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Design and Working Model of Humidifier with Evaporative Cooling Pads

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Abstract:

Accordingly, wide-spread usage of evaporative coolers can help delay adding expensive new power plants to the electric grid and the controversial transmission lines that often accompany them. So a number of utility companies in areas with hot, dry summers and substantial population growth have programs to promote efficient evaporative coolers. The main aim of the paper is to design a model of humidifiers with Eco-cool evaporative cooling pad uses the simple principle of evaporative cooling which is nothing but passing fresh air through wet surface to bring down the temperature. The eco-cool evaporative cooling pads are saturated with water, sprayed onto it through pre-fixed channels. Fresh air, which is warm or hot is blown with help of blower through the wet eco-cool pad. The water evaporates when it comes in contact with the warm/hot air thus, cooling as well as humidifying of the air is done. Low power consumption and high reliability of the evaporative pads, wide range of applications including domestic use, remain as special attractions to this humidifier. In addition, the latest evaporative cooler designs are a lot easier on the grid than compressor-based cooling systems. In future addition to improve the performance, modern evaporative coolers include the options for thermostatic control and automated flushing of reservoir water to reduce buildup of impurities.

Keywords:

Centrifugal Air Blower, Eco-cool pads, Thermocouple, Water storage, Feed Pump, Indicator Panel, Wind Outlet.

I. INTRODUCTION:

In many parts of the world cooling pads, are used such as cellulose, card board, paper pads used for people cooling in factories, warehouses and various types of industrial applications.

We sell many cooling evaporative pads to garment factories to improve worker comfort. We have cooling pads for hog, poultry and animal confinement buildings. Our poultry pads are designed to promote poultry health and production and require environmental control of heat, temperature and ventilation in order to produce profitable returns. Cooling pads for agriculture are used worldwide for animal confinement buildings to cool all types of animals as well as greenhouse crops. There are many types of cooling media but cellulose is the most effective. Many types of cooling or wet pad cooling media has been used, aspen chips, even hog hair and fog types but Munters cooling pad media dominates the worlds evaporative cooling pad installations.

The principal types of pads by name are:

- Kool-Cel Pads (Acme pads) (sometimes called Kool Cell pads, KoolCel pads, cool-cell pads, or cool cel pads)
- CELdek Pads (or Cel-dek pads)
- Kuul Pads
- Munters Pads

These can be in all sizes, thickness, width and heights to meet all standards of the above types of pads. Demand for blower and pad cooling systems in workplace and factory environments is growing dramatically, particularly in emerging nations and in industries such as garment factories, warehouses and product storage facilities. We can get the replacement greenhouse cooling pads and industrial cellulose wet pads for industrial using evaporating cooler systems. The Eco-cool Evaporative Cooling Pads are made of special grade cellulose paper and are engineered from specially treated cross-sectional fluted media, capable of absorbing and retaining water to provide the maximum cooling efficiency. They are cross-corrugated to maximize the mixing of air and water and eliminate water carryover. Saturation effectiveness ranging from 50 to 98% can be achieved depending upon air velocity and depth of the cooling pad.

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A temperature reduction to 10-20°C (50-68°F) can be achieved by passing the hot fresh air through the wetted pads. The temperature reduction depends on the dry bulb and wet bulb temperature of the ambient incoming air, the thickness of the pad (in the direction of the air travel), the geometry of the pad, the air velocity through the pad and provided the proper amount of water is used and distributed evenly so that all of the pads are wet through their depth, height and width. The hotter and drier the incoming air, the higher is the temperature reduction, after passing through the wetted Eco-Cool pads. Plus Eco-cool can be customized for special applications and is compatible with all air handling and conditioning systems. It retrofits easily into existing Evaporative cooling systems (desert coolers).

Advantages:

•Lower Edge buildup – it has smooth/fine edges, which helps to lessen buildup of dust particles thus enhancing the life span of the pads and is easy to maintain, can be washed and scrubbed easily.
•Structural strength – They are treated with stiffening and rot-resisting agents for structural, which along with the specially engineered fluted strength preventing sagging and resisting sagging. Its higher structural strengths help save on the cost of support material.
•Weight – They are designed to take almost 20 to 40% higher amount of water in the same amount of space.
•Gluing - The cross section of the Eco-cool Evaporative Cooling Pads are glued with special glue that has a very long life even with intermittent wetting and drying cycles.
•Energy efficient – It allows higher cooling with lower air volume; pads are over 80% efficient.
•Longer life - Eco-cool is synthesized with specialized anti-rot chemicals.
•More effective - Eco-cool can handle treble the air velocity over the same area, compared to any other type of pads.

