STUDY OF INTERNAL HEAT EXCHANGER EFFECTS ON CAR AIR CONDITIONING SYSTEM

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VERIFICATION

I have read this thesis
and from my opinion the thesis
is sufficient in aspects of scope and quality for awarding
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DECLARATION

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

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PENGAKUAN

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

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DEDICATION

To

My Beloved Family

Mom & Dad

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ABSTRACT

Internal or suction line heat exchangers (IHX) are used in some car air conditioning systems with basic objective to optimalize the liquescence process of the refrigerant before entering the expansion device. This purpose is achieved by exchanging thermal energy between the cool gaseous refrigerant in the low pressured suction line and the warm liquid refrigerant in the high pressured liquid line in the A/C system. These devices can have either positive or negative influences on the Coefficient of Performance (COP) of the car air conditioning system, depending on the working fluids, the operating condition and the configuration of heat exchanger. The finding from the experimental test indicated the COP of the system with adoption of IHX will be up to 7.92% increment than the system without adoption of IHX if rotational speed of engine was increased.

ABSTRAK

Penukar haba dalaman atau saluran sedutan (*IHX*) *selalunya digunakan dalam sistem penyamanan udara dengan objektif asalnya menyempurnakan proses pencecairan bahan penyejuk sebelum memasuki peralatan ekspansi. Tujuan tersebut dicapaikan dengan menukarkan tenaga haba di antara gas bahan penyejuk sejuk di salur sedutan yang tekanannya rendah dan cecair bahan penyejuk panas di salur cecair yang tekannya tinggi di dalam sistem penyamanan udara. Penukar haba boleh membawa impak positif atau negatif ke atas COP(Coefficient of Performance) sistem penyamanan udara kereta, bergantung dengan bahan penyejuk digunakan, syarat operasi, dan rekabentuk penukar haba. Kesimpulan dari kajian menyatakan bahawa COP sistem yang menggunakan penukar haba dalaman akan lebih tinggi sebanyak 7.92% daripada COP sistem yang tidak menggunakan penukar haba dalam sekiranya laju putaran enjin ditingkatkan.*

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LIST OF SYMBOLS

COP	=	Coefficient of Performance
c_p	=	Specific heat capacity at constant pressure, kJ/kg K
h	=	Enthalpy, kJ/kg
$\dot{m}$	=	Mass flow rate
n	=	Polytrophic index
P_c	=	Compressor electrical power consumption, kW
P	=	Pressure, kPa
q_o	=	Refrigerating effect, kJ/kg
Q_o	=	Refrigerating capacity, kW
t	=	Compression ratio
T	=	Temperature, °C or K
v	=	Specific volume, m^3/ kg
IHX	=	Internal heat exchanger
SLHX	=	Suction-line heat exchanger
ε	=	Effectiveness
Δp	=	Pressure drop, kPa
ΔT	=	Temperature difference, °C or K

Subscripts

g	=	Gaseous
K	=	Condenser
l	=	Liquid
o	=	Evaporator
R	=	Refrigeration

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NOMENCLATURE

Temperature - A measure of the average kinetic energy of the particles in a sample of matter, expressed in terms of units or degrees designated on a standard scale.

Degree Celsius - A temperature scale (also called *centigrade*) in which 0° represents freezing and 100° represents the boiling point. To convert Celsius temperatures to Fahrenheit scale, multiply the Celsius figure by 9, divide by 5 and add 32.

Absolute Temperature - The reading on a scale with zero at the thermodynamic null, most particularly the Kelvin scale.

Pressure - It is defined as force per unit area. It is usually more convenient to use pressure rather than force to describe the influences upon fluid behaviour. The standard unit for pressure is the Pascal, which is a Newton per square meter.

Specific volume - The volume occupied by a unit of mass of a material. It is equal to the inverse of density.

Heat - The energy which is spontaneously flowing from an object with a high temperature to an object with a lower temperature.

Conduction - The transfer of thermal energy between the neighbouring molecules in a substance due to temperature gradient.

Convection – The process by which heat is transferred by movement of a heated fluid such as air or water.

Radiation - The process by which heat is transferred between bodies by electromagnetic radiation.

Latent heat – the characteristic amount of energy absorbed or released by a substance during a change in its physical state that occurs without changing its temperature.

Specific heat - the measure of the heat energy required to increase the temperature of a unit quantity of a substance by unit degree.

Critical Temperature – The maximum point at which a gas can be liquefied or condensed by raising the pressure.

Critical Pressure – The pressure that is necessary to liquefy a gas at that temperature.

Phases of Refrigerant

a) *Compressed liquid* – Pure liquid, at less than saturation temperature (boiling point at pressure)

b) *Saturated liquid* – Pure liquid, but at the saturation temperature (any additional of heat will cause some vaporization)

c) *Saturated liquid/ vapour mixture* – A mixture of liquid and vapour at the temperature and pressure of saturation.

d) *Saturated vapour* – Purely vapour, but at the saturation temperature (any loss of heat will cause some condensation to occur)

e) *Superheated vapour* – Purely vapour, above the saturation temperature.

Subcritical System – The refrigeration system where condenser and evaporator operate with temperature below the refrigerant's critical temperature.

Transcritical System – The refrigeration system where the cycle incurs temperatures and pressures both above and below the refrigerant's levels.

Humidity – the amount of water in the ambient air. The amount of water vapour suspended in air can vary from a perfectly dry 0% to foggy 100%.

Relative Humidity (RH) – The amount of water vapour air hold varies with temperature.

CHAPTER I

INTRODUCTION

1.1 Background Study

Internal heat exchanger (IHX) also known as Suction-line/Liquid-line heat exchanger (SLHX) is a derivation from the traditional heat exchangers. Its purpose/concept is similar with other type of heat exchangers, which is a device to build for efficient transfer heat from one place to another. However, it has several notable differences with other traditional heat exchanger in term of size, shape, structure, usage, etc.

Nowadays, the developments of internal heat exchanger are rapid. It has an important role on air-conditioning system based on the vapour compression cycle. The internal heat exchanger often use in automotive air conditioning, with the basic objective of assuring the subcooling of refrigerant before entering the expansion device. This process is achieved by exchanging enthalpy (energy) between the cool gaseous refrigerant in the suction line and the hot liquid refrigerant at liquid line. However, according to previous research result, the devices can have positive or negative influences on the overall efficiency, depending on it design and configuration.