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Effect of Evaporative Cooling on Air Conditioning Test Rig

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Abstracts

In this manuscript, we tries to prove that the size of air conditioner and power consumption by air conditioner can reduce by provide the effect of evaporative cooling on condenser. So, In our experiment we obtained the Co-efficient of performance of air conditioning test rig and condition of air supplied by air conditioning test rig without evaporative then obtained the Co-efficient of performance of air conditioning test rig and condition of air supplied by air conditioning test rig. After find out the result in both cases, we compared both results and calculated the effect of evaporative cooling on air conditioning test rig with the help different parameters such temperature and pressure at different location, refrigerant flow rate, outlet air condition by D.B.T and W.B.T, wattmeter reading etc. We mentioned these results on P-h diagram and Psychrometric chart for better understanding. During our experiment we sprayed water on condenser at the rate of **500 ml/17 Minutes**.

Keywords: Co-efficient of performance (C.O.P), Evaporative cooling, Co-efficient of performance, Refrigerant flow rate, Power consumption

Introduction

Air conditioner is used to provide cooling by the use of mainly four components Compressor, Condenser, expansion device and evaporator. These four components are operate with a refrigerant which works as heat carrier in this system. It extracts the heat from evaporator in the form of latent heat and rejects that heat to atmosphere through the condenser [4]. Therefore heat rejection capacity depends on difference between refrigerant temperature at condenser and atmospheric temperature [5]. Quantity of heat rejection also affects the quantity of heat absorption through evaporator. It is clear that more heat rejection will result more heat absorption.
Atmospheric temperature varies according to Environmental condition i.e. during the summer atmospheric temperature becomes higher which decreases the temperature difference between refrigerant and atmosphere, results less heat rejection which decreases the overall performance of refrigeration system[6].

In this paper, by experiment on Air conditioner test rig we proved that lower the condenser temperature means higher the performance of refrigeration system. Performance of refrigeration system can be improved by provide the evaporative cooling effect on condenser by spray of water on condenser which add the evaporative cooling effect on condenser. In last publication of December 2013 we have proved that by evaporative cooling on condenser the C.O.P is increased by 39.04% which is great achievement. Same if uses evaporative cooling effect on air conditioning unit that will reduce the size and operating cost of air conditioning unit.

Fig.1. Refrigeration Test Rig

Methodology

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If T_1, T_2 temperature of surrounding and temperature of evaporator than co-efficient of performance of system with Carnot cycle is given by-

$$(C.O.P)_{Ref.} = \frac{T_2}{T_1 - T_2} \quad (A)$$

Equation (A) defines that C.O.P of refrigeration system depends on T_1 and T_2. It means C.O.P of refrigeration system will be higher if T_1 is lower or T_2 is higher. Since lower temperature of evaporator is desirable so we should not increase the temperature of evaporator i.e. T_2. On other hand, we cannot reduce the temperature of surrounding i.e. T_1.

So evaporative cooling of condenser is best option of reduce the temperature of water up to wet bulb temperature of air.

For analyses the effect of evaporative cooling we have used following steps –

Steps - 1) First of all measure the D.B.T and W.B.T of ambient air with the help of Sling Psychrometer.

2) Start the air conditioner test rig for 30 minutes.

3) After 30 minutes, read the temperatures after compressor, after condenser, after expansion, after evaporator, D.B.T of supplied air, W.B.T of supplied air, suction pressure and exhaust pressure.

3) Also read the time taken by wattmeter to utilize 0.1 KWh energy by test rig.

4) Now repeat above mentioned procedure for spray water of temperature 24^o C.

Results

Here Following abbreviations are used:

P_1 = Discharge Pressure
P_2 = Suction pressure
T_1 = Temperature after compressor,^{o}C
T_2 = Temperature after condenser,^{o}C
T_3 = Temperature after expansion device,^{o}C
T_4 = Temperature after evaporator,^{o}C
DBT = Dry bulb temperature temperature,^{o}C
WBT =Wet bulb temperature ^{o}C

A) Refrigeration effect with spray water temperature of 23^O C

Properties	**Before**	**After Evaporative cooling of condenser**
P_1	**133 psi**	**133 psi**
P_2	**2.2 psi**	**2.2 psi**
T_1	**62^o C**	**52^o C**
T_2	**37^o C**	**33^o C**
T_3	**1^o C**	**-3^o C**
T_4	**32^o C**	**30^o C**

