Direct Evaporative 360 Degree Rotation Air Cooler

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Abstract-
The initiative aims to develop an energy-efficient, environmentally friendly direct evaporative air cooler suitable for hot and dry regions. Unlike traditional coolers that provide one-directional airflow, this innovative design offers 360-degree air circulation, ensuring consistent cooling throughout the room. The cooling chamber is cubical in shape and incorporates four cooling pads with an exhaust fan mounted above. This setup enables simple 360-degree evaporative cooling by direct contact between water particles and a moving air stream. When hot and dry air passes through a wet cooling pad, it undergoes a temperature reduction while experiencing an increase in specific humidity due to water evaporation, which absorbs latent heat from the incoming air. To address the rising global energy demand, this project proposes an energy-efficient solution that integrates a humidity control system with a split unit, thereby enhancing user comfort by regulating air moisture. The goal is an efficient, cost-effective, and comfortable cooling solution, overcoming challenges in existing technologies.

Keywords: Evaporative Cooling, Latent heat, specific humidity, vaporization, thermal conduction, 360°air cooler, low operating cost

INTRODUCTION:

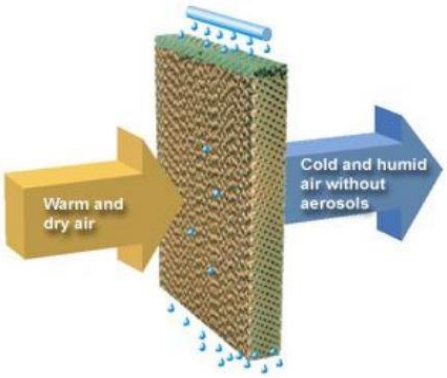

FIGURE 1: Direct Evaporative Cooling system

Human always efforts for better comfort and sophistication of his life. Evaporative cooling has been used for centuries as a method of conditioning houses, and only recently has it been understood thermodynamically. It involves saturating air adiabatically by spraying water onto 360-degree cooling pads without transferring heat to or from the surroundings. This process differs from traditional air conditioning, which uses vapor compression or absorption refrigeration cycles. Simple 360 evaporative cooling is achieved by direct contact of water droplets & a moving air stream. However, dry air will come stickier & will drop in temperature, If the water is circulated without a source of heat & cooling. When hot and dry air passes through a wet cooling pad, typically made of honeycomb pad, the air's temperature decreases while its specific humidity increases due to water evaporation. This 360-degree evaporative process can provide a considerable degree of summer comfort in areas with high dry-bulb temperatures and low relative humidity. However, it does not dehumidify the air but instead adds humidity. Before residential air conditioning became widespread, evaporative cooling was the primary mechanical method for making home interiors comfortable during hot, dry summers, especially in desert regions. While these cooling systems are energy-efficient and cost-effective, they may

struggle during periods of high humidity, reducing their efficiency. These cooling systems are economical in terms of energy usage. During the energy crises of the last two decades, 360˚ evaporative cooler use was promoted as one means to control household utility bills.

LITERATURE REVIEW:

Michael T. Talbot and James H. Fletcher Explains in this paper title Design and development of portable forced air cooler, published by Automotive Research & Testing Center (ARTC) in 2012 that Designing and construct a domestic (portable) air-cooler depends upon external parameters as inlet temperature, humidity, etc. And step involved in designing cooler.

Sunil J. Kavle,Vivek M. shahane and Vitthal N. Garje explains in this paper title Manufacturing of 360˚ rotation air cooler, published by International Journal of Mechanical And Production Engineering Oct-2014. That the present investigation is evident that for drip type 360˚ Evaporative cooling the performance characteristic can be related to the variables like thickness and atmospheric conditions. And from the given result it also is seen that higher level of effectiveness can be achieved with decreasing the power consumption.

Miss Namrata Govkar And Mr. Amol Yadav explains in this paper title Modern Evaporative Cooler Published by International Journal of Innovative Research in Science, Engineering and Technology, July 2016 that Evaporative air conditioner is also very affordable and efficient in keeping work and living spaces cool. This paper helps in detail study of evaporative cooling its characteristic, performance parameter, material selection.

