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Partial Evaporative Cooler

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Abstract - *In this world, different types of old-style swamp coolers are use but it produces unnecessary humid air than required, causes the uncomfortable condition to the humans thus, we developed partial evaporative cooler. The partial evaporative is a new technique of the cooling system with air washing. We used earthen plates (Baked soil plates) and arranged it in C shape. It can control the water evaporation and moisture content in air results controlled humid air. It doesn't contain any type of grass wool for cooling. It works on forced induction which helps air to present more time in the chamber and cools fast. It has only two openings, one for inlet of hot air and another for an outlet for the cooled. The partial evaporative cooling system can provide years of trouble-free service and cool, clean, comfortable, fresh air at a lower energy cost than swamp coolers.*

Key Words*: *Earthen plates, Partial evaporative, Air washing

1. INTRODUCTION

An evaporative cooler is a device that cools air through the evaporation of water. Evaporative cooling uses the fact that water will absorb a relatively large amount of heat in order to evaporate. The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapor. This can cool air using much less energy than refrigeration. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants. Partial evaporative cooling strategies can offer the same benefits as indirect evaporative cooling systems without the complexity of equipment and ductwork.

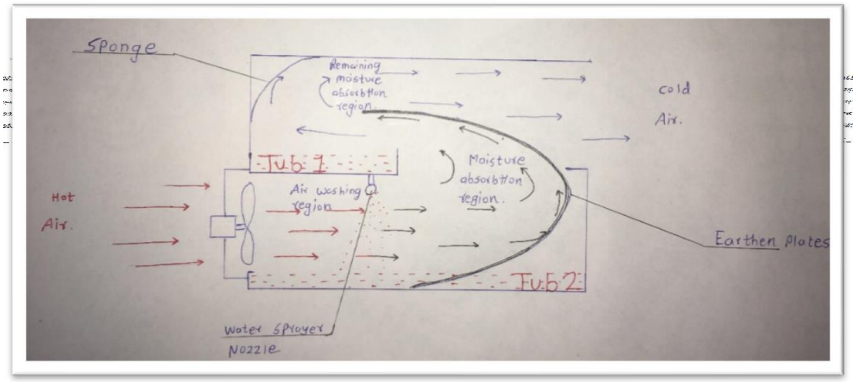

Fig -1: Working diagram of partial evaporative cooler

1.1 LITERATURE REVIEW

An earlier form of evaporative cooling, the windcatcher, was first used in ancient Egypt and Persia thousands of years ago in the form of wind shafts on the roof. They caught the wind, passed it over subterranean water in a qanat and discharged the cooled air into the building. Modern Iranians have widely adopted powered evaporative coolers. Evaporative coolers lower the temperature of air using the principle of evaporative cooling, unlike typical air conditioning systems which use vapor-compression refrigeration or absorption refrigeration. Evaporative cooling is the conversion of liquid water into vapor using the thermal energy in the air, resulting in lower air temperature. The energy needed to evaporate the water is taken from the air in the form of sensible heat, which affects the temperature of the air, and converted into latent heat, the energy present in the water vapor component of the air, whilst the air remains at a constant enthalpy value. This conversion of sensible heat to latent heat is known as an isenthalpic process because it occurs at a constant enthalpy value. Evaporative cooling, therefore, causes a drop in the temperature of air proportional to the sensible heat drop and an increase in humidity proportional to the latent heat gain. But swamp cooler has no control over air quality which certainly changes at day and nights because of change in atmospheric air.

A partial evaporative cooler is a new concept of the swamp cooler. It is a modification of evaporative cooler. It has advantages over swamp cooler like it doesn't produce much moisture in the air and also it controls humidity in the air for cooling effect. It doesn't contain any type of grass wool for cooling. It only has earthen plates for cooling effect thus, we get clear cold air from partial evaporative cooler. Due to low moisture and humidity, a partial evaporative cooler is possible to use in laboratory, industries because high humidity air can cause corrosion to instruments, machines.

1.2 Construction

A partial evaporative cooler has two openings. One for inlet, situated at the back-bottom side of the cooler and another is at front side for an outlet. It also has two equal water storage tubs. Tub1 at the middle portion of cooler and another at the lower portion of cooler i.e. tub2. The arrangement is done in such a way that water is sprayed over the air by the help of a nozzle. When the air is washed, the remaining water with dust from the air is collected at tub2. We can control the humidity and moisture of air by controlling the amount of water spraying on the hot air according to human comfort and climatic condition.