B) Inlet and Outlet condition of air

- **Before evaporative cooling of condenser**

Inlet conditions -
DBT =31^o C, WBT = 22^o C
Outlet Conditions-
DBT = 27^o C, WBT = 21^o C

- **After evaporative cooling of condenser**

Inlet conditions -
DBT =31^o C, WBT = 22^o C
Outlet Conditions-
DBT = 25^o C, WBT = 18^o C

C) Flow rate of refrigerant and energy consumption

Before Evaporative cooling
Flow rate of refrigerant measured by flow-meter = 8 LPH
Energy consumption measured by wattmeter = 0.1KWh/16 Minutes
After Evaporative cooling
Flow rate of refrigerant measured by flow-meter = 6 LPH
Energy consumption measured by wattmeter = 0.1KWh/21 Minutes

D) Moisture condensed rate

Before Evaporative cooling,
Moisture condensed rate = Nil
After Evaporative cooling
Moisture condensed rate = 70ml/minutes

E) P-h diagrams

P-h diagram Before Evaporative cooling of condenser

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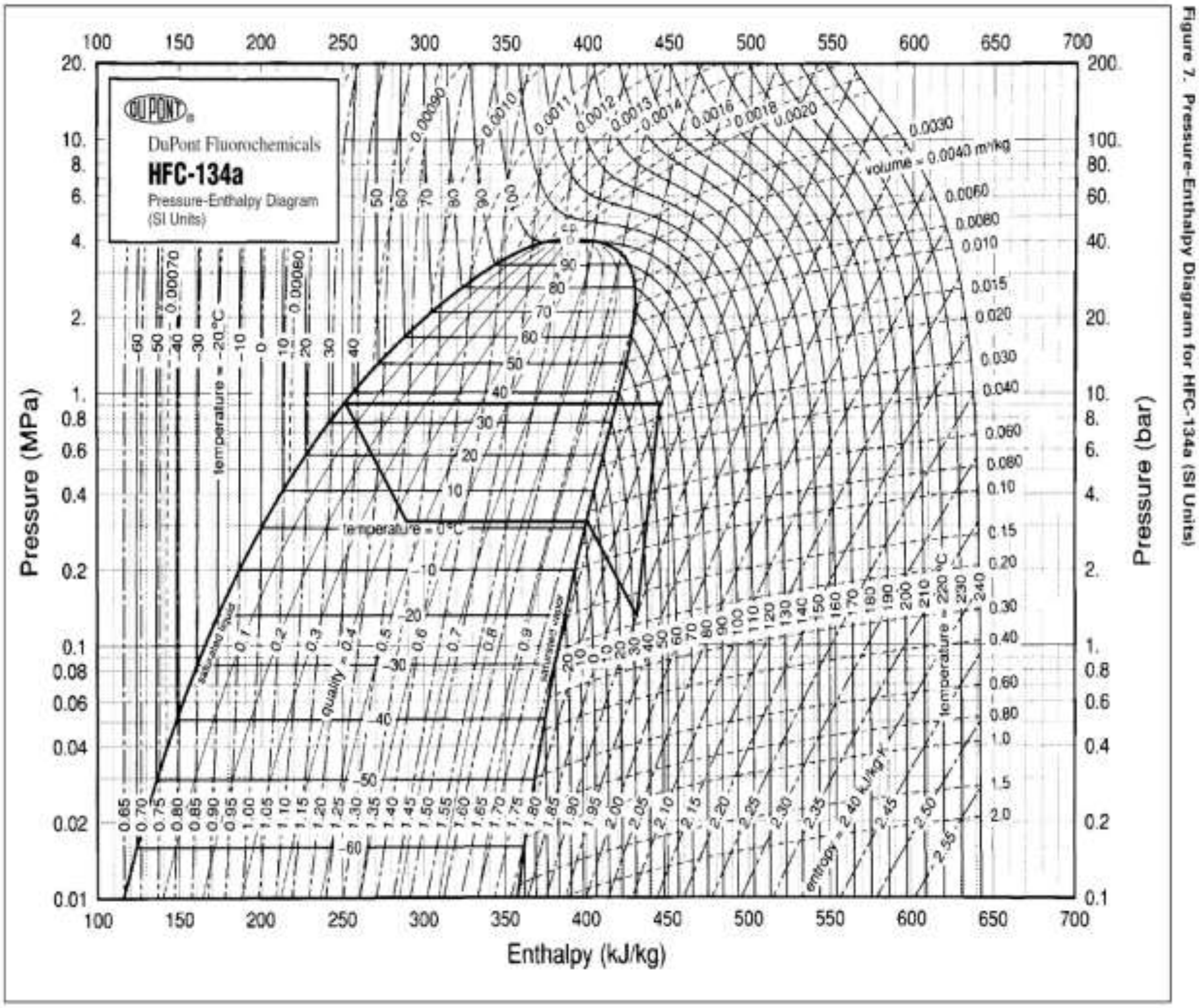

