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Design and Fabrication of Corrugated Wall Evaporative Cooler

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ABSTRACT: The design and Fabrication of the Corrugated wall Evaporative Cooler project aimed to develop an efficient cooling system suitable for hot and dry climates. The cooler utilizes the principle of evaporative cooling to lower ambient temperatures, making it a cost-effective and environmentally friendly alternative to traditional air conditioning systems. This paper involved the design and construction of a corrugated wall evaporative cooler prototype. The cooler's design included a water reservoir, a pump system for water circulation, and a series of corrugated walls for increased surface area contact with the airflow. The prototype was tested under various environmental conditions to evaluate its cooling effectiveness, energy efficiency, and overall performance. The results of the testing phase demonstrated that the corrugated wall evaporative cooler was able to significantly reduce ambient temperatures while consuming minimal energy compared to conventional cooling methods. The cooler's design and fabrication process were optimized to ensure ease of maintenance and durability, making it a practical solution for cooling residential, commercial, and industrial spaces in arid regions.

KEYWORDS: Corrugated wall, Evaporative cooler, Corrugated wall Evaporative cooler

I. INTRODUCTION

Evaporative cooling is a cost-effective and environmentally friendly way to provide cooling in hot and dry climates. Corrugated wall evaporative coolers are a specific type of evaporative cooling system that utilizes corrugated surfaces to maximize water evaporation and enhance cooling efficiency. These systems are commonly used in residential, commercial, and industrial settings to provide relief from high temperatures while consuming less energy compared to traditional air conditioning systems. In this paper, we aim to design and fabricate a corrugated wall evaporative cooler that offers efficient cooling performance and is suitable for various applications. By combining innovative design concepts with practical fabrication techniques, we seek to create a reliable and effective cooling solution that meets the needs of our target users.

By carefully considering factors such as material selection, system design, and manufacturing processes, we aim to develop an evaporative cooler that delivers optimal cooling capacity while minimizing energy consumption and maintenance requirements. By leveraging the principles of evaporative cooling and incorporating corrugated wall technology, our goal is to provide a sustainable and affordable cooling solution that contributes to improved comfort and well-being in hot and dry environments.

Evaporative cooling represents a sustainable and energy-efficient method for maintaining comfortable indoor environments and cooling industrial processes. By harnessing the principle of water evaporation to remove heat from the air, evaporative coolers offer an eco-friendly alternative to conventional air conditioning systems, particularly in arid and semi-arid regions where they perform most effectively. However, enhancing the cooling efficiency of evaporative coolers while ensuring affordability and practicality remains an ongoing challenge. Traditional designs often feature flat or honeycomb-shaped surfaces for water evaporation, limiting their effectiveness in maximizing surface area and optimizing airflow contact. To address these limitations, innovative approaches are necessary. This research endeavours to explore and develop a novel solution through the design and fabrication of a corrugated wall evaporative cooler. Corrugated surfaces offer inherent advantages, including increased surface area-to-volume ratio and enhanced air-water interaction, which can potentially improve cooling efficiency. By employing corrugated walls in the design of evaporative coolers, this study aims to achieve superior performance in terms of cooling effectiveness and

energy efficiency. The primary objectives of this research encompass the optimization of structural design, airflow dynamics analysis, material selection, and fabrication processes to realize the full potential of the corrugated wall evaporative cooler. Through experimental evaluation and analysis, the effectiveness of the proposed design will be assessed, providing valuable insights into its practical applicability and potential for widespread adoption. This paper presents a comprehensive examination of the design and fabrication process, experimental methodology, results, and implications of the corrugated wall evaporative cooler, aiming to contribute to the advancement of evaporative cooling technology and the promotion of sustainable cooling solutions.

II. PROBLEM IDENTIFICATION

This idea of design and fabrication of a corrugated wall evaporative cooler is generated because In India every summer season we use the conventional evaporative cooler and the conventional evaporative cooler requires more water and there for the requirement of water is increases and in India some places there are more water problems therefore they cannot afford conventional evaporative cooler. Because the conventional cooler required more water. And there is a most and big problem is that the waste evaporative occurs. There we invented the corrugated wall.

