

AUTOMOTIVE AIR CONDITIONER BOOSTER

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This report had been done
in partial fulfillment for
Bachelor of Mechanical Engineering (Thermal – Fluid)

Faculty of Mechanical Engineering
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“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”

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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 kemampuan 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 penyejukan 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.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	i
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	<i>ABSTRAK</i>	vii
	CONTENTS	viii
	LIST OF TABLES	xii
	LIST OF FIGURES	xiii
	LIST OF SYMBOLS	xviii
	LIST OF ABBREVIATIONS	xix
	LIST OF APPENDICES	xx
CHAPTER 1	INTRODUCTION	1
	1.1 Introduction of Project	1
	1.2 Problem Statement	4
	1.3 Objectives	5
	1.3 Scope of Research	5
CHAPTER 2	LITERATURE REVIEW	6
	2.1 Automotive Air Conditioning Systems	6
	2.1.1 Compressor	8

2.1.2	Condenser	8
2.1.3	Evaporator	9
2.1.4	Pressure Regulating Devices	9
2.1.4.1	Orifice Tube	10
2.1.4.2	Thermal Expansion Valve	10
2.1.4.3	Receiver Drier	11
2.1.4.4	Accumulator	12
2.2	Evaporative Cooling Pad	13
2.2.1	Previously Research	13
2.2.2	Effect of Evaporative Cooling Pad	16
2.3	System Design	22
2.3.1	Direct/Indirect Evaporative Cooling	22
2.3.2	Indirect Evaporative Cooling System	26
2.3.3	Indirect Evaporative Cooling Apparatus	28
CHAPTER 3	METHODOLOGY	32
3.1	Experimental Setup	32
3.1.1	Industrial Refrigeration and Air Conditioning System Experiment	32
3.1.2	Procedures of Industrial Refrigeration and Air Conditioning System Experiment	34
3.1.2.1	Without Evaporative Cooling Pad Experiment	34
3.1.2.2	With Evaporative Cooling Pad Experiment	35
3.1.2.3	Location of Evaporative Cooling Pad in Experiment	36
3.1.3	Dyno-Test Experiment	38

3.1.4	Procedures of Dyno-Test Experiment	39
3.1.4.1	Without Evaporative Cooling Pad Experiment	39
3.1.4.2	With Evaporative Cooling Pad Experiment	40
3.1.4.3	Location of Evaporative Cooling Pad in Experiment	41
3.2	Evaporative Cooling Pad	43
3.3	Other Apparatus	44
3.3.1	Thermocouple	44
3.3.2	Electrical Tape	45
3.3.3	Pressure Gauge	45
CHAPTER 4	RESULTS AND DISCUSSION	46
4.1	Introduction	46
4.2	Industrial Refrigeration Trainer System	46
4.2.1	Experimental Result analysis for Cooler Stage	48
4.2.2	P-h Diagram Analysis	51
4.2.2.1	P-h Diagram Analysis without Evaporative Cooling Pad for Cooler Stage	51
4.2.2.1	P-h Diagram Analysis with Evaporative Cooling Pad for Cooler Stage	53
4.2.3	Coefficient of Performance Analysis	55
4.2.3.1	Coefficient of Performance Analysis for cooler stage	55

4.3 Dyno-Test	56
4.3.1 Dyno-test analysis without evaporative cooling pad	56
4.3.2 Dyno-test analysis with evaporative cooling pad	58
4.3.3 Dyno-test comparison analysis	60
CHAPTER 5	
CONCLUSION	64
5.1 Conclusion	64
REFERENCES	65
APPENDICES	67

LIST OF TABLES

NO.	TITLE	PAGE
2.1	Experimental results of the test (Run A) (Source: Ebrahim Hajidavalloo (2007))	19
2.2	Experimental results of the test (Run B) (Source: Ebrahim Hajidavalloo (2007))	21
4.1	Air Temperature at different stage point	47
4.2	Air Temperature at different stage point for Cooler Stage	49
4.3	Enthalpy for cooler stage without evaporative cooling pad	52
4.4	Enthalpy for cooler stage with evaporative cooling pad	54
4.5	Coefficient of Performance for cooler stage	55
4.6	Maximum Power and Torque for Dyno-test without evaporative cooling pad	57
4.7	Maximum Power and Torque for Dyno-test with evaporative cooling pad	59
4.8	Comparison of experimental result dyno-test with and without evaporative cooling pad	62

