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Modified Double Pad Evaporative Cooler

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Abstract – The evaporative cooler was the subject of numerous US patents in the 20th century; many of these, starting in 1906, suggested or assumed the use of excelsior (wood wool) pads as the elements to bring a large volume of water in contact with moving air to allow evaporation to occur. A typical design, as shown in a 1945 patent, includes a water reservoir (usually with level controlled by a float valve), a pump to circulate water over the excelsior pads and a squirrel-cage fan to draw air through the pads and into the house. This design and this material remain dominant in evaporative coolers in the American Southwest, where they are also used to increase humidity. In the United States, the use of the term swamp cooler may be due to the odor of algae produced by early unit. The idea that if the same concept will be used in air cooler then it may give better results than an ordinary air cooler with the use of Honeycomb.

Keywords: - Evaporative Cooler, US patents, American Southwest, Honeycomb etc.

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INTRODUCTION

Air Conditioners aren't feasible and economic in rural, arid and desert regions. So Air coolers are used for cooling rooms in houses. But the common limitation of Air coolers is effectiveness of cooling and they consume water in good amount too.

How to provide more cooling with same power used from Air coolers?

As desert coolers reduces the temperature but not till that extent as Air Conditioners provide. So, there was a rising need of even more effective lowering of temperature which double pad honeycomb cooling pads can provide.

In places where reduction of temperature is the most important priority for healthy survival like in dessert regions, semi-arid and arid lands etc. and people can't afford Air Conditioners for that purpose, hence this project will try to eliminate their problem by lowering the temperature more than a normal Dessert cooler not till the level of Air Conditioners but it will provide effective cooling by using Double padded honeycomb cooling pads through which air will pass from both the pads and hence reduces the temperature. Moreover honeycomb cooling pads will also contribute for the same purpose.

It will be cheap and easily affordable by people thus providing a healthy and cooler environment for better survival of mankind.

LITERATURE REVIEW

While living in village of Rajasthan in scorching heat of 50 degree Celsius, we found a common problem of villagers and people there in dry areas. In too hot and dry temperatures normal air desert coolers take too much of water and the cooling is not up to mark. People cannot afford air conditioners and the electricity also in not 24*7 available. So our team decided for a design thinking session to analyze the problem deeply. Below are the problems we analyzed:-

1) Air desert coolers efficiency was less and temperature difference is only 5-6 degree Celsius.

2) Air desert coolers were consuming too much water, approximate 50 litres is 4 hours. In area like Jaiselmer of Rajasthan water scarcity is also there

3) For dry and hot conditions only AC can be alternate which is neither viable nor economically feasible for majority of people

These are some points we observed in various villages of Rajasthan and Haryana too. So our research journey starts from here. We have searched on Google and market survey was done to dig deeper. We have only found single pad evaporative cooler available in market and both theoretically. But our thermodynamics study motivated us to try something new. So we got an idea of putting two evaporative pads in cooler and our research started.

OBJECTIVES OF THE STUDY

Our aim is to make a DOUBLE PAD EVAPORATIVE COOLER that can reduce the temperature to a considerable extent by fitting two honeycomb cooling pads with some distance in between them in the cooler.

SCOPE OF THE STUDY

The scope of work helps in planning the steps or procedures that must be followed and carried out and completed in order to make the double pad evaporative cooler.

For making an evaporative cooler, doing a proper Literature review is very much essential. It involves getting to know how the existing coolers work, how are they made and what modifications or changes can be brought upon in order to make it both economical and efficient. Before we come up with the design, it's very important that we learn about the type of design and also the mechanism incorporated in the design.

Few points to remember:-

- Gaining knowledge about the normal desert cooler and its temperature variations.
- To apply the knowledge in our project with all the changes we want to inculcate in making a double pad evaporative cooler.
- Making the modified cooler by inserting all parts like pump, motor, fan, cooling pads etc. by various mechanical cutting ways like drilling etc. and assembling them.
- Overhauling of the cooler and checking for any leakage etc and concluding the final reduced temperature.

After the design has been successfully made and tested for any discrepancy, we will start building our project. For the ease of making, all the equipment and materials must be collected forehand and kept ready for further use. After the completion of the project it must be tested for the actual variation in temperature that our actual aim was at the starting.

PRINCIPLE

The principle underlying evaporative cooling is the fact that water must have heat applied to it to change from a liquid to a vapor. When evaporation occurs, this heat is taken from the water that remains in the liquid state, resulting in a cooler liquid.

