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MODERN EVAPORATIVE COOLER

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ABSTRACT

Human always tries for better comfort and sophistication at each level of his life. Considering air conditioning, evaporative cooler is used in dry climates. But such evaporative coolers are not suitable in humid environment and also their performance is poor in the places where ventilation is not proper. Reason behind this is nothing but, uncontrollable humidity increment in the working environment (cabin) due to process of evaporation. Report is sequential details about research carried out on the evaporative cooler in order to remove this disadvantage. The important parameter in whole report is nothing but relative humidity which should be maintained in specific range for getting better thermal comfort. Report briefly explains the basic concept required to understand evaporative cooling and performance of evaporative cooling. It also explains why evaporative cooler is not as effective as air conditioners.

KEYWORDS*:* Evaporation, Conductivity, Humidity, Heat transfer

INTRODUCTION

Refrigeration, in today's world has a vital importance. In domestic consideration, it is used in various appliances like refrigerator, air coolers, food preservation units, air conditioners etc. By considering wide scope of the topic, it is necessary to study and do research on the topic of refrigeration in order to make it more economical and efficient.

EVAPORATION

It is the process of change of state of matter from its liquid form to gaseous form by absorbing heat equal to the latent heat of vaporization. Process of evaporation takes place at the surface of the liquid. It absorbs the remarkable amount of heat from surrounding in the process. Evaporation is basic principle behind conventional swamp coolers. Evaporation is the process which takes place throughout the day

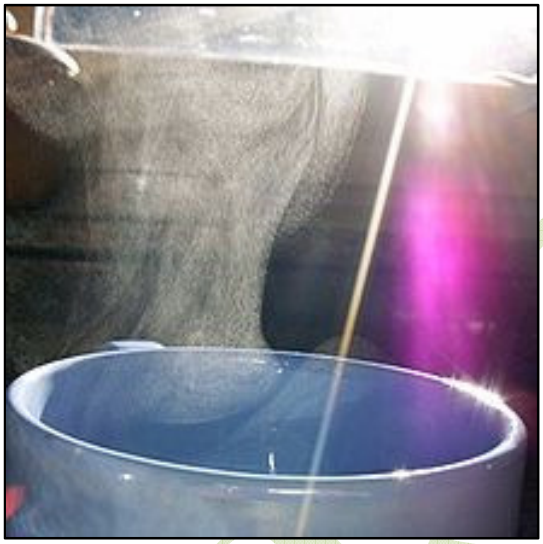


Fig: Evaporation rate

i) HUMAN COMFORT CONDITION

Every cooling system tries to fulfill the human comfort conditions. It is expected from an efficient cooling system to satisfy thermal comfort within a smallest amount of input in the form of money or energy.

Following are some important human comfort conditions:

- Oxygen supply
- Heat removal
- Moisture removal
- Air motion
- Purity of air
- Favorable temperature

i.)SATISFACTION BY COOLING SYSTEMS

To satisfy the human comfort conditions, all the above factors must be taken into consideration while designing any type of cooling system.

a)SWAMP COOLERS Swamp coolers use the principle of evaporation of water to achieve thetemperature as low as possible. Evaporation is the process in which heat is absorbed and utilizes in phase transformation of material. Control of dust and impurities is done by introducing filters in the path of air when it flows through the cooler.**Butswamp coolers failtosatisfy the condition ofhumidity control and** this is our main objective to control humidity.

ii)CONVENTIONAL EVAPORATIVE COOLER

In low-humidity areas, the evaporating water into the air provides a natural and energy efficient means of cooling. Evaporative coolers, also called as swamp coolers, rely on this principle, cooling outdoor air by

passing it over water-saturated pads, causing the water to evaporate into it. The cool air with temperature of 24°C to 28°C is then directed into the home, and pushes warm air out through windows.

When operating an evaporative cooler, windows are opened part way to allow warm indoor air to escape out as it is replaced by cool air. Unlike central air conditioning systems that recirculate the same air, evaporative coolers provide a steady stream of fresh air into the house.

