AUTOMOTIVE AIR CONDITIONER BOOSTER

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I declare that I have been done reading this report
and in my opinion, this report fulfill the condition in all
aspect that must be in project writing as need in partial fulfillment
for Bachelor of Mechanical Engineering (Thermal – Fluid)

Signature	:	……………………………
Supervisor Name	:	Mr Shamsul Bahari b Azraai
Date	:	……………………………

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APRIL 2010

"I declare that this report had been done originally from me except some of them where I have been explain each one of them with its sources"

Signature	:	……………………
Name	:	Mohd Firdauz Jaafar
Date	:	…………………….

Especially to my beloved parents,

My lovely brothers,

My respectfully lecturers,

Also my faithfully friends,

Your prayers always with me every way that I went…

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ABSTRACT

Throughout this project, an Automotive Air Conditioner Booster will be introduced and analyzed in order to make this project successful and reach the objective. A cooling pad will be used in order to see the outcome for vapor compression refrigeration cycle in order for the coefficient of performance of it will be increase while the power consumption will be decrease. A water circulation system will be designed in order to keep the cooling pad in wet condition. The power of an automobile also will be tested to know whether there has been an effect or not. In this project, two experiments had been done by using Industrial Refrigeration Trainer System to determine the Coefficient of Performance and compressor power saving of the air conditioning system and by using Dyno-Test to determined Maximum Power and Torque Load of the Perodua Kancil EX660. For the result, the Coefficient of Performance of air conditioning increased from 4.056 to 7.081 for cooler stage. The percentage power saving is determined which is 5.83% for cooler stage. The maximum power and torque load also proved this project which is the value increased from 39.6 hP to 42.9 hP and from 52.1 Nm to 58.3 Nm at maximum air conditioner. Application of evaporative cooling pad can increase the coefficient of performance and cooling capacity of the vapor compression refrigeration cycle for automotive air conditioner while decreasing its power consumption.

ABSTRAK

Sepanjang projek ini, satu produk yang dinamakan '*Automotive Air Conditioner Booster'* akan dicipta dan dianalisis untuk memastikan kejayaan dan objektif projek ini tercapai. Satu lapisan penyejuk akan digunakan untuk melihat hasil bagi kitaran penguapan kemampatan pendinginan sama ada kecekapan prestasi akan meningkat sementara kuasa yang digunakan akan menurun. Satu sistem kitaran air direka bagi memastikan lapisan penyejuk sentiasa dalam keadaan basah. Kuasa yang digunakan oleh automobile juga akan dijalankan ujikaji untuk memastikan ia nya dipengaruhi oleh sistem penyejuk yang telah diubahsuai tadi. Kajian ini menggunakan dua eksperimen iaitu dengan menggunakan '*Industrial Refrigeration Trainer System'* untuk menentukan kecekapan prestasi sistem penyejukkan dan penjimatan tenaga pemampat serta menggunakan '*Dyno-Test'* untuk menentukan Kuasa Maksimum dan Tenaga Putaran Maksimum yang dihasilkan oleh Perodua Kancil EX660. Dan keputusannya, pekali prestasi bagi sistem penyejuk meningkat dari 4.056 kepada 7.081 untuk peringkat pendingin. Peratusan penjimatan kuasa pemampat juga diperolehi iaitu 5.83% untuk peringkat pendingin. Kuasa dan Tenaga Putaran Maksimum yang diperolehi juga membuktikan projek ini dimana nilainya meningkat dari 3.96 hP kepada 4.29 hP dan dari 52.1 Nm kepada 58.3 Nm pada keadaan maksimum untuk sistem penyejukan. Aplikasi lapisan penyejuk ini dapat meningkatkan pekali prestasi dan keupayaan pendinginan bagi kitaran mampatan untuk sistem pendinginan sekaligus mengurangkan pengambilan kuasanya.

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LIST OF SYMBOLS

T	=	Temperature, Celsius ºC / Fahrenheit, F
A	=	Ampere, ohm
T	=	Torque, Nm or Kg.m
P	=	Pascal, kPa
Q	=	Flow rate, l/h
P	=	Compressor Power Input, kW
$T_{ambient}$	=	Ambient Temperature, ºC
T_a	=	Temperature of air at the front cooling pad, ºC
T_b	=	Temperature of air at the front condenser, ºC
T_c	=	Temperature of air at the back condenser, ºC
T_5	=	Temperature of refrigerant after expansion valve (Freezer), ºC
T_6	=	Temperature of refrigerant after expansion valve (Cooler), ºC
T_7	=	Temperature of refrigerant evaporator in cooling chamber (Freezer), ºC
T_8	=	Temperature of refrigerant evaporator in cooling chamber (Cooler), ºC
Nm	=	Newton Meter
P-h	=	Pressure – Enthalpy Diagram
K	=	Kelvin