LIST OF FIGURES

NO.	TITLE	PAGE
1.1	Typical Single Stage Vapor Compression Refrigeration Cycle (Source: http://en.wikipedia.org/wiki/Vapor-compression_refrigeration)	3
1.2	Evaporative Cooling Pad (a) zoom in cooling pad, and (b) 3 Dimension of cooling pad	3
2.1	Automotive Air Conditioner System (Source: http://www.familycar.com/ac1.html)	7
2.2	Schematic of evaporative cooling (Source: Munters 2001)	13
2.3	Side Elevation of Cooler Pad Assembly (Source: Robert W. Wrightson 1982)	14
2.4	Evaporative Cooler with Pad (Source: Bryant Essick 1944)	15
2.5	Schematic diagram of the retrofitted air conditioner (Source: Ebrahim Hajidavalloo 2007)	16

2.6	Top view of the retrofitted air conditioner (Source: Ebrahim Hajidavalloo 2007)	17
2.7	Water circulation diagram of evaporative media pad (Source: Ebrahim Hajidavalloo 2007)	18
2.8	The P–h diagram of conventional and evaporative cooling cycle (Run A) (Source: Ebrahim Hajidavalloo 2007)	20
2.9	The P–h diagram of conventional and evaporative cooling cycle (Run B) (Source: Ebrahim Hajidavalloo 2007)	22
2.10	Schematic Diagram of Various Indirect Evaporative Cooling Configurations (Source: Ghassem Heidarinejad, Mojtaba Bozorgmehr, Shahram Delfani and Jafar Esmaeelian 2009)	24
2.11	Configuration of Indirect Evaporative Cooler (Source: G.P. Maheshwari, F. Al-Ragom and R.K. Suri 2001)	25
2.12	Schematic View of an Indirect Evaporative Hybrid Cooling System (Source: Khanh Dinh 1987)	26
2.13	Vapor Compression System (Source: Khanh Dinh 1987)	27
2.14	Vapor Compression System (Source: Khanh Dinh 1987)	27

2.15	Perspective view of the Invented Heat Exchange Module (Source: Barry R. Brooks 1999)	29
2.16	Invented Heat Exchange Module that having mesh installed inside the exposed secondary air passage (Source: Barry R. Brooks 1999)	29
2.17	(a) Twin-Walled with Corrugated Sheets, and (b) Its Detailed View (Source: Barry R. Brooks 1999)	30
2.18	Cross Sectional Side Schematic view of an Embodiment of the Invented Heat Exchanger Module, having a water retention pad installed in the space above the water reservoir at the bottom of the module (Source: Barry R. Brooks 1999)	30
2.19	Invented Heat Exchange Module having a plurality of small V-shaped slots positioned transverse (Source: Barry R. Brooks 1999)	31
2.20	Another Embodiment of troughs for water distribution, where the troughs each have one elongated slot (Source: Barry R. Brooks 1999)	31
3.1	ET 412C Industrial Refrigeration Trainer with PC Data Acquisition (Source: http://www.gunt.de/)	33
3.2	Layout of the Industrial Refrigeration Trainer (Source: http://www.gunt.de/)	33
3.3	Top View for Location of Temperature Taken	36

3.4	Schematic Drawing of Industrial Refrigeration Trainer with Evaporative Cooling Pad	37
3.5	Side View for Location of Evaporative Cooling Pad with Water Circulation System	42
3.6	Schematic drawing for location of Evaporative Cooling Pad 42	
3.7	Evaporative Cooling Pad (Source: http://www.tradeget.com/)	43
3.8	Thermocouple	44
3.9	Electrical Tape	45
3.10	Pressure Gauge	45
4.1	Diagram of experiment without evaporative cooling pad for cooler stage	50
4.2	Diagram of experiment with evaporative cooling pad for cooler stage	50
4.3	P-h diagram for Industrial Refrigeration Trainer without evaporative Cooling pad for cooler stage	52
4.4	P-h diagram for Industrial Refrigeration Trainer with evaporative cooling pad for cooler stage	54
4.5	Graph of Power and Torque versus Engine for Dyno-test without evaporative cooling pad at low air conditioner	56
4.6	Graph of Power and Torque versus Engine for Dyno-test	

	without Evaporative cooling pad at maximum air conditioner	57
4.7	Graph of Power and Torque versus Engine for Dyno-test with evaporative cooling pad at low air conditioner	58
4.8	Graph of Power and Torque versus Engine for Dyno-test with evaporative cooling pad at maximum air conditioner	59
4.9	Graph of Power and Torque versus Engine for Dyno-test result between with and without cooling pad at low air conditioner	61
4.10	Graph of Power and Torque versus Engine for Dyno-test result between with and without cooling pad at maximum air conditioner	62

