

Development and Performance Testing of Evaporative Cooling Air Cooler Cooling with Dehumidification and Heating

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Abstract- Energy consumption all over the world is increasing rapidly and there is pressing need to develop ways to conserve energy for future generation. The conventional refrigeration system consumes very large amount of power (about 1.5 KW). Also for cooling, Evaporative coolers are the better option. The cost of Evaporative coolers is low and also it consumes less power than that of AC. The main drawback of Evaporative cooler is that the air supplies by it has very large amount of Humidity. Due to which when an individual sits in the air of evaporative coolers, he fills stickiness on his body which is not comfortable condition. So this project work involves the design and manufacturing of the “evaporation cooling air cooler cooling with dehumidification and heating” which will not increase the humidity of air. It will maintain the room at comfort conditions by using the silica gel to reduce the humidity of air. This cooler will work in both the season winter and summer. In winter season, cooling module is stop and heating module is on, so that air is heated by heater and it will ultimately increase the temperature of air. In summer season, cooling module is on and heating module is off, it will ultimately decrease the temperature of air up to 10°C. In summer season silica gel is also be used to reduce the humidity of air. After manufacturing this air cooler efficiency is measured by various performance measuring devices and instruments. Here thermometer and hygrometer are used to measure the temperature of air and humidity of air.

I. INTRODUCTION

Air Cooler is one of the appliances that keeping the atmosphere cold. The basic idea of water cooling is to find a medium that can handle and transport heat more efficiently than air. Water has a good ability to

retain heat, in the meantime stay in a liquid form. As long as can circulate cool water to the hot parts. Water can cool it down more efficiently than air. Method of Air cooling is a dissipating heat. Which works by making the object to be cooled have a larger surface area or have an increased flow of air. Evaporative cooling is based on a physical phenomenon in which Evaporation of a liquid into surrounding air cools an object or a liquid in contact with it. As the liquid turns to a gas, the phase change absorbs heat. Latent heat of Evaporation. Water is an excellent coolant because it is plentiful, non-toxic, and evaporates easily in most climates. The concept, was refined, became the Evaporative coolers which will provide a low cost, alternative to refrigerated air conditioning. Fresh outside air is pulled through moist pads where it is cooled by Evaporation and circulated through a house or building by a large blower. Air Cooler is one of the appliances that keeping the atmosphere cold. An air cooler serves to cool down the hot air in a room or vehicle. Air cooler cools the atmospheric air in a room or vehicle by adding water to the air. The water is added in the form of mini droplets. The air cooler has a fan installed in it that pulls the warm air from outside through a water wetted filter medium. The water in the cooler is evaporated by the warm air drawn by the fan. The evaporated water releases in the room. The temperature of the room comes down because the warm air is drawn by the fan of the air cooler.

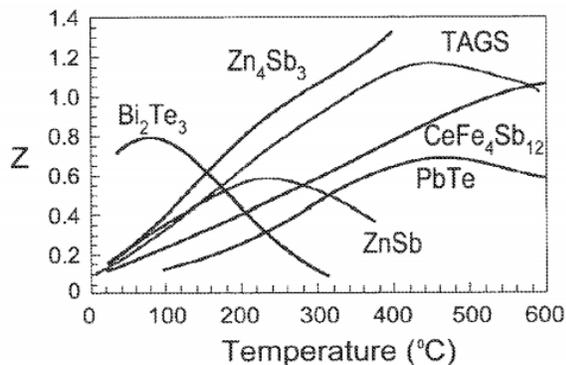
An air cooler is not the same as an air conditioner. The air cooler does not use compressor and refrigerant gas. We can say that though the air cooler

is not as effective as air conditioner, it is not harmful for the environment and its cost is effective.

II. REVIEW

Jain, J. and Hindoliya, D. [1] has study regenerative evaporative cooler. A conventional direct evaporative cooler has been modified by adding a water to air, heat exchanger in the path of outgoing air stream. The heat exchanger cools the air further by using cooled water available in the collecting tank Experiments have been conducted to study the performance of the regenerative evaporative cooler. It has been found that the efficiency and COP of regenerative system increases by 20-25%. The regenerative cooler having higher cooling capacity may be advantageous as it may attract more people for maximum utilization of this low energy consuming device leading to energy conservation in residential and commercial buildings.

Wei He, Gan Zhang, Jie Jie [2] invented that Energy crisis and environment deterioration are two major problems for 21st century. Thermoelectric device is a promising solution for those two problems. This review begins with the basic concepts of the thermoelectric and discusses its recent material researches about the figure of merit. It also reports the recent applications of the thermoelectric generator, including the structure optimization which significantly affects the thermoelectric generator, the low temperature recovery, the heat resource and its application area. Then it reports the recent application of the thermoelectric cooler including the thermoelectric model and its application area. It ends with the discussion of the further research direction.