LIST OF ABREVIATIONS

COP	=	Coefficient of Performance
hP	=	Horse Power

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION OF PROJECT

Nowadays, there are a lot of new product and new technologies in order to make our living smoother. One of them is the evaporative cooling pad. According to Phillip D. Calvert (2003), evaporative cooling has been a source of inexpensive cooling in the residential and commercial market since the early 1900's. In general, an evaporative cooling unit includes a housing having a fan and one or more water saturated pads. The air is cooled by moisture evaporative as the air passes through the pads. Evaporative coolers are particularly suited for outdoor use or application where air conditioning is impractical or cost prohibitive such as warehouses, aircraft hangars, auto repair shop and gymnasiums.

The vapor-compression refrigeration system uses a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere. All such systems have four components: a compressor, a condenser, an expansion valve and an evaporator.

Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapor is then in the thermodynamic state known as a superheated vapor and it is at a temperature and pressure at which it can be condensed with typically available cooling water or cooling air. That hot vapor is routed through a condenser where it is cooled and condensed into a liquid by flowing through a coil or tubes with cool water or cool air flowing across the coil or tubes. This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away by either the water or the air.

The condensed liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and vapor refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated. The cold mixture is then routed through the coil or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapor mixture. That warm air evaporates the liquid part of the cold refrigerant mixture.

At the same time, the circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature. The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in the condenser and transferred elsewhere by the water or air used in the condenser. To complete the refrigeration cycle, the refrigerant vapor from the evaporator is again a saturated vapor and is routed back into the compressor. Figure 1.1 shows the typical single stage vapor compression cycle.

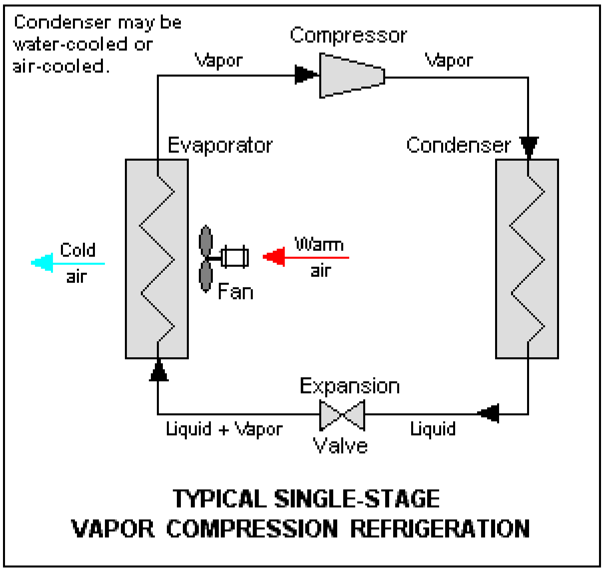

Figure 1.1: Typical Single Stage Vapor Compression Refrigeration Cycle
(Source : http://en.wikipedia.org/wiki/Vapor-compression_refrigeration)

The effect of the cooling pad is it can increase the COP and cooling capacity of the vapor compression refrigeration cycle while decreasing its power consumption. Decreasing the vapor compression power consumption can make the performance of the car increased more than usual. These phenomena happen with decreasing the power consumption needed by the vapor compression while the car will get more power consumption to increase its performance. It can give full or at least more power to generate power consumption of car same as if the air conditioning of the car was turned off. Figure 1.2 shows the evaporative cooling pad.

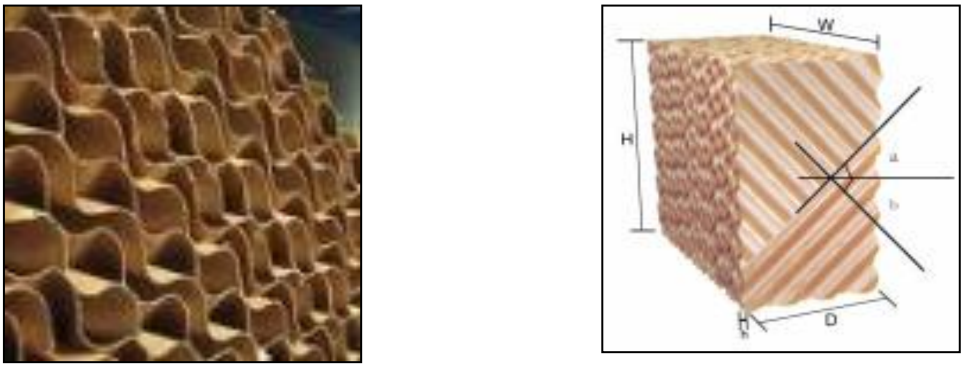

Figure 1.2: Evaporative Cooling Pad (a) zoom in cooling pad, and (b) 3 Dimension of cooling pad