LIST OF SYMBOLS

T	=	Temperature, Celsius °C / 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, °C
T _a	=	Temperature of air at the front cooling pad, °C
T _b	=	Temperature of air at the front condenser, °C
T _c	=	Temperature of air at the back condenser, °C
T ₅	=	Temperature of refrigerant after expansion valve (Freezer), °C
T ₆	=	Temperature of refrigerant after expansion valve (Cooler), °C
T ₇	=	Temperature of refrigerant evaporator in cooling chamber (Freezer), °C
T ₈	=	Temperature of refrigerant evaporator in cooling chamber (Cooler), °C
Nm	=	Newton Meter
P-h	=	Pressure – Enthalpy Diagram
K	=	Kelvin

LIST OF ABBREVIATIONS

COP	=	Coefficient of Performance
hP	=	Horse Power

LIST OF APPENDICES

NO.	TITLE	PAGE
A	Sample Calculation	67
B	Electricity Saving Data	69
C	Freezer Stage Data	70
D	Industrial Refrigerant Trainer Experiment	75
E	Dyno-Test Experiment	79

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.

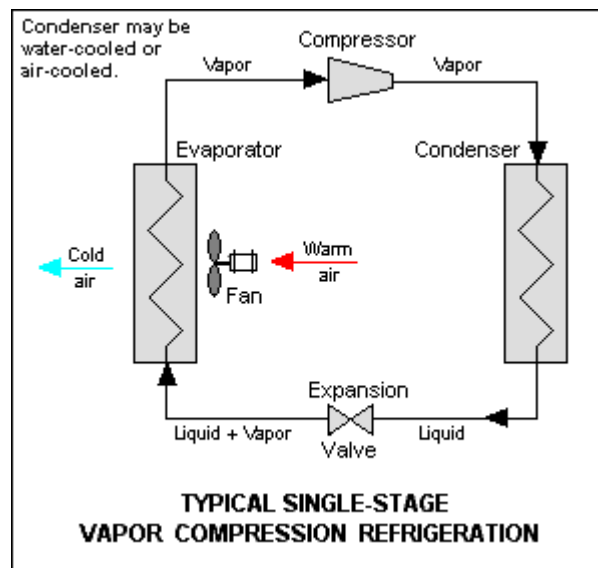


Figure 1.1: Typical Single Stage Vapor Compression Refrigeration Cycle
(Source : http://en.wikipedia.org/wiki/Vapor-compression_refrigeration)

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.

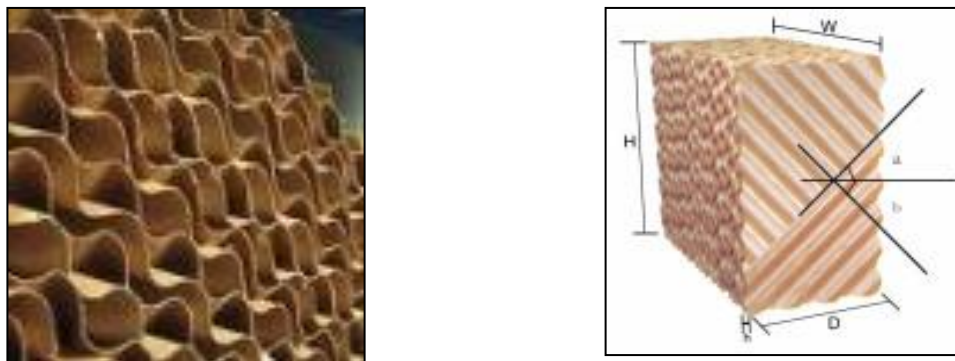


Figure 1.2: Evaporative Cooling Pad (a) zoom in cooling pad, and (b) 3 Dimension of cooling pad