When the tub2 fills full, electronic water pump starts and sends water back to the tub1 for continuous air washing and air moisturizing purpose. Earthen plates are arranged in such a way that air with water droplets strikes on it causes separation of air and water droplets. These earthen plates cool the air due to its own natural characteristics. And at last, the sponge is fitted to absorb remaining moisture from the air and allow air to exit through the outlet port. All components are fitted in such a way that air travels in smooth 'S' shape from the cooler. And the whole unit is wrapped in polystyrene sheet for insulation purpose.

1.3 Working

When the air is sucked by partial evaporative cooler, air flows through water sprayer which washes and moisturizes the hot air. Due to this heavy dust particle from the air get separated and clean air flows through. But when the water is sprayed into the air and propelled with a flow, the water in this spray consists of fine droplets, causing the small water droplets to evaporate quickly due to absorbing the heat from the air. The evaporation cools the air. The energy needed to evaporate the water is taken from the air in the form of sensible heat, which affects the temperature of the air, and converted into latent heat, the energy present in the water vapor component of the air, whilst the air remains at a constant enthalpy value. This conversion of sensible heat to latent heat is known as an isenthalpic process because it occurs at a constant enthalpy value. Evaporative cooling, therefore, causes a drop in the temperature of air proportional to the sensible heat drop and an increase in humidity proportional to the latent heat gain. That is how sweating works: The water particles on the surface of the skin carry off the heat with them as they evaporate, cooling the skin.

After this process, remaining water droplets present in the airstrikes on earthen plates. Because of this striking, water droplets get separate from the air and wet the earthen plates. Because there are a large a number of extremely small pores on the earthen plate through which the water kept on the plates keeps on evaporating and takes the latent heat required for vaporization from the earthen plates and remaining water. The earthen plates and water hence lose heat and this makes the air cool. Thus, earthen plates never get full of trap water droplets. When the air is passed through earthen plates it must go through Sponge which absorbs remaining moistures present in the air and allows cold air to flow out. In short, the evaporation of water is done to cool an environment.

2. MAIN COMPONENTS & DISCRIPTION

Earthen plates; - Earthen plate is basically a baked soil plate, placed on metal mesh arranged in 'C' shape. There are a large number of extremely small pores on the earthen plate through which the water kept on the plates keeps on evaporating and takes the latent heat required for vaporization from the earthen plates and remaining water. The earthen plates and water hence lose heat and this makes the water on the plates cool.

Water spraying nozzle; - A spray nozzle is a precision device that facilitates dispersion of liquid into a spray. The water spray nozzle is designed to spray water directly onto the surface via a nozzle with a carefully predetermined spray pattern. In a partial evaporative cooler, this happens due to the natural phenomenon of liquid as liquid flow from high altitude to low altitude due to gravitation force.

Polystyrene Sheet; - Polystyrene is a synthetic aromatic polymer made from the monomer styrene. Polystyrene can be solid or foamed. General-purpose polystyrene is clear, hard, and rather brittle. It is an inexpensive resin per unit weight. It is a rather poor barrier to oxygen and water vapors and has a relatively low melting point. Polystyrene is one of the most widely used plastics, the scale of its production being several million tons per year. Polystyrene can be naturally transparent but can be

colored with colorants. It can be also used as insulation purpose. It acts as a barrier between two different temperature mediums.

Table -1: Comparison

Comparison of Swamp cooler and Partial evaporative cooler		
Parameters	**Swamp cooler readings**	**Partial evaporative cooler readings**
Initial temperature	27˚C	38˚C
Temperature at inlet	25˚C	36˚C
Temperature at outlet	23˚C	31˚C
Wet bulb temperature	-	20˚C
Dry bulb temperature	-	30˚C
Temperature drop	2˚C	5˚C
Speed of fan	1400rpm	1400rpm
Time required	1 hr. 30 min	45min

3. ADVANTAGES, DISADVANTAGES AND APPLICATION

3.1 ADVANTAGES

- It can be use in any medium humid region.
- It can be use in laboratory, industries due to low moisture and humidity in air.
- Energy saving can be as high as 75%.
- Less Expensive to install and operate.
- Better air distribution in the conditioned space due to higher flow rates.
- Very environment friendly as no harmful chemical are use.
- Low quantity of consummation of water.
- It consumes low amount of electricity.
- Simple construction and design.
- Lower Maintenance costs.

3.2 DISADVANTAGES

- It consumes more space.
- Unsuitable for very high humid regions.

3.3 APPLICATION

- It can be used for cooling building for thermal comfort.
- It can be used in laboratories and industrial purpose.
- It can be used at open floor space.
- It is mostly suited for climates where the air is hot and humidity is low/medium.