II. RELATED WORK:

The idea behind the proposed model is to design an ECO AIR HUMIDIFIER which uses evaporative cooling to provide an airflow that is cooler than the surrounding air. Water from the tank is pumped up and dripped onto the cooling pad inside of the air cooler. As hot ambient air is pulled through this cooling pad, the water in the cooling pad evaporates.

Evaporation is an endothermic process (it absorbs heat) - the energy used in evaporating the water drops the temperature of the air flowing through the cooling pad. As a result, the airflow from the cooler is much colder than the ambient air. When air blows through a wet medium—a tee shirt, aspen fibers (excelsior), or treated cellulose, fiberglass, or plastic—some of the water is transferred to the air and its dry bulb temperature is lowered. The cooling effect depends on the temperature difference between dry and wet bulb temperatures, the pathway and velocity of the air, and the quality and condition of the medium.

In this system the type of evaporation is endothermic process. The water is poured in the sump and then pumped on to the over head tank. From there the water is sent onto the pads through the small holes in the tank. The pads get drenched with water. When the blower is run, a low pressure area is created in the chamber which sucks the air (ambient) through the evaporative cooling pads. The ambient air is hot and when the air flows through the pads, the water evaporates by absorbing the heat from air. The air on losing temperature gets cooled and the evaporated water is mixed with air and thus air gets humidified.

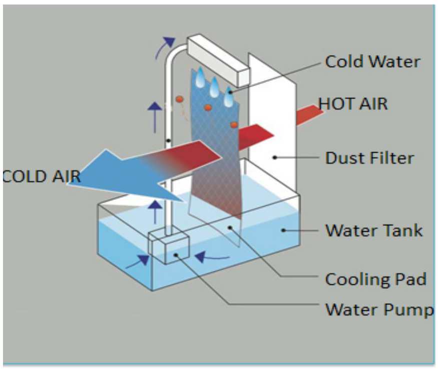

Figure 1: Image of model of Evaporating cooling system

Design Characteristics and Calculations of Evaporating Cooling System

Blower and pad cooling systems must be properly designed to obtain maximum evaporative efficiency during periods of intense hot weather. This requires a non-turbulent potential flow through the greenhouse to avoid mixing the cooled air at plant level with warmer air in the top of the greenhouse.

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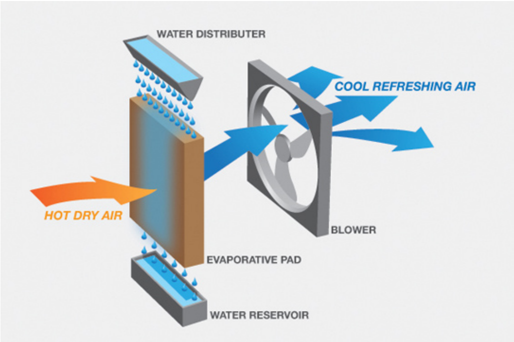

Figure 2: Image of Pad cooling system

1.1 Blower:

The blower and pad cooling system consists of large volume centrifugal blower and a correctly sized continuous wet pad system, both properly located with respect to the greenhouse layout. The fans exhaust the air and develop a slight vacuum or negative pressure throughout the entire house because it is substantially air tight. This slight vacuum draws air in through the cooling pad system and causes cooled air to move smoothly through the growing region of the crops absorbing heat. The warmed air is then expelled by the centrifugal blower in the opposite wall. This system produces a potential type air flow that moves a cool layer of non-turbulent air through the plants for best cooling efficiency.

1.2 Pad System:

The pad system requires a sufficient flow area to accommodate the large air volume needed to remove the intense solar heat. It is composed of wet table, fibrous material, in the form of self supporting special fluted cellulose cooling cells. It is kept wet by water re-circulating through it. The pad system also distributes the air uniformly and by virtue of its resistance, restricts the turbulence from the outdoor air, delivering a smooth, laminar flow of cool air into the house.

