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Effect of water temperature during evaporative cooling on Refrigeration system

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ABSTACT: Refrigerator is mainly a composition of four devices Compressor, Condenser, Expansion device and evaporator which have some limitations [1]. Temperature range of working is also a limitation for Refrigerator which affects their performance. Here we provide more effort to reduce the limitations related to working temperature range and try to modify the size of refrigerator with the effect of evaporative cooling.Since condenser rejects latent heat of refrigerant to atmosphere due to higher temperature of refrigerant at condenser. So due to this rejection of heat it provides the cooling in evaporator [2]. Co-efficient of performance of refrigeration system mainly depends on temperature difference between the condenser and that medium where heat is to be rejected. More temperature difference, more heat rejection so more cooling on account of same work to refrigeration system. But if the temperature difference is less, less heat rejection will be there so less cooling by giving same amount of work which decreases the Co-efficient of performance of the system. [3]

KEY-WORD- Co-efficient of performance (C.O.P), Evaporative cooling, Percentage increment in C.O.P

INTRODUCTION-

Refrigeration system is used to provide cooling by the use of mainly four components Compressor, Condenser, expansion device and evaporator. These four components are operated 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 toEnvironmental condition i.e. during the summer atmospheric temperature becomes higher which decreases the temperature difference between refrigerant and atmosphere, results less heat rejection whichdecreases the overall performance of refrigeration system[6].

In this paper, by experiment on Ice plant test 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

If T_1, T_2 temperature of surrounding and temperature of evaporator in case of refrigerator than co-efficient of performance is given by-

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

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 can not 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) Fill the tank of ice plant with 10 kg of water and notedown the initial temperature of water and Wattmeter reading .Then start the compressor for 50 minutes.

2) Note down the reading, temperatures after
compressor, after condenser, after expansion, and after evaporator water temperature, suction pressure andexhaust pressure when test rig utilized the 0.1Kwh power.

3) After that spray the water of temperature 18^oC on condenser and again read the temperatures at previous locations when test rig utilized the 0.1Kwh power.
4) Now repeat this procedure for spray water of temperature 23^o C and 30^o C.

Results -

Here Following abbreviations are used:
P_1 = Discharge Pressure
P_2 = Suction pressure
T_1 = Temperature after compressor,^oC
T_2= Temperature after condenser,^oC
T_3 = Temperature after expansion device,^oC
T_4 = Temperature after evaporator,^oC
T_5 = Water temperature,^oC

A) Refrigeration effect with spray water temperature of 18^O C

	Before	**After 10 Minutes**
P_1	**133 psi**	**133 psi**
P_2	**2.2 psi**	**2.2 psi**
T_1	**65**	**54**
T_2	**43**	**36**
T_3	**6**	**3**
T_4	**24**	**2**
T_5	**19**	**6**

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

	Before	**After 10 Minutes**
P_1	**133.3 psi**	**133.3 psi**
P_2	**2.2 psi**	**2.2 psi**
T_1	**65**	**60**
T_2	**40**	**34**
T_3	**15**	**4**
T_4	**16**	**3**
T_5	**18**	**7**

C) Refrigeration effect with spray water temperature of 30^O C

	Before	**After 10 Minutes**
P_1	**133.3 psi**	**133.3 psi**
P_2	**2.2 psi**	**2.2 psi**
T_1	**65**	**60**
T_2	**40**	**35**
T_3	**16**	**9**
T_4	**30**	**16**

T_5	**23**	**15**

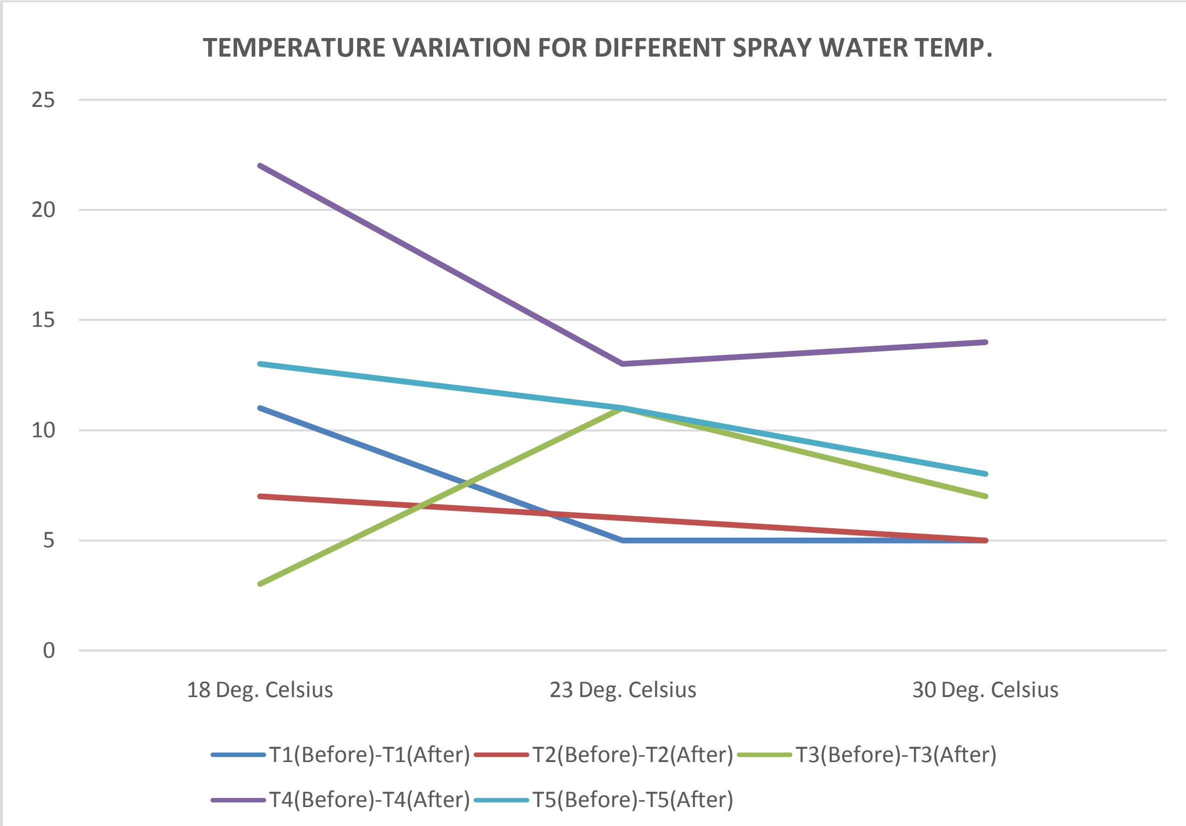

Fig2. Variation of temperature for different spray water temperature

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