III. LITERATURE REVIEW

Prashant Patunkar (2022) Traditional air conditioning systems use a lot of energy; thus, dew point evaporative air-cooling systems could be a good alternative. Many experts studied the impact of constructional and operating characteristics on the Maisotsenko cycle (M-cycle) to improve its performance. Cooler performance is influenced by the heat exchanger. Heat exchangers were constructed using flat and corrugated plates. The present study proposes the use of geometrically modified trapezoidal corrugated plates for counterflow heat exchanger, which consists of alternate air and water flow passageways. The numerical model is developed to predict the performance under various inlet air conditions and channel dimensions. In the standard range of incoming air properties such as relative humidity, the performance parameters assist in making cooler recommendations

Mohammed A Sulaiman (2023) In this study four new geometries of heat and mass exchangers for dew point evaporative cooling are investigated and their performance is compared to that of the commonly used flat plate and corrugated plate exchangers. In the proposed exchangers, each dry channel is completely enclosed by its adjacent wet channels, and each wet channel is completely enclosed by its adjacent dry channels (related detailed information is presented graphically in this paper). In addition, a robust numerical model was developed and examined under various operational and geometrical conditions. The analysis showed that the proposed dew point evaporative coolers improve the chilled air temperature, water consumption, cooling capacity, and energy efficiency.

Ana Tejero-González (2021) Direct evaporative cooling is widely known for being an energy-efficient air conditioning solution for arid and/or semi-arid climates. Commercialized evaporative cooling pads vary in material and construction characteristics while existing research proposes several alternative wetted media and configurations. The most studied factors in the evaporative cooling pad operation are the air velocity or air mass flow rate, air psychrometric conditions; the pad thickness, its geometric characteristics and configuration, and the water flow rate supplied. The pad's performance is commonly characterized by its saturation effectiveness, pressure drop, temperature drop and humidity increase achieved in the treated air, water evaporation and consumption, cooling capacity, coefficient of performance and heat and mass transfer coefficients.

IV. METHODOLOGY

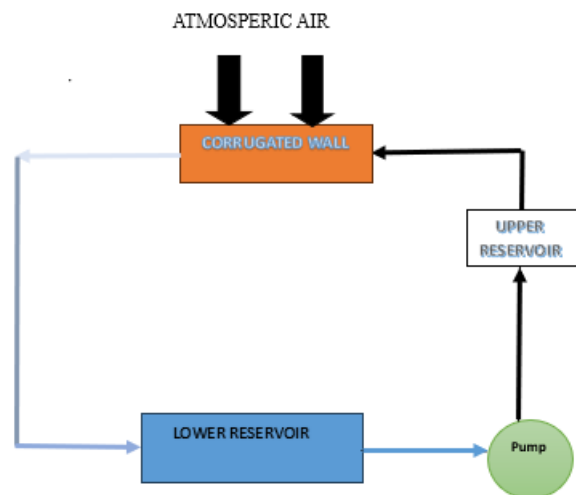
- 1. Define Requirements and Constraints:** Determine the cooling capacity needed based on the size and temperature of the space to be cooled. Consider any space limitations, budget constraints, and environmental factors.
- 2. Research and Analysis:** Study existing evaporative cooler designs and their performance metrics. Analyze different types of corrugated materials and their suitability for the cooler walls. Research fan types and sizes are suitable for the desired airflow and cooling capacity.
- 3. Design Phase:** Develop a detailed design plan, including dimensions, materials, and airflow path. Calculate the surface area of the corrugated walls and determine the optimal corrugation size and spacing for maximum evaporation. Design the water distribution system to evenly wet the corrugated walls, considering factors such as flow rate and distribution pattern. Select or design a fan system that can provide sufficient airflow through the wet walls. Design the water reservoir to hold an adequate supply of water for continuous operation.

4. Fabrication: Procure or fabricate the necessary materials, including corrugated sheets, piping for the water distribution system, and a fan. Cut and shape the corrugated sheets according to the design specifications. Assemble the corrugated sheets to form the walls of the cooler, ensuring a tight seal between them. Install the water distribution system, connecting it to the water reservoir and ensuring proper flow to wet the corrugated walls evenly. Install the fan system at one end of the cooler to draw air through the wet walls.

5. Testing and Optimization: Conduct initial tests to evaluate the cooling performance of the evaporative cooler. Measure temperature and humidity levels inside and outside the cooler to assess its effectiveness. Make adjustments to the design or fabrication as needed to optimize cooling efficiency, such as adjusting the water flow rate or fan speed.

6. Installation and Maintenance: Install the evaporative cooler in the desired location, ensuring proper ventilation and access to water and power sources. Establish a regular maintenance schedule, including cleaning the corrugated walls, inspecting and repairing the water distribution system, and replacing worn-out components. Monitor the performance of the evaporative cooler over time and make any necessary adjustments to maintain optimal cooling efficiency.

