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Design and Fabrication of a 360° Air Cooler with Humidity Control

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Abstract:
The increasing global demand for energy has intensified the need for efficient and sustainable cooling technologies. Conventional air conditioning systems consume significant electrical power (typically around 1.5 kW), making them costly and environmentally taxing. Evaporative air coolers provide an economical and energy-efficient alternative; however, they often increase indoor humidity, reducing comfort levels.
This study presents the design and fabrication of a **360-degree air cooler integrated with a humidity control approach**. The system ensures uniform airflow distribution in all directions while maintaining acceptable moisture levels. The proposed model aims to deliver enhanced thermal comfort, reduced energy consumption, and affordability, especially in hot and dry climatic conditions. The integration of eco-friendly materials and advanced airflow design makes the system suitable for sustainable cooling applications.

Keywords: Evaporative cooling, 360° airflow, energy efficiency, humidity control, eco-friendly cooling

1. Introduction

Cooling systems play a vital role in maintaining human comfort, particularly in regions experiencing high temperatures. Traditional refrigeration-based air conditioners, while effective, consume large amounts of energy and rely on refrigerants that may harm the environment.
Evaporative cooling is a natural and energy-efficient process based on **adiabatic cooling**, where water evaporation absorbs heat from the surrounding air. This process reduces air temperature while increasing moisture content.
The **360° air cooler** is an innovative solution designed to:

- Provide uniform cooling in all directions
- Minimize energy consumption
- Enhance user comfort through improved air distribution

Unlike conventional coolers, which direct airflow in a single direction, this system ensures **multi-directional cooling**, making it suitable for open and shared spaces.

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2. Problem Identification

The development of this system addresses several limitations of existing cooling technologies:

- High energy consumption of conventional air conditioners
- Uneven cooling distribution in traditional air coolers
- Increased humidity causing discomfort
- Lack of air purification features
- Limited portability and flexibility

Objectives

- Design a **low-cost and energy-efficient cooling system**
- Enable **360° uniform air distribution**
- Improve air quality using **TiO_2 nano-coating**
- Incorporate **fragrance system for enhanced comfort**
- Reduce environmental impact

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3. Components Used

3.1 AC Motor

An electrical device that converts electrical energy into mechanical energy to drive the fan for airflow circulation.

3.2 Water Pump

Circulates water from the storage tank to the cooling pads, ensuring continuous wetting.

3.3 Cooling Pads

Porous materials that facilitate water evaporation and heat absorption from incoming air.

3.4 Exhaust Fan

Pushes the cooled air outward in all directions.

3.5 Water Storage Tank

Stores water required for the evaporative cooling process.

[Insert Image 2: Components Layout Diagram]
(Label motor, pump, fan, pads, and tank clearly)

4. Working Principle

The system operates on the principle of **evaporative cooling**:

- Hot air enters from all directions
- Air passes through wetted cooling pads
- Water absorbs heat and evaporates
- Air temperature decreases while humidity increases
- Fan distributes cool air uniformly in 360° direction

[Insert Image 3: Working Principle Diagram]
(Show airflow + evaporation process step-by-step)

5. Methodology

1. **Design Phase**
   - Create a cylindrical or multi-sided structure for 360° airflow
   - Select lightweight and durable materials
2. **Fabrication Phase**
   - Assemble frame structure
   - Install motor, fan, and pump
   - Fit cooling pads on all sides
3. **Implementation**
   - Water is circulated continuously over pads
   - Air is drawn inside through pads
   - Cooling occurs due to evaporation
   - Air is distributed via directional baffles

4. **Enhancements**
   - TiO_2 nano-coating for antibacterial effect
   - Fragrance chamber for improved user experience

6. Advantages

- Low initial and operating cost
- Energy-efficient (significantly less than AC)
- Eco-friendly (no refrigerants required)
- Uniform cooling in all directions
- Easy maintenance
- Portable and lightweight design

7. Limitations

- Ineffective in high humidity regions
- No precise humidity control
- Not suitable for individuals with respiratory issues
- Cooling efficiency depends on environmental conditions

8. Applications

- Residential cooling
- Outdoor seating areas
- Workshops and small industries
- Rural and semi-urban areas

9. Results and Discussion

The developed 360° air cooler demonstrated:

- Temperature reduction of approximately **10–20°C**
- Uniform airflow distribution across surrounding space
- Reduced power consumption compared to conventional AC

Performance depends on:

- Ambient temperature
- Relative humidity
- Cooling pad thickness and material

10. Conclusion

This study successfully demonstrates the design and fabrication of a **360° evaporative air cooler** that is energy-efficient, cost-effective, and environmentally friendly. The system overcomes the limitations of traditional coolers by ensuring uniform air distribution and improved comfort.

Future improvements may include:

- Advanced humidity control systems

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- Solar-powered operation
- Smart sensors for automated control

The proposed model is highly suitable for **hot and dry climates**, offering a sustainable alternative to conventional cooling systems.

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