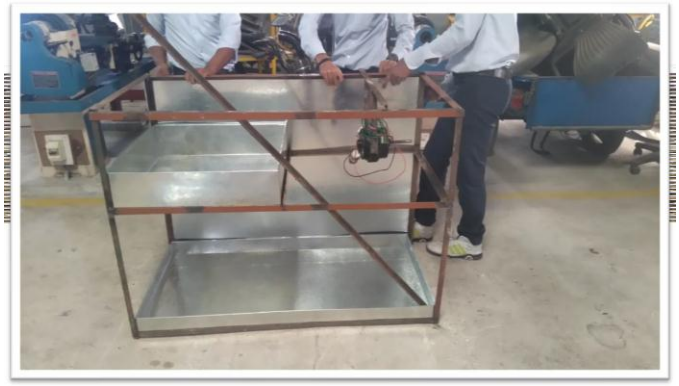

Fig -2: Framework structure of partial evaporative cooler

4. FUTURE SCOPE

We can make our partial evaporative cooler more energy saver and comfortable for human beings.

By measuring fresh air quality and applying changes according to it, we can control air quality present in the room. This can be done by introducing automatically varying water sprayer and air discharge fan. It will measure humidity and moisture from the air and will do suitable changes according to it.

5. CONCLUSIONS

This is the new technology of the cooling system. This cooler can control humidity and moisture of air by reducing the energy consumption and water consumption of cooler. This results in most favorable and healthy air quality to humans. It doesn't contain any type of grass wool for cooling. The latter can provide years of trouble-free service and cool, clean, comfortable, fresh air at a lower energy cost than conventional air conditioners and initial costs are competitive as well. Our implementation in this cooler we use polystyrene sheet for insulation. And this cooler doesn't need to work at the open place because there is only one port for air inlet and it only needs to get fresh air continuously. Due to the modification now, it is possible to use this cooler in the close room as the will does not create any discomfort to the human body.

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REFERENCES

[1] R. H. Turner and F. C. Chen, "Research Requirements In The Evaporative Cooling Field",ASHRAY Transaction, New York, Vol.93 Part1(1987)

[2] R. K. Rajput, Heat and Mass Transfer,1 stMulticolor Edition, 1991K. Elissa, "Title of paper if known," unpublished.

[3] Manohar Prasad, Refrigeration and Air Conditioning, 1st Edition, 1999

[4] Halasz, B. "A general mathematical model of evaporative cooling devices", Rev. Gen. Thermal, Vol. 37, pp. 245-255, 1998.

[5] Arora and Domkundwar, A course in Refrigeration and Air-Conditioning,7th Edition, Delhi, Dhanpat Rai& Co., 2002

[6] José Rui Camargo, "Evaporative Cooling: Water for Thermal Comfort"RevistaAmbiente e Água –An Interdisciplinary Journal of Applied Science,Brasil, Vol. 3 n. 2(2008)

[7] Edward G. Pita, An Energy Approach, 4 th edition, 2009

[8] R.K. Kulkarni, S.P.S. Rajput, "Comparative performance of evaporative cooling pads of alternative materials," International Journal of Advance Engineering Sciences and Technologies, 10 (2011) 239 – 244

[9] J.K. Jain, D.A. Hindoliyab, "Experimental performance of new evaporative cooling pad materials" Sustainable Cities and Society 1 (2011) 252– 256

[10] R. S. Khurmiand J. K. Gupta, A Textbook of Refrigeration and Air Conditioning,5th Edition, New Delhi, Eurasia Publishing House, 2011

[11] R. K. Rajput, Refrigeration and Air Conditioning, 2nd Edition, 2012

[12] Martand Telsung, Industrial Engineering and Production Technology,1 st Edition, New Delhi, S. Chand Publication, 2012

[13] Banyat Niyomvas and Bunjerd Potakarat "Performance Study of Cooling Pads" Advanced Materials Research 664 (2013) 931-935.

[14] Lateef L. Akintunji, Ibrahim U. Haruna et. al. "Theoretical performance analysis of coconut coir as aedia in evaporative coolers" International Journal of Scientific & Technology Research, 3 (3) (2014)

[15] Richard Bourne, "Advanced Evaporative Cooling White Papers", Public Interest Energy Research, California Energy Commission, P500-04-016-A1(March 2004) NOVATEUR PUBLICATIONS INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT] ISSN: 2394-3696 VOLUME 2, ISSUE 4, APR.-2015. Page 8

[16] https://en.mm.wikipedia.org/wiki/evaporative_cooler