BLOCK DIAGRAM



Components: -



1. GI Sheet

GI sheet typically refers to galvanized iron sheet, which is a type of steel sheet coated with a layer of zinc to prevent corrosion. It's commonly used in construction, roofing, and manufacturing applications due to its durability and rust-resistant properties. The zinc coating also provides additional protection against scratches and abrasions. GI sheets come in various thicknesses and sizes, making them versatile for different uses in industries such as automotive, agriculture, and infrastructure.

2. Cooler body



The cooler body refers to the main structural component of an evaporative cooler, including the corrugated wall evaporative cooler. It is essentially the outer shell or enclosure that houses and supports all the essential components of the cooling system. The cooler body plays a critical role in the functionality, durability, and efficiency of the evaporative cooler. Here are the key aspects and functions of the cooler body

3. Cooler fan



The cooler fan is a vital component in maintaining optimal temperatures for electronic devices and machinery. Designed to efficiently dissipate heat and enhance airflow, the cooler fan ensures reliable performance and prolongs the lifespan of your equipment. Whether it's for computers, gaming consoles, or industrial machinery, the cooler fan is an indispensable solution for managing thermal conditions and promoting smooth operation.

4. Cooler pump



A cooler pump works by continuously circulating coolant through the cooling system, typically comprised of a radiator, tubing, and cooling blocks. The pump draws coolant from the reservoir and pushes it through the system, transferring heat away from the components it comes into contact with. This continuous flow of coolant helps maintain stable temperatures within the system, preventing overheating and ensuring optimal performance of the components. As the

coolant passes through the radiator, heat is dissipated into the surrounding air, allowing the coolant to cool down before returning to the pump and repeating the cycle.

5. Cooler motor



The cooler fan motor operates by converting electrical energy into mechanical energy, which drives the rotation of the fan blades. When powered on, the motor's electromagnetic coils create a magnetic field, which interacts with the permanent magnets or other magnetic components within the motor, causing the rotor (the central shaft of the motor) to spin. This rotation transfers to the fan blades attached to the rotor, creating airflow within the cooling system. The speed and efficiency of the cooler fan motor can be controlled by adjusting the voltage or frequency of the electrical supply to the motor. Regular maintenance, such as cleaning and lubrication, helps ensure the smooth operation and longevity of the cooler fan motor.

V. RESULT

The culmination of designing and fabricating a corrugated wall evaporative cooler yields a practical and efficient cooling apparatus. This cooler incorporates intelligently designed corrugated walls, optimizing surface area to facilitate evaporation. Its robust frame, crafted from resilient materials like plastic, metal, or cardboard, ensures durability. An integrated water distribution system, complete with a reservoir, pump, and distribution pipes, ensures even moisture dispersion across the walls. Complemented by a fan or blower, which draws air through the moistened corrugations, the system efficiently lowers ambient temperatures through evaporation. Thoughtful airflow pathways are engineered to enhance cooling efficacy, while proper drainage mechanisms prevent water accumulation and mold formation. Accompanied by comprehensive installation and maintenance instructions, this evaporative cooler presents a cost-effective and environmentally friendly cooling solution suitable for residential, commercial, and industrial environments alike.

VI. APPLICATION

The application of a corrugated wall evaporative cooler is versatile, spanning various sectors and environments. In residential settings, it offers an affordable and energy-efficient alternative to traditional air conditioning systems, particularly in dry climates. These coolers can be installed in homes, apartments, or even outdoor spaces like patios and garages to provide comfortable cooling during hot summer months. In commercial settings, such as offices, warehouses, and retail stores, corrugated wall evaporative coolers offer a cost-effective solution for maintaining comfortable working conditions while reducing energy costs. Industrial applications include cooling large manufacturing facilities, data centres, and agricultural buildings where maintaining optimal temperatures is crucial for productivity and equipment performance. Additionally, these coolers can be utilized in outdoor events, construction sites, and temporary structures to provide relief from heat stress. Overall, the versatility and efficiency of corrugated wall evaporative coolers make them an attractive cooling solution across a wide range of applications and environments.

VII. CONCLUSION

In conclusion, the design and fabrication of a corrugated wall evaporative cooler offer a practical and efficient cooling solution for various applications. By maximizing surface area for evaporation, utilizing durable materials, and integrating effective water distribution and airflow systems, these coolers provide cost-effective and environmentally friendly cooling. From residential to commercial and industrial settings, corrugated wall evaporative coolers offer a versatile and reliable alternative to traditional air conditioning systems, helping to maintain comfortable temperatures while reducing energy consumption. With proper installation and maintenance, these coolers can effectively mitigate heat stress and create comfortable environments even in the hottest climates. Overall, the design and fabrication of corrugated wall evaporative coolers represent a sustainable and practical approach to cooling solutions in today's diverse range of applications.

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