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)

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in partial fulfillment for
Bachelor of Mechanical Engineering (Thermal – Fluid)

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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.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>CONTENTS</td>
<td></td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td></td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td></td>
<td>xix</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td></td>
<td>xx</td>
</tr>
</tbody>
</table>

## CHAPTER 1  INTRODUCTION

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

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

3.1.4.1 Without Evaporative Cooling Pad Experiment

3.1.4.2 With Evaporative Cooling Pad Experiment

3.1.4.3 Location of Evaporative Cooling Pad in Experiment

3.2 Evaporative Cooling Pad

3.3 Other Apparatus

3.3.1 Thermocouple

3.3.2 Electrical Tape

3.3.3 Pressure Gauge

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

4.2 Industrial Refrigeration Trainer System

4.2.1 Experimental Result analysis for Cooler Stage

4.2.2 P-h Diagram Analysis

4.2.2.1 P-h Diagram Analysis without Evaporative Cooling Pad for Cooler Stage

4.2.2.1 P-h Diagram Analysis with Evaporative Cooling Pad for Cooler Stage

4.2.3 Coefficient of Performance Analysis

4.2.3.1 Coefficient of Performance Analysis for cooler stage
4.3 Dyno-Test
   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

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

<table>
<thead>
<tr>
<th>NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Typical Single Stage Vapor Compression Refrigeration Cycle</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(Source: <a href="http://en.wikipedia.org/wiki/Vapor-compression_refrigeration">http://en.wikipedia.org/wiki/Vapor-compression_refrigeration</a>)</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Evaporative Cooling Pad</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(a) zoom in cooling pad, and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) 3 Dimension of cooling pad</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Automotive Air Conditioner System</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(Source: <a href="http://www.familycar.com/ac1.html">http://www.familycar.com/ac1.html</a>)</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Schematic of evaporative cooling</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>(Source: Munters 2001)</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Side Elevation of Cooler Pad Assembly</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>(Source: Robert W. Wrightson 1982)</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Evaporative Cooler with Pad</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(Source: Bryant Essick 1944)</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Schematic diagram of the retrofitted air conditioner</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(Source: Ebrahim Hajidavalloo 2007)</td>
<td></td>
</tr>
<tr>
<td>Image Number</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.6</td>
<td>Top view of the retrofitted air conditioner</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>(Source: Ebrahim Hajidavalloo 2007)</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Water circulation diagram of evaporative media pad</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(Source: Ebrahim Hajidavalloo 2007)</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>The P–h diagram of conventional and evaporative cooling cycle (Run A)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(Source: Ebrahim Hajidavalloo 2007)</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>The P–h diagram of conventional and evaporative cooling cycle (Run B)</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>(Source: Ebrahim Hajidavalloo 2007)</td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>Schematic Diagram of Various Indirect Evaporative Cooling Configurations</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>(Source: Ghassem Heidarinejad, Mojtaba Bozorgmehr, Shahram Delfani and Jafar Esmaeelian 2009)</td>
<td></td>
</tr>
<tr>
<td>2.11</td>
<td>Configuration of Indirect Evaporative Cooler</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(Source: G.P. Maheshwari, F. Al-Ragom and R.K. Suri 2001)</td>
<td></td>
</tr>
<tr>
<td>2.12</td>
<td>Schematic View of an Indirect Evaporative Hybrid Cooling System</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(Source: Khanh Dinh 1987)</td>
<td></td>
</tr>
<tr>
<td>2.13</td>
<td>Vapor Compression System</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>(Source: Khanh Dinh 1987)</td>
<td></td>
</tr>
<tr>
<td>2.14</td>
<td>Vapor Compression System</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>(Source: Khanh Dinh 1987)</td>
<td></td>
</tr>
</tbody>
</table>
2.15 Perspective view of the Invented Heat Exchange Module  
(Source: Barry R. Brooks 1999)

2.16 Invented Heat Exchange Module that having mesh installed 
inside the exposed secondary air passage  
(Source: Barry R. Brooks 1999)

2.17 (a) Twin-Walled with Corrugated Sheets, and  
(b) Its Detailed View  
(Source: Barry R. Brooks 1999)

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)

2.19 Invented Heat Exchange Module having a plurality of small 
V-shaped slots positioned transverse  
(Source: Barry R. Brooks 1999)

2.20 Another Embodiment of troughs for water distribution, 
where the troughs each have one elongated slot  
(Source: Barry R. Brooks 1999)

3.1 ET 412C Industrial Refrigeration Trainer with PC Data 
Acquisition  
(Source: http://www.gunt.de/)

3.2 Layout of the Industrial Refrigeration Trainer  
(Source: http://www.gunt.de/)

3.3 Top View for Location of Temperature Taken
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 43
(Source: http://www.tradeget.com/)

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

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

COP  =  Coefficient of Performance
hP   =  Horse Power
### LIST OF APPENDICES

<table>
<thead>
<tr>
<th>NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sample Calculation</td>
<td>67</td>
</tr>
<tr>
<td>B</td>
<td>Electricity Saving Data</td>
<td>69</td>
</tr>
<tr>
<td>C</td>
<td>Freezer Stage Data</td>
<td>70</td>
</tr>
<tr>
<td>D</td>
<td>Industrial Refrigerant Trainer Experiment</td>
<td>75</td>
</tr>
<tr>
<td>E</td>
<td>Dyno-Test Experiment</td>
<td>79</td>
</tr>
</tbody>
</table>
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.
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 1.1:** Typical Single Stage Vapor Compression Refrigeration Cycle  
(Source: http://en.wikipedia.org/wiki/Vapor-compression_refrigeration)

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