Prof. Satish Markad, Vishal Nathile, Faizan Qureshi et.al. In this research paper suggested to reduce electricity consumption for refrigeration cum air conditioner, air cooler and water cooler, also save water and forest which are affected a great impact to maintain an ecological balance and to make it cost effective, so normal person can offer this product. Environmental groups and governmental agencies have cooperated over the last two decades to bring about reductions in refrigeration and air conditioning systems energy consumption and refrigerant emissions.

Bhupendra Sahare, Chavvikant Shahu et.al. In above research paper we learned, Mathematically of the proposed cooler utilized for air cooling has been developed by writing equations of energy balance for the various parts as well as give the details of the parts for selection as per requirement in the cooler. They give the information about design the cooler with minimum cost and space and give determination of the consumption as compared to the domestic cooler.

R N S V Ramanakanth, C.Lakshmi Sindhuja, J. Emeema et.al.In these research paper it shows that the portable air conditioning system satisfies the need of the user at the most economical cost. The portable air conditioner is having very low manufacturing and maintenance cost. Its cooling power is comparable to wall air conditioner.

OBJECTIVE:

1. Focus on using an energy-efficient cooling mechanism such as direct evaporative cooling, which can provide effective cooling in hot and dry climates without consuming excessive energy.
2. Continue with this concept of providing 360-degree airflow to ensure uniform cooling throughout the room with low operating costs.

PROBLEM IDENTIFICATION:

As global temperatures rise due to climate change, the demand for effective cooling solutions increases. Due to the current power crisis, saving energy is crucial. Efforts being concentrated on finding resources or method of saving energy. However, existing air coolers often lack smart features that are essential for optimal performance and energy efficiency. In this project, we're creating a 360-degree evaporative cooler that's affordable and eco-friendly. It doesn't pollute and keeps air humidity stable, unlike regular coolers. This cooler's airflow reaches all directions, allowing people to sit comfortably anywhere. The focus is on making it easy on the budget and environment while ensuring everyone's comfort.

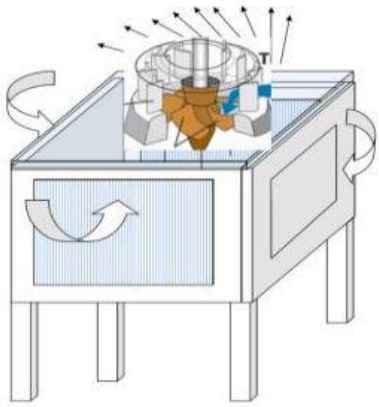

FIGURE 2: 3D view of 360-degree cooler

Components of 360 air cooler: -

• **Exhaust Fan:** - It is used to send cooled air to environment. Material of fan is both side coated iron. a centrifugal fan has greater weight axial fan is suitable for this model.

FIGURE 3: Exhaust fan

• **Submersible pump**:- The pump in the cooling system of a cooler that causes the water to circulate. The pump is mechanical device used to circulate the fluids from bottom to top. The specifications of the pump are power 18W and having 1m head.

FIGURE 4: Submersible pump

• **AC motor:-** Motor is an electrical machine that converts electrical energy into mechanical energy. In cooler it is used to rotate the exhaust fan and to remove the hot air from cooler. The specifications of motor are power 50W, 2600 RPM, single phase induction motor as it less noisy.

FIGURE 5: Motor

• **Cooling pad**: - It is used because it has high efficiency and cooling rate. Its type are Khus grass, Cellulose pads, Coconut coir and honeycomb pad. It is used in air cooler to cool the surrounding.

FIGURE 6: Honeycomb pad

• **Water storage tank: -** It's used to STORE the water needed for cooling STORAGE capacity 40 liters. The material used for the water sump is MS.

FIGURE 7: Water Storage tank

• **Baffles: -** Baffles is the component used for distributing the air in all 360-degree direction. It is made of MS material as it has to absorb vibration, impact forces due to air and it should be corrosive resistance as it has to frequently operate in wet or moistures environment.

FIGURE 8: Baffles

• **Frame: -** The material used for frame is MS or cast iron. As it has to support the other parts It should be strong to withstand the force, stresses and vibration. And even as it is constantly in contact with wet environment it should also have high corrosive resistance.