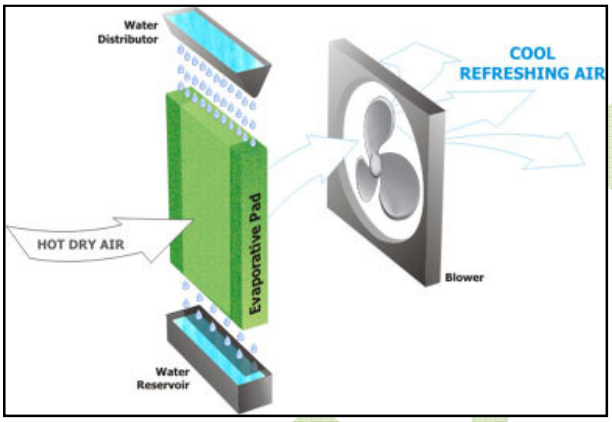


Fig.The basic design of conventional evaporative cooler

ADVANTAGES:

1.Low initial cost as well as working cost

2.Eco-friendly, since no any such chemical reaction takes place which creates hazardous product.

3.Water is used as refrigerant which is freelyavailable in the nature.

DISADVANTAGES:

1. Increases humidity in the cabin
2. Requires proper ventilation in cabin.
3. Sometimes it works with noise.
4. Higher maintenance than air conditioners.

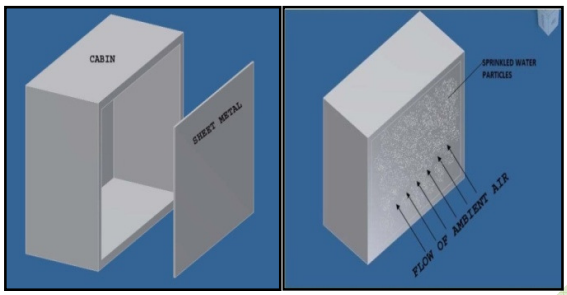
IV].OBJECTIVE

1. To achieve 7°C to 8°Cof temperature drop by evaporation.
2. To achieve optimum design with minimum capital investment.
3. To utilize various resources from campus and outside the campus effective manner.
4. To present this innovative idea in various engineering colleges and in conferences preceding.

V].CONSTRUCTION AND WORKING

CASE I:

the conventional design is unable to keep specific humidity constant in the cabin. We suggested another design which can keep specific humidity inside the cabin at constant level. The basic construction and working of modified design is as illustrated below



Construction **working**

CONSTRUCTION:

In the new design, we made one wall of cabin by sheet metal (aluminium) and the remaining walls are thermally insulated by covering their internal surfacewith an insulating material as shown in fig. 5.1. Sheet metal is fixed to the cabin with the help of nails. The insulating material used is nothing but the sheets of thermocol. Sheet metal used here absorbs the heat from the cabin and rejects it to the atmosphere. Hence for maximum heat absorption the sheet should be having maximum surface area and minimum thickness.

WORKING:

After fixing the sheet metal to the cabin, the water droplets are sprinkled on the outer surface of the sheet metal and a flow of air is passed on it. This will evaporate sprinkled water particles on the surface of sheet metal and due to evaporation latent heat of vaporization is absorbed from the surrounding medium. Now in this case, surrounding medium is nothing but the sheet metal, so heat is directly absorbed from sheet making it cooler than ambient environment. Now cooling effect generated over sheet metal is utilized inside the cabin for cooling internal air.

OBSERVATION:

Observation table for conventional cooler:

Sr. no.	Parameter	Reading
1.	Initial temperature	25°C
2.	Final temperature	23°C
3.	Temperature drop	2°C
4.	Time required	1 hr 30 min
5.	Thickness of metal sheet	1 mm
6.	Speed of fan	1300rpm

POSSIBLE IMPROVEMENT:

In this case we observed that several problems like, insulation of cardboard was not proper and rigidity of the setup is also not up to the mark. Also when the sprinkled water came into contact of cardboard paper, several gaps are created and it hampered the insulation.

Case II:

Second case is constructed with better insulation and rigidity, we detected lack of air circulation in case I we put small DC motor fan inside the room.

OBSERVATION:

Observation table for modern cooler:

Sr. no.	Parameter	readings
1	Initial temperature	32°C
2	Final temperature	23°C
3	Temperature drop	9°C
4	Time required	1 hr
5	Thickness of metal sheet	0.5 mm

VI]DESIGN CONSIDERATION

SELECTION OF MATERIAL FOR METAL SHEET:

Here selected aluminium (Al) as a material for metal sheet due to following properties:

1. High thermal conductivity i.e. k= 225 W/m K
2. Low cost.
3. High corrosion resistance.
4. Light in weight

SELECTION OF INSULATING MATERIAL:

Here selected polystyrene (thermocol) as an insulating material inside the cabin due to following properties

1. Low thermal conductivity i.e. k= 0.1154 W/mK
2. High rigidity
3. Light in weight
4. Low cost
5. Easy to fabricate the cabin

ERGONOMICS OF CABIN:

The ideal design of any workplace should ensure that the person using it will have adequate and comfortable posture that he can see what he must and he can operate his controls in an effective manner. The workplace design is influenced by ergonomic considerations.