Evaporative cooling systems use the same principle as perspiration to provide cooling for machinery and buildings. A cooling tower is a heat-rejection device, which discharges warm air from the cooling tower to the atmosphere through the cooling of water. In the HVAC industry, the term "cooling tower" is used to describe both open and closed circuit heat rejection equipment.

HVAC (stands for **H**eating, **V**entilation and **A**ir **C**onditioning) is a control system that applies regulation to a heating and/or air conditioning system. Usually a sensing device is used to compare the actual state (e.g., temperature) with a target state. Then the control system draws a conclusion what action has to be taken (e.g., start the blower).In an HVAC system, heat is generated by the sun shining on the building, the computers, and people. The heat is picked up in the air handlers which are indirectly tied to the refrigerant through several heat exchangers. The heat boils the refrigerant from a liquid to a vapor. Cooling Tower water is circulated through a heat exchanger where refrigerant vapor is condensed and heat is transferred to the water. The purpose of the cooling towers is to cool the warm water returning from the heat exchanger so it can be reused. In the open cooling tower, the warm return water from the heat exchanger is sprayed over the "fill". The fill provides the surface area to enhance the heat transfer between the water and air, causing a portion of the water to evaporate. That cool water then loops back to the beginning of the process, to absorb more heat from the heat exchanger.

In a closed circuit cooling tower, cold water or a solution of ethylene or propylene glycol is used to provide cooling. Unlike in an open cooling tower, the fluid used to provide cooling is enclosed in a coil and is not exposed directly to the air. Cold water is re-circulated over the outside of the coil, which contains the fluid that has been heated by the process. During operation, heat is transferred from the fluid through the coil to the spray water and then to the atmosphere as a portion of the water evaporates. The cool fluid in the coil then loops back to the beginning of the process, to be reused in the process.

OBSERVATIONS

Double evaporative pads air cooler with honeycomb is expected to be the best Air cooler and most efficient in hot, arid regions. Here are some graphs shown which will finally conclude that our Double evaporative air pad cooler is far better than the ordinary coolers in the market. For this, various case studies were made and many observations were taken to show the effect of honeycomb in the air cooler.

General Observations:-

- Double evaporative pads air cooler is good to use in hot and dry regions. Temperature decrease of 8-9 degree Celsius was noticed

whereas an ordinary cooler decreases the temperature by 5-6 degrees. However this range of decreasing temperature depends on various factors like humidity, moisture, external air flow rate, external temperature and other climatic factors.

- To show how good honeycomb pads are, we plotted different graphs using only honeycomb pads in single layer, double layer with water and without water too. There is significant drop in temperature in every case study even readings were taken without water due to honeycomb pads without evaporative cooling. So we can use honeycomb pads as a cooling object and can place outside windows to take fresh cold air.

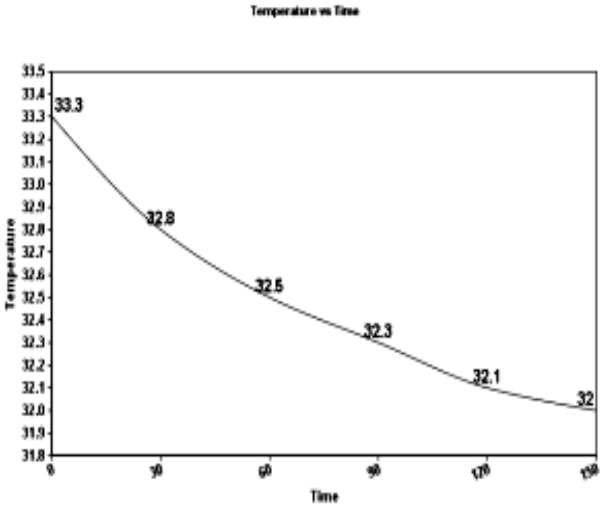
- The Air cooler readings were taken in various conditions. Humidity and other things weren't calculated but ambient temperature is mentioned in every graph. Room Dimensions where case study was done was about 8X8 feet.

GRAPHS

1. Single evaporative pad without Water (Temperature vs. Time)

Since we used honeycomb pad as a cooling medium so for a single layer of honeycomb we have taken the readings of temperature with respect to time to check the effect of honeycomb pads on temperature decrease. Water is not supplied and only honeycomb single layer is present.