Chinenye, N. [3] has developed a clay evaporative cooler for the purpose of preservation of fruits and vegetables at a lower temperature and also to study

the physical parameters such as cooling efficiency, cooling capacity, etc. in the system. The results showed that the evaporative cooler reduces the temperature up to 10 °C and increases the relative humidity of incoming air for the storage chamber. The evaporative cooler was able to preserve freshly harvested tomatoes for about 19 days. It is observed that clay is a material which helps in evaporative cooling and has shown proven results and hence can be used as a vital element in the air cooling system. Poonia, M. et al. [4] has study a multi- utility desert cooler is one in which water cooling as well as cold storage systems are attached in addition to the air cooling system. The average effectiveness was found to be 65.42% and a temperature range of 22-27 °C was achieved. It can be used only in areas with high temperature and low relative humidity hence reducing its scope.

III. MATHOLOGY

The steps for calculation of thermal performance of Air cooler are outlined in detail as follow:-

Discharge of water:

$$P = \rho Q g H \dots\dots\dots (1)$$

Flow velocity of water:

$$Q = A_i V_i = A_o V_o \dots\dots\dots (2)$$

Total heat generated:

$$Q = VI \cos \phi \dots\dots\dots (3)$$

Heat transferred through peltier module to air (taking in account conduction only due to small area):

$$Q = KA \frac{dt}{dx} \dots\dots\dots (4)$$

Tank Capacity:

$$V = lbh \dots\dots\dots (5)$$

Cooling efficiency:

$$\eta_{cooling} = \frac{T_1 - T_2}{T_1 - T_3} \dots\dots\dots (6)$$

Cooling capacity:

$$Q_c = m C_p (T_1 - T_2) \dots\dots\dots (7)$$

Moisture absorbed by silica crystal gel:

$$Q_a = m_a (w_1 - w_2) \dots\dots\dots (8)$$

IV. RESULTS

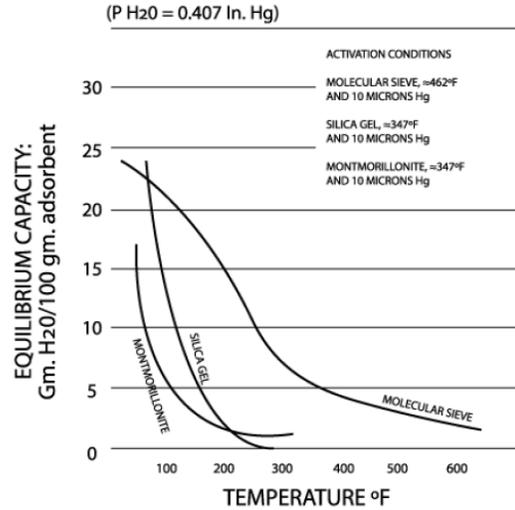
By using Peltier module atmospheric air temperature reduced to 33.7°C to 24.1°C.

By using Peltier module temperature of normal water temperature reduced to 32.1°C to 21.1°C.

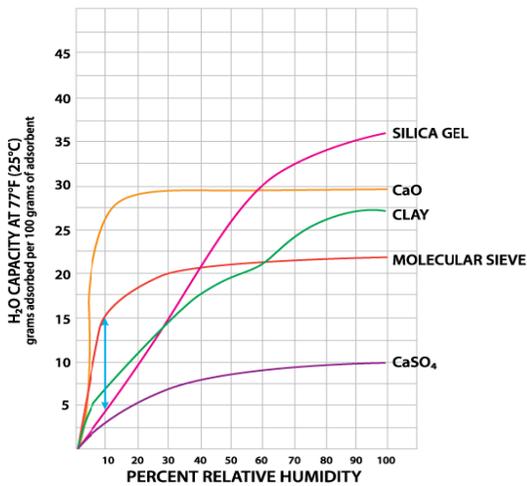
By the use of silica powder for the dehumidification the relative humidity of the region is reduced to 57% from 70% at that condition of atmosphere.

Result Tables:

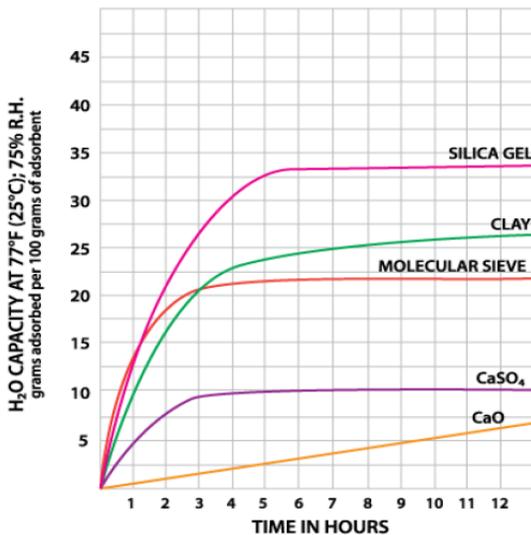
Time(min.)	Dbt. °C	Wbt °C	Relative Humidity (%)
0	31	28	70
15	29	26.5	69
30	28.4	26.3	68
45	27.9	25.8	62
60	27.4	24.9	57



Absorption rate of various Absorbents:



Equilibrium capacity of various absorbents



Equilibrium H₂O capacity:

V. CONCLUSION

In present study, an experiment analysis carried on evaporative air cooler which is attached to peltier module for the purpose of cooling water and silica crystal gel to absorption of water particles from flowing air over it. By performing this experiments can conclude that, this project can be used in summer and winter both seasons, in summer it can maintain temperature of the atmosphere around 24°C which is most favorable for human being.

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