VII] PSYCHROMETRIC STUDY

Psychrometry deals with the study of moist air i.e. dry air mixed with water vapour or humidity it also include study of behavior of dry air and water vapour mixture under various sets of conditions. Though the earth's atmosphere is mixture of gases including nitrogen, oxygen, argon and carbon dioxide, yet for the purpose of Psychrometry, it is considered to be a mixture of dry air and water vapour only.

PSYCHROMETRIC TERMS:

Though there are many psychrometric terms, yet the following are important from this report point of view.

DRY AIR:

The pure dry air is a mixture of a number of gases such as nitrogen oxygen carbon dioxide hydrogen argon neon etc. But the nitrogen and oxygen have major portion of the combination. The molecular mass of dry air is taken as 28.966 and the gas constant of air 'R_a' is equal to 287 J/kg K.The molecular mass of water vapour is taken as18.016 and the gas constant for water vapour 'R_v' is equal to 461 J/kg K.

MOIST AIR :

"It is a mixture of dry air and water vapour." The amount of water vapour present in the air depends upon the absolute pressure and temperature of the mixture.

SATURATED AIR:

"It is a mixture of dry air and water vapour, when the air has diffused the maximum amount of water vapour into it." The water vapours usually occur in the form of superheated steam as an invisible gas. However when the saturated air is cooled, the water vapour in the air starts condensing, and the same may be visible in the form of moist, fog or condensation on the cold surfaces.

DEGREE OF SATURATION:

"It is the ratio of actual mass of water vapour in the unit mass of dry air to the mass of water vapour in the same mass of dry air when it is saturated at the same temperature."

HUMIDITY:

"It is the mass of water vapour present in 1 kg of dry air."It is generally expressed in terms of gm/kg of dry air. It is also called as specific humidity or humidity ratio.

ABSOLUTE HUMIDITY:

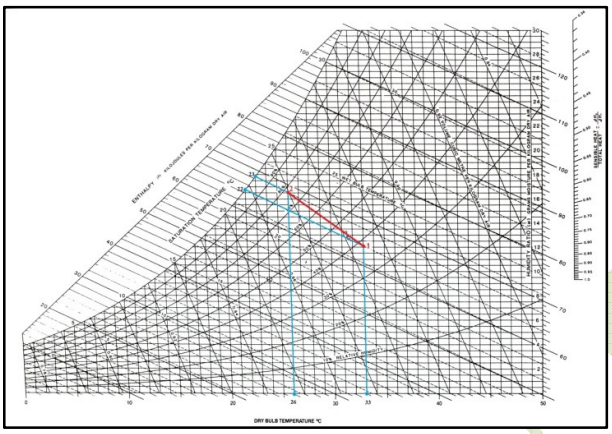
"It is the mass of water vapour present in $1m^3$ of dry air."It is generally expressed in terms of gm/m^3 of dry air. It is also expressed in terms of grains/m^3 of dry air.
Mathematically,1 kg of water vapour is equal to 15430 grains.

RELATIVE HUMIDITY:

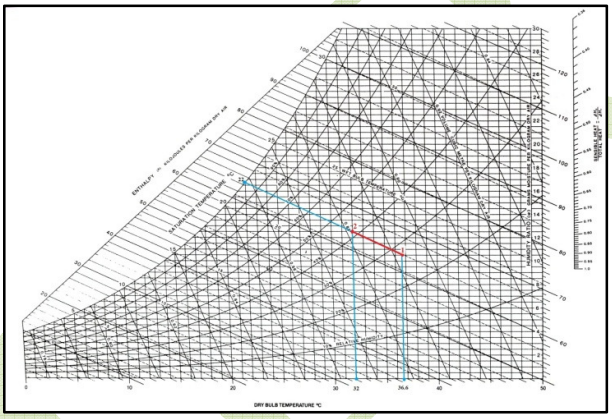
"It is the ratio of actual mass of water vapour in a given volume of moist air to the mass of water vapour in the same volume of saturated air at the same temperature and pressure."

It is briefly written as RH and generally denoted by 'Φ'.

VIII].COMPARISON BASED ON PSYCHROMETRIC CHART



Psychometricchart for conventional cooler



Psychometric chart for modern cooler

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Working on this project was one of the wonderful and existing experiences in our life. This project not only bears testimony of extensive efforts but also reflects co-operations, help and guidance, which we received time to time from college.

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