1.3 Rate of Air Exchange:

Because the solar heat comes into a greenhouse on a ground surface area basis, the air flow rates for ventilation are always determined on a cubic feet per minute (cfm) for each square foot of floor area. The basic air flow rate of 8 cfm per square foot has been determined to be sufficient for moderately shaded greenhouses having a maximum interior light intensity of about 5000 foot candles. However, in warm climates and houses with tall gutters (>12 feet), 11-14 cfm per square foot is advisable. This basic air flow rate is then adjusted for elevations over 1,000 feet above sea level, the expected interior light intensity, the allowable greenhouse temperature increase, and the distance from the pad to the blower.

1.4 Exchange Rate Adjustments:

Elevation: The heat removal capacity of air depends on its weight and not on its volume. Because air is less dense at higher altitudes the elevation of the greenhouse must be considered in design calculations. At higher elevations a greater volume of air is needed to provide the equivalent weight of air required at normal elevations. Light Intensity: The interior light intensity, which depends on the location of the greenhouse and the amount of shading, determines the amount of heat input into the greenhouse. Temperature Increase: The greenhouse temperature increase from pad to fan is a design factor. It is inversely proportional to the air flow rate and can be adjusted to any value desired. Usually a 7°F rise in temperature is tolerated. If it is important to hold a more constant temperature across the greenhouse, it will be necessary to raise the velocity of air movement through the greenhouse. This completes the adjustment and design factors necessary for a heat balance. Combining all these factors determines the house adjustment factor (FHouse) as follows:

1.5 Pad-to-blower Distance:

The pad and blower should be located on opposite walls. The preferred pad-to-blower distance ranges from 100 to 200 feet. This distance is an important design consideration. Distances greater than 200 feet can result in unacceptable temperature increases across the house. For very long houses (>200 feet), consider installing pads in each end and roof-mounted blower at the midpoint. For short pad-to-blower distances (<100 feet) the cross sectional air flow velocity within the house becomes too low and the house feels clammy or stuffy even though the air flow rate is technically correct.

This can be compensated for by increasing the size of the fans which increases the cost of the system. 1.6 Total Air Flow RequiredThe correct factor FVel is ignored for pad-to-fan distances of 100 feet or greater. For pad-to-fan distances less than 100 feet, calculate

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BOTHFHouse and FVel and use the LARGER of the two to complete the total air flow requirement where, TOTAL CFM = L × W × 8 cfm/ft2 × FHouse (unless FVel is >FHouse) Next select the size and number of fans that collectively equal or exceed the rate of air movement required and should be rate to do so at a static water pressure of 0.1 inches. If slant-wall fans are used, the fans should be rate to do so at a static water pressure of 0.5 inches. The static pressure rating takes into account the resistance encountered by drawing air through the pad and the fan itself. Fans should not be spaced more than 25 feet apart and should be evenly spaced.

1.7 Pad Design:

The size of the pad system is determined by adding the total cfm for each centrifugal blower selected and dividing the cfm that can be moved through one square foot of pad per minute. Cross-fluted cellulose pads, 4 inches thick can move 250 cfm/ft2 and cross-fluted cellulose pads, 6 inches thick can move 400 cfm/ft2 (6-inch pad flutes are designed differently than 4-inch pads). This area is then divided by the length of the wall on which the pads will be mounted to determine the actual pad height.

1.8 Pump Capacity:

Water must be delivered to the top of a 4-inch thick pad at the rate of 0.5 gpm per linear foot of pad. For pad lengths of 30 to 50 feet, a 1¼-inch water-distribution pipe is required, while for lengths of 50 to 60 feet, a 1½-inch pipe is needed. Sixty feet is the longest recommended pipe length. A 120-foot pad length could be serviced from a water supply at the midpoint supplying two 60-foot distribution pipes. At every 3 inches, 1/8-inch holes should be made in the pipe. The flow rate for a 6-inch thick pad is 0. 75 gpm per linear foot of pad a 1¼-inch distribution pipe is used for pads 30 feet and shorter, while a 1½-inch pipe is used for 30- to 50-foot pad lengths. The longest pipe length recommended is 50 ft. Again, 1/8-inch holes are spaced 3 inches apart in these distribution pipes.