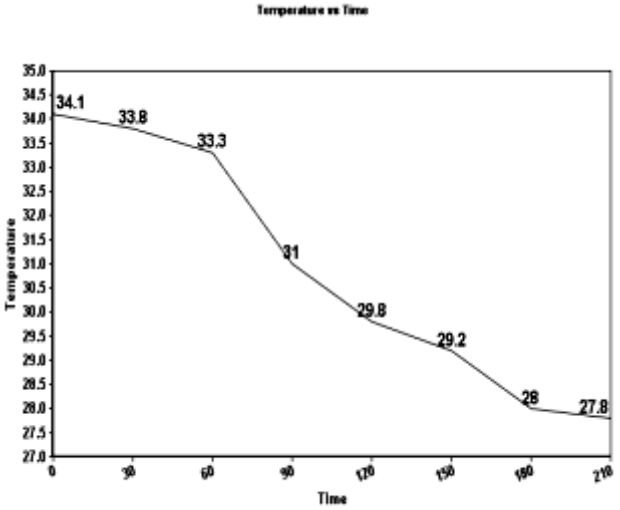
Ambient Temperature: 33.3 °C.



2. Single evaporative pad with Water (Temperature vs. Time)

Temperature vs. time graph is plotted when single layer is present and water is supplied via pump in Air cooler.

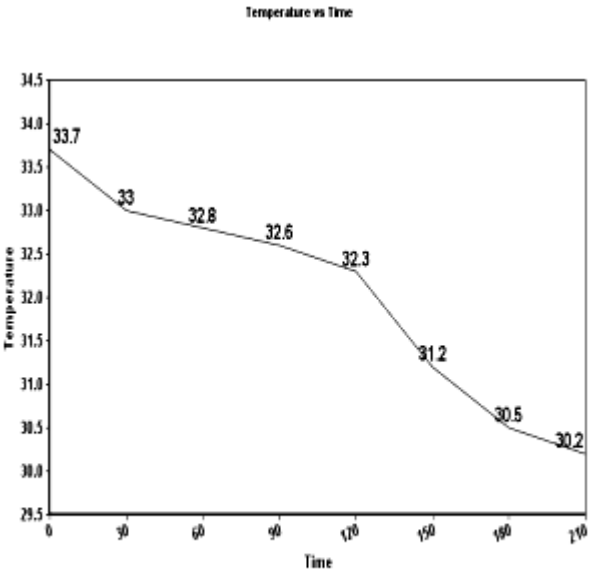
Ambient temperature: 34.1°C



3. Double evaporative pad without water (Temperature vs. Time)

Now double evaporative pads are placed. Firstly temperature vs. time graph is plotted to measure the cooling of honeycomb pads without water.

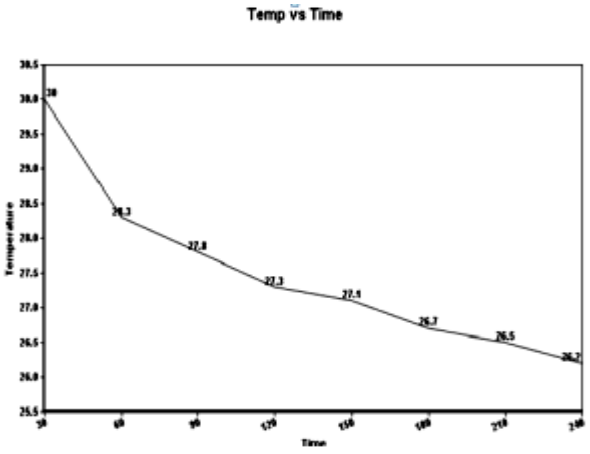
Ambient temperature: 33.7°C.



4. Double evaporative pad with water (Temperature vs. Time)

Double evaporative pad decreases the temperature even more than a single evaporative pad as air will now passes from two layers of cooling pads and hence become even cooler. Since evaporative pads are made up of honeycomb, so cooling effect can be directly observed from the graph below.

Ambient temperature: 33.8°C.



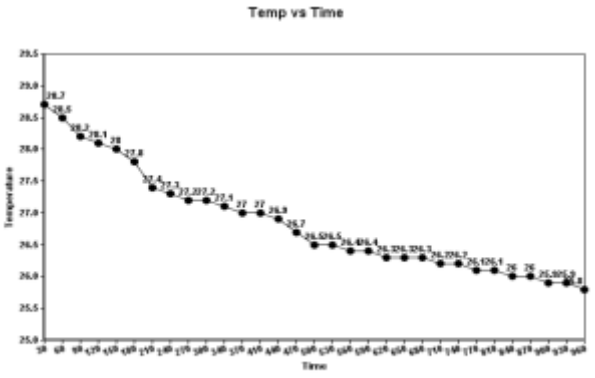
5. Double evaporative pad with water. (Readings taken 1.5 meters away from cooler)

Since Evaporative Air Cooler takes time to cool the whole room. Therefore, by changing positions various temperature records were observed.