Fig.2 P-h diagram for air conditioner test rig without evaporative cooling

- P-h diagrams with evaporative cooling

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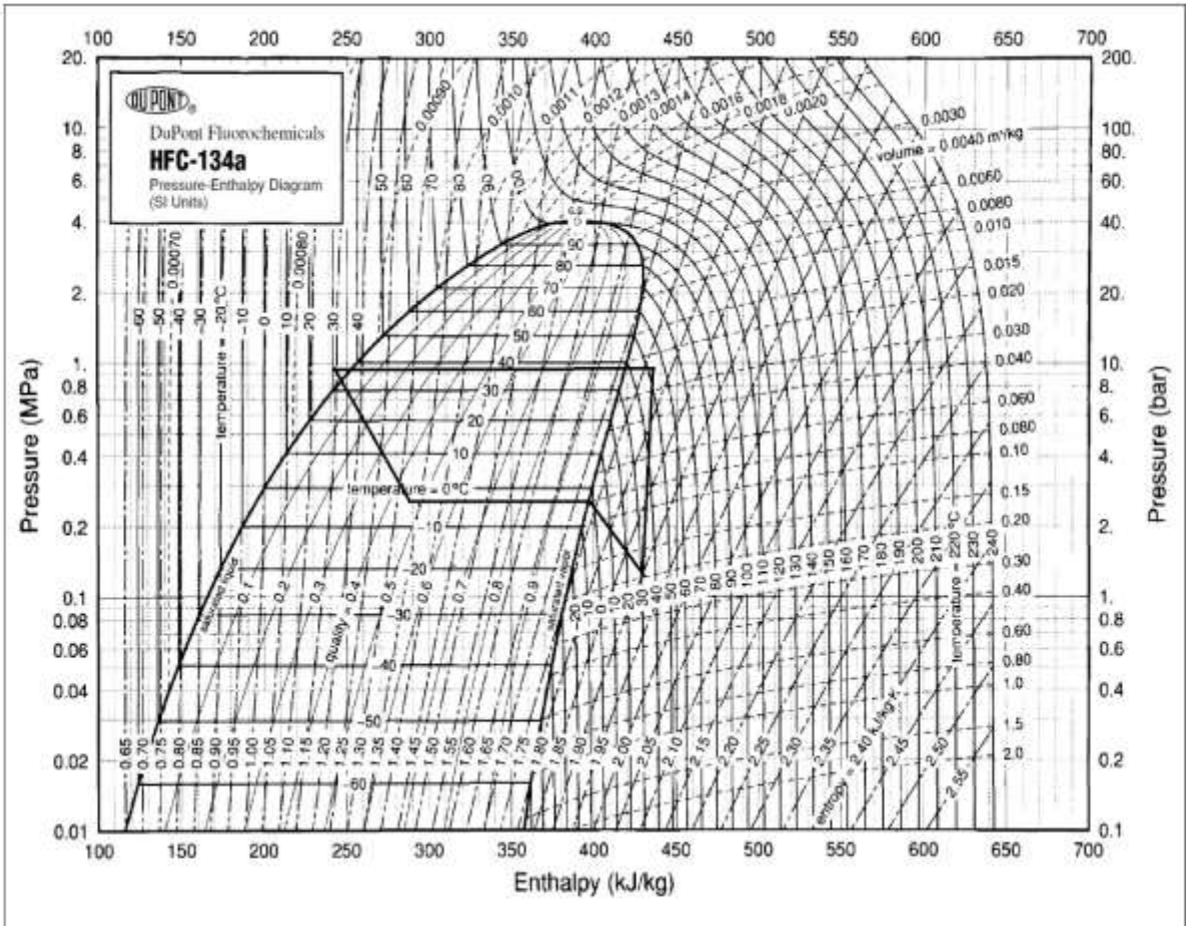