1.9 Sump Tank Volume:

The sump tank volume should be at least 0.75 gal/ft2 of 4-inch thick pad and 1.0 gal/ft2 of 6-inch thick pad. These sump volumes are designed to operate at half the depth of the tank and will provide room to accommodate water returning from the pad when the system is turned off.

III. HARDWARE DESIGN FOR PROPOSED METHODOLOGY:

The paper presents the design of working model of a humidifier with evaporative cooling pads. Evaporative cooling is responsible for the chill you feel when a breeze strikes your skin the air evaporates the water on your skin, with your body heat providing the energy. The ancient Egyptians hung wet mats in their doors and windows, and wind blowing through the mats cooled the air the first attempt at air conditioning. This basic idea was refined through the centuries: mechanical fans to provide air movement in the 16th century, cooling towers with fans that blew water-cooled air inside factories in the early 19th century, swamp coolers in the 20th century.

These simple examples illustrate direct evaporative cooling. Modern technology has dramatically increased the efficiency and effectiveness of direct evaporative cooling and made possible four other types of evaporative cooling: indirect evaporative cooling, indirect/direct evaporative cooling, indirect/indirect evaporative cooling, and indirect/DX evaporative cooling. The portable working model of humidifier with evaporative cooling pads is used to fulfill the objectives of the proposed idea we need to understand the basic elements of few electronics parts like centrifugal air blower, Eco-cool pads, Thermocouple, Water storage, Feed Pump, Indicator Panel, Wind Outlet etc.

a. Centrifugal Air Blower:

Centrifugal blowers look more like centrifugal pumps than fans. The impeller is typically gear-driven and rotates as fast as 15,000 rpm. In multi-stage blowers, air is accelerated as it passes through each impeller. In single-stage blower, air does not take many turns, and hence it is more efficient.Centrifugal blowers typically operate against pressures of 0.35 to 0.70 kg/cm2 , but can achieve higher pressures. One characteristic is that airflow tends to drop drastically as system pressure increases, which can be a disadvantage in material conveying systems that depend on a steady air volume. Because of this, they are most often used in applications that are not prone to clogging.

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Figure 3: Image of Centrifugal Blower

b. Eco-Cooling Pads :

Eco-Cool Evaporative Cooling Pad uses the simple principle of evaporative cooling i.e. passing fresh air through the wet surface to bring temperatures down. The Eco-Cool Evaporative pads are saturated with water, sprayed on to it through prefixed channels. Fresh air, which is warm or hot, is blown (with the help of a fan) through the wet Eco-Cool Pad. The water evaporates when it comes in contact with the warm/ hot air, thus cooling as well as humidifying the air entering the area. Eco-friendly and economic, Eco-Cool provides the ideal media to keep temperatures low in industrial, commercial and residential areas

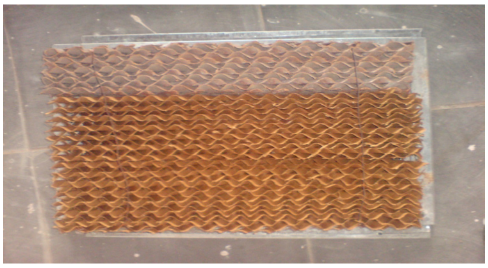

Figure 4: Image of Evaporative cooling pad

c. Thermocouple:

A thermocouple is a temperature-measuring device consisting of two dissimilar conductors that contact each other at one or more spots, where a temperature differential is experienced by the different conductors (or semiconductors)It also produces a voltage when the temperature of one of the contact points differs from the reference temperature of another, in a process known as the thermoelectric effect. Thermocouples are a widely used type of temperature sensor for measurement and control, and can also convert a temperature gradient into electricity.

Commercial thermocouples are inexpensive, interchangeable, are supplied with standard connectors, and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self powered and require no external form of excitation. The main limitation with thermocouples is accuracy; system errors of less than one degree Celsius (°C) can be difficult to achieve.Any junction of dissimilar metals will produce an electric potential related to temperature. Thermocouples for practical measurement of temperature are junctions of specific alloys which have a predictable and repeatable relationship between temperature and voltage. Different alloys are used for different temperature ranges. Properties such as resistance to corrosion may also be important when choosing a type of thermocouple. Where the measurement point is far from the measuring instrument, the intermediate connection can be made by extension wires which are less costly than the materials used to make the sensor. Thermocouples are usually standardized against a reference temperature of 0 degrees Celsius; practical instruments use electronic methods of cold-junction compensation to adjust for varying temperature at the instrument terminals. Electronic instruments can also compensate for the varying characteristics of the thermocouple, and so improve the precision and accuracy of measurements.