We took reading 1.5 m away horizontally from Double evaporative air pad cooler.

The graph between temperature and time is plotted below. This graph illustrates that Air cooler took 10-15 minutes to cool the whole room. It depends on Area of the room. So for different areas rate of cooling per min will differ.

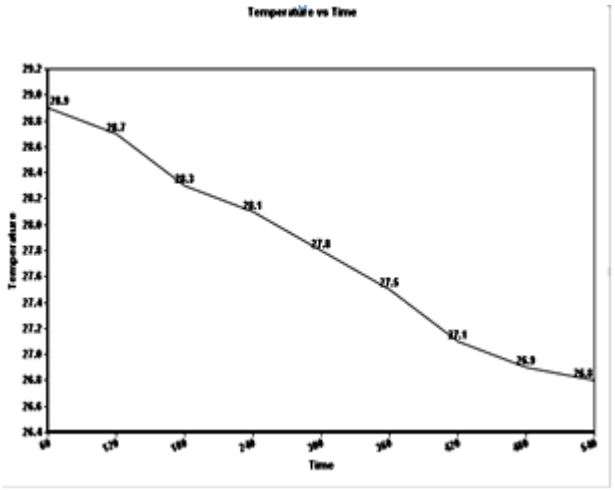
Ambient temperature: 28.8°C.



6. Double evaporative pad with water. (Readings taken 2 meters away from cooler)

The temperature variation is shown by the graph as follows:-

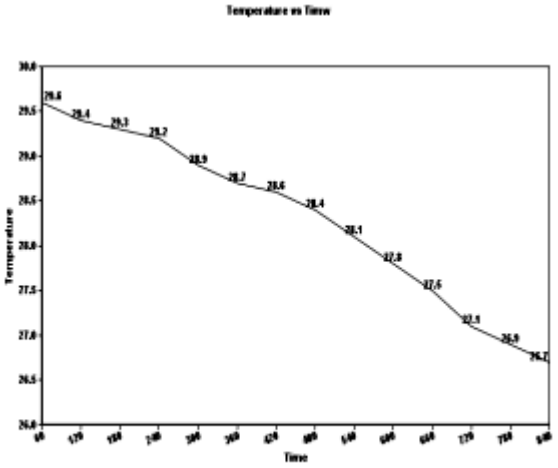
Ambient temperature: 29.1°C.



7. Double evaporative pad with water. (Readings taken 2.5 meters away from cooler)

The temperature variation is shown by the graph as follows:-

Ambient temperature: 29.6°C.



CALCULATIONS

EFFICIENCY - CALCULATION of EER (Energy Efficient ratio)

1. 12000 BTU/Hr (British thermal unit) = 1 ton

2. EER is a measure of how efficiently a cooling system will operate when the outdoor

temperature is at specified level. Higher EER means higher efficiency.

3. SEER (Seasonal Energy efficiency ratio) is a measure of efficiency over an entire cooling season, as opposed to a single outdoor temperature.

4. SEER = Seasonal BTUs of cooling **/** Seasonal watt hours used.

5. Power input to fan = 45 W

6. Power input to fan = 45 W

7. Power input to pump = 18 W

8. Total power input = 63 W

EER Formula:

EER= BTU/Hr divided by Total Power input

BTU/Hr Calculations:

- Height of room = 10 ft
- Width of room = 8 ft
- Length of room = 8 ft
- Temperature to be reduced = 8°C

Now, BTU/Hr = 648 W (Using BTU calculator software)

- EER = 648 W / 63 W
- EER = 10.28 (Theoretical)

Observations and Result

Poor rated Air conditioners used in 1970s were having EER value close to 7. Nowadays EER value differs from AC to AC. Generally Air conditioners have EER value higher than 10. **Our Air Cooler also gave 10.28 EER values which is quite astonishing and competitive to Air conditioners**. These are all theoretical calculations as cooler gives different results in different conditions.

Our honeycomb Double evaporated Air cooler gave up to 8°C difference which is significant value for a cooler. Also the temperature of water inside the tank of cooler when measured was lower than that of room temperature too. So it cools water too. The space between two honeycomb evaporative pads is cooler due to which we got better results.

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