Fig.3 P-h diagram for air conditioner test rig with evaporative cooling

F) Psychrometric chart

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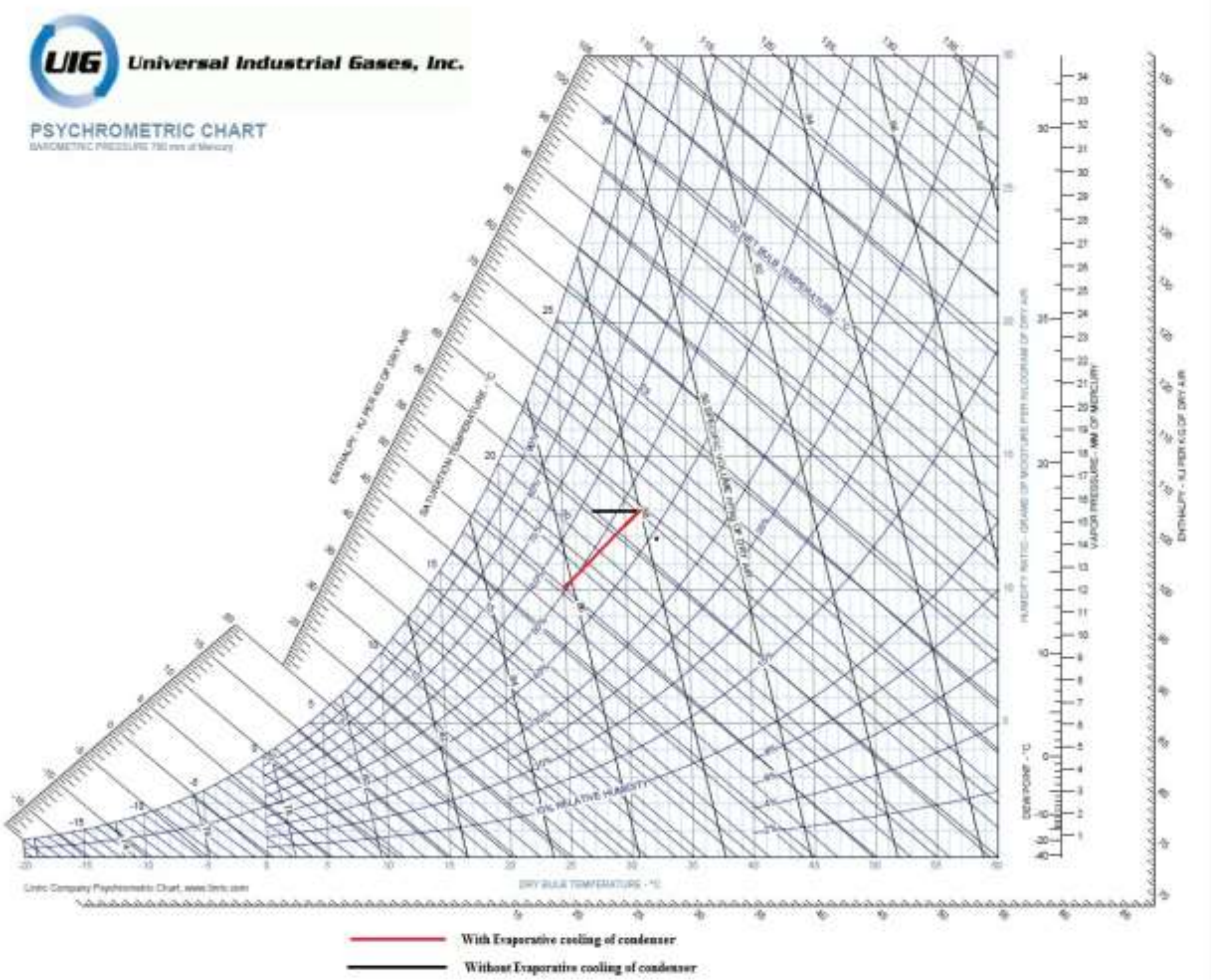

Fig:4 Psychrometric chart for air with evaporative cooling and without evaporative cooling

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