Figure 5: Image of Thermo couple

d. Water Storage:

The system has a sump at the bottom. The water is stored in the sump. A sub-merged centrifugal mini-pump is kept in the tank to pump the water from sump to the over head tank at the top of the system. The over head storage consists of a over flow pipe to sump & small drain holes for dripping the evaporative pads. The water from these holes fall directly onto the pads and thus the pads get drenched/ dripped with water

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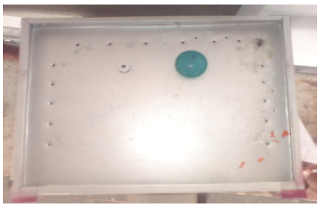

Figure 6: Image of water tank (storage)

e. Feed Pump:

This pump consists of an impeller of radial discharge type. The impeller is connected to a motor with a shaft. The pump is immersed in water and power is supplied. The water in the rotating impeller gains centrifugal for which tends the water to flow outside. The casing of the pump is made in such a way that the water from impeller is guided in a single direction by creating an exit at a single spot. This pump helps in circulating the water throughout the system which is very essential for bringing down the temperature of water and air. A discharge tube from the pump is connected to over head tank and from there the water is sent to pads through small holes in over head tank.

Figure 7: Image of Feed Pump

f .Indicator Panel:

The SUBZERO SZ-7510-S-P Cooling controllers are designed for management of refrigeration and food processing applications. The controllers have 1 NTC inputs for ambient and defrost temperatures and 2 relay outputs for control purposes. The controllers feature a simple user interface and are housed in a compact panel mounting enclosure. The SZ-7510-S-P controllers are powered from 85 to 270Vac/dc. It is a 2 Digit 7 segment LED, Compact size, Temperature unit - °C, NTC sensor input, Programmable High and Low alarms, Restart time delay, Set point lock, Programmable display offset, Relay action – Cool, 85 to 270V AC/DC supply voltage.

Figure 8: Image of Indicator panel

Press and hold the SET button until the LED display blinks. Adjust the desired temperature using the arrows up and down and then press set button. The controller cut offs at SET temperature. If the temperature increases, the system automatically starts. As the usage in this system is simple, the only cooling-controller is used.

g. Wind Outlet:

A circular section wind outlet is provided. The outlet of blower is of rectangular section. So, as to insert a ducting to the outlet, a converter is used. It enables the system to be placed out-door. The air flow can be brought into the room through a duct by connecting it to the wind outlet of the system.

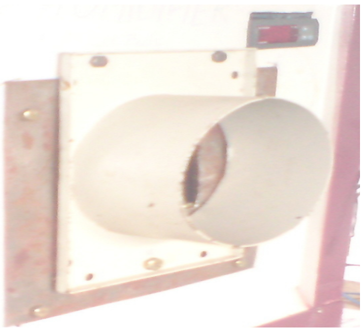

Figure 9: Image of Wind Outlet

IV. CONCLUSION:

In conclusion this paper has provided an initial analysis into a new era of Designing and a new working Model Of Humidifier With Evaporative Cooling Pads integrated using centrifugal air blower, Eco-cool pads, Thermocouple, Water storage, Feed Pump, Indicator Panel, Wind Outlet and provided realistic opportunity for Eco-cool evaporative cooling pad uses the simple principle of evaporative cooling system optimization. There are many differences between old-style swamp coolers and modern evaporative cooling systems.

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The present devices 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. In addition, the latest evaporative cooler designs are a lot easier on the grid than compressor-based cooling systems. Instead of peak demands of three to five kilowatts (kW) or more, typical demands for mid-size evaporative coolers are on the order of one kW. At the future extension the level in addition to improved performance, modern evaporative coolers include options for thermostatic control and automated flushing of reservoir water to reduce buildup of impurities. Accordingly, wide-spread use of evaporative coolers can help delay adding expensive new power plants to the electric grid and the controversial transmission lines that often accompany them. That's the reason a number of utility companies in areas with hot, dry summers and substantial population growth have programs to promote efficient evaporative coolers.

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