kesan pekali prestasi dalam sistem penyaman udara di dalam sebuah kereta. Kajian ini telah mengambil sistem penyejukkan kereta Proton Wira sebagai bahan kajian. Eksperimen dijalankan terhadap dua jenis sistem iaitu penyejukan dengan mengunakan penukar haba terbina dalam dan satu lagi adalah sistem tanpa penukar haba. Perbandingan di antara hasil eksperimen menggunakan dan tanpa menggunakan penukar haba terbina telah dibuat. Dengan menggunakan penukar haba di dalam sistem penyejukkan pekali prestasi telah ditambahkan. Penukar haba ini meningkatkan pekali prestasi di dalam sistem penyejukkan sebanyak 24%.

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LIST OF SYMBOLS

Concise list of symbols in order of appearance:

α	=	Thermal Diffusivity, m^2/s
Ar	=	Archimedes Number
β	=	Volume Expansivity, K^{-1}
COP	=	Coefficient of Performance
g	=	Acceleration due to Gravity, m/s^2
Gr	=	Grashof number
HX	=	Heat Exchanger
L	=	Length, m
Pe	=	Peclet Number
Q	=	Heat Supplied, W
Re	=	Reynolds Number
T	=	Temperature, °C
U	=	Velocity, m/s
ν	=	Viscosity, m^2/s
W	=	Input Power, W
h	=	Enthalpy, kJ/kg
ε	=	Effectiveness

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CHAPTER I

INTRODUCTION

1.1 Background Study

Heat exchangers are widely used in industry both for cooling and heating large scale industrial processes. The type and size of heat exchanger used can be tailored to suit a process depending on the type of fluid, its phase, temperature, density, viscosity, pressures, chemical composition and various other thermodynamic properties.

Heat exchangers are found in most chemical or mechanical systems. They serve as the system's means of gaining or rejecting heat. Some of the more common applications are found in heating, ventilation and air conditioning (HVAC) systems, radiators on internal combustion engines, boilers, condensers, and as preheaters or coolers in fluid systems.

All air conditioning systems contain at least two heat exchangers, usually called the evaporator and condenser. In case, evaporator or condenser, the refrigerant flows into heat exchanger and transfer heat, either gaining or releasing it to the cooling medium. Commonly, the cooling medium is air or water.

1.2 Problem Statement

Demand for greater occupant comfort in recent years has made air-conditioning indispensable in all automobiles. Meanwhile, issues related to environmental protection have raised high on the global agenda, leading to stricter regulations on emissions of greenhouse gases such as carbon dioxide and on emissions of toxic pollutants such as nitrogen oxides and hydrocarbons. Higher fuel efficiency in an automobile is important for lower exhaust emissions. Minimizing the air conditioning system's energy consumption is an important means of achieving higher fuel efficiency.

1.3 Objectives

To study heat exchanger effect in term of Coefficient of Performance (COP) in a car air conditioning system.

1.4 Scope

The research will be focus on the effect of car air conditioning system after add on the heat exchanger to the system. An experiment will be conduct to test the coefficient of performance of car air conditioning system before and after add on the heat exchanger. The experiment is referenced from an actual car air conditioning system follow the standard had been set. Following this, the coefficient of performance will be calculated from the experimental result to see the effect of heat exchanger on car air conditioning system. The literature review on the principles of theories must be study for preparing this research study.

CHAPTER II

LITERATURE REVIEW

2.1 Heat Exchanger

A heat exchanger is a device built for efficient heat transfer from one medium to another, whether the media are separated by a solid wall so that they never mix, or the media are in direct contact. In the most efficient heat exchangers, the surface area of the wall between the fluids is maximized while simultaneously minimizing the fluid flow resistance. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, and natural gas processing. One common example of a heat exchanger is the radiator in a car, in which a hot engine-cooling fluid, like antifreeze, transfers heat to air flowing through the radiator.