FIGURE 9: Frame

Working of 360˚ air cooler: -

The 360-degree air cooler operates on a simple yet effective principle of evaporation. When hot air with low relative humidity encounters water, the water absorbs latent heat and undergoes a phase change, turning into vapor. This vapor is then carried away by the air, reducing the air temperature and increasing its relative humidity. In this cooler, air enters from all four directions, drawn in by a fan. As the outside hot air flows through a cellular pad soaked with water, evaporation occurs, leading to the desired cooling effect. The cooled air is then channeled through a system of baffles that distribute it in a 360-degree direction. Water is supplied to the cellular pad using a pump located in a sump or bottom tank. The pump draws water from the bottom tank, which is continuously filled, and directs it onto stationary pads placed on the backside of two side doors through a delivery pipe. Simultaneously, an exhaust fan starts and draws in atmospheric air, forcing it through the wet pads. This direct contact between water particles and the moving air stream facilitates cooling. As the air comes into contact with water, it becomes saturated at the wet-bulb temperature of the incoming air. This process transfers sensible heat from the air to the water as latent heat, resulting in a considerable cooling effect. Over time, the air inside the cooler can be sufficiently cooled through the 360-degree evaporative process, leading to a significant increase in humidity. For enhanced cooling performance, users can add ice cubes or chilled water to the bottom tank, further improving the cooling capacity of the system.

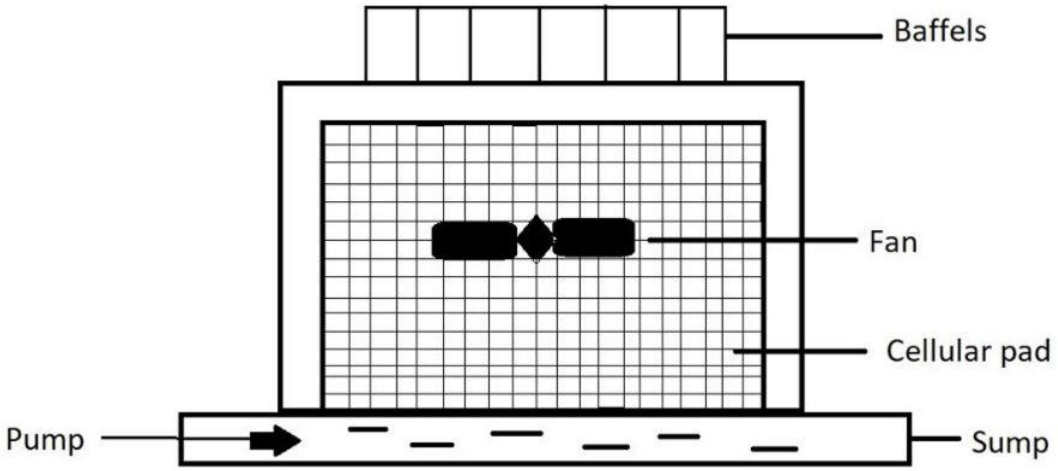

FIGURE 10: Block diagram

FIGURE 11: Actual Image

CONCLUSION:

Through above research paper and model, it is concluded that 360° cooler can cool air up to 10° to 12°due to direct evaporation of water. And this system cost much low as compared to regular air cooler. It also has advantage of saving the natural recourses as it works on natural phenomenon and it is pollution free. From the present investigation it is evident that for drip type 360 evaporative cooling the performance characteristics cooling can be related to the variables like the atmospheric conditions such as humidity control, and comfort in hot and dry regions. The result also indicates that a considerable saving in power consumed is possible and at the same time the cooling effectiveness can be enhanced.

Future scope: -

- A dehumidifier at the cooler's inlet boosts efficiency, enabling use in high humidity conditions.
- A potentiometer can adjust the blower fan's capacity, regulating airflow according to requirements.
- Replacing the tank material with stainless steel prevents environmental corrosion and erosion.
- The front air diverting strips can be auto-diverting and manually operated by coupling the lever with a belt and pulley drive.
- . Temperature control can be achieved by regulating the speed of the pad roller and drive motor.

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