2.1.1 Flow Arrangement

Heat exchangers may be classified according to their flow arrangement. There are three primary flow arrangements with heat exchangers which are counter-flow, parallel-flow, and cross-flow (Figure 2.1). In the counter-flow heat exchanger, the fluids enter the exchanger from opposite sides. This is the most efficient design because it transfers the greatest amount of heat. In the parallel-flow heat exchangers, the two fluids enter the exchanger at the same end, and travel in parallel to one another to the other side. In a cross-flow heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

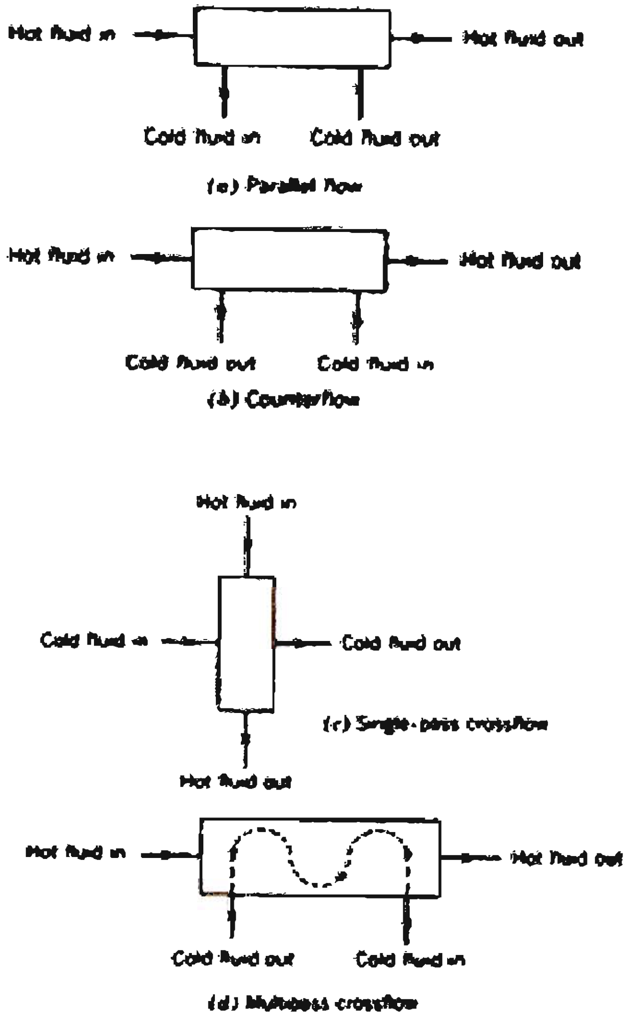

Figure 2.1: Types of flow arrangement for Heat Exchanger

(Source: Ramesh and Dusan, (2003))

For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may channel fluid flow or induce turbulence.

2.1.2 Types of Heat Exchangers

2.1.2.1 Shell and Tube Heat Exchanger

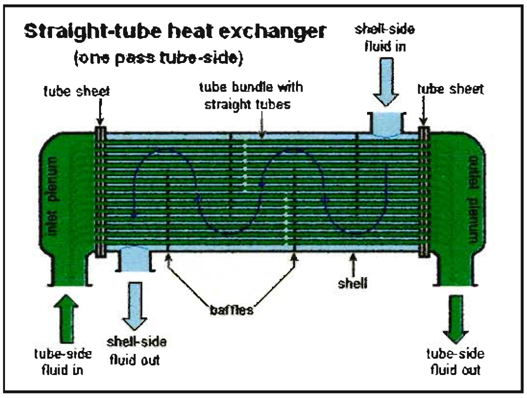

Figure 2.2: Straight-tube Heat Exchanger (shell-and-tube type) with 1 pass on tube side (Source: *http://en.wikipedia.org/wiki/Heat_exchanger*, (2006))

Shell and tube heat exchangers consist of a series of tubes. Figure 2.1 is shown an example of shell and tube heat exchanger. One set of these tubes contains the fluid that must be either heated or cooled. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned etc. Shell and Tube heat exchangers are typically used for high pressure applications. This is because the shell and tube heat exchangers are robust due to their shape.

There are several thermal design features that are to be taken into account when designing the tubes in the shell and tube heat exchangers. These include tube diameter, tube thickness, tube length and tube pitch.