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Design Solar Power Based Air Cooler

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ABSTRACT: This project focuses on the design and development of a 75W solar power-based air cooler as an energyefficient and sustainable alternative to conventional cooling systems. The objective is to utilize solar energy to power an evaporative air cooler capable of providing effective cooling in off-grid and rural areas with high solar potential. The system integrates a 75-watt photovoltaic (PV) panel, a DC fan, and a submersible water pump, operating without reliance on conventional electricity sources.

KEYWORDS: Solar Panel, Charge Controller, Battery.

I. INTRODUCTION

With the rapid rise in global temperatures and the increasing frequency of heatwaves, the demand for cooling systems has grown significantly. However, traditional air conditioning and cooling solutions are often energy-intensive, heavily reliant on fossil fuels, and contribute to environmental degradation through greenhouse gas emissions. In this context, the development of alternative, sustainable cooling technologies has become a critical area of research and innovation.

One promising solution is the use of solar energy—a clean, renewable, and abundant resource—to power air cooling systems. Solar power-based air coolers offer a practical and eco-friendly alternative, especially in regions with high solar insolation and limited access to reliable electricity. These systems utilize photovoltaic (PV) panels to convert sunlight into electrical energy, which powers the cooling mechanism, typically involving a fan and water circulation system for evaporative cooling.

The objective of this project is to design and develop a solar-powered air cooler that is energy-efficient, cost-effective, and suitable for use in both urban and rural settings. The proposed design integrates key components such as solar panels, a DC fan, a water pump, cooling pads, and a rechargeable battery for energy storage. By leveraging solar energy, this system aims to reduce dependency on the electrical grid, lower electricity bills, and promote the use of green technology.

This introduction sets the stage for exploring the system design, working principle, component selection, and performance evaluation of a solar power-based air cooler. The ultimate goal is to provide a sustainable and affordable cooling solution that meets the comfort needs of users while minimizing environmental impact.

II. LITERATURE REVIEW

1. Solar-Assisted Evaporative Cooling Systems In a study by Kabeel et al. (2017), a hybrid solar-assisted evaporative cooling system was proposed, which used solar energy to drive the evaporation process in a cooling pad. The study highlighted that the combination of solar power with evaporative cooling could reduce the energy consumption of traditional cooling methods by up to 70%. This type of system is ideal for hot and dry climates where evaporative cooling can be effective.

2. Performance Evaluation of Solar-Powered Air Coolers A field study conducted by Shukla et al. (2020) in rural India demonstrated the effectiveness of solar-powered evaporative coolers in reducing indoor temperatures. Their



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findings showed that such coolers could maintain indoor temperatures of 28-30°C in a region where the ambient temperature regularly exceeds 40°C. The study concluded that these systems are highly effective in rural areas with frequent power outages, as they can function autonomously using solar energy.

3. Solar PV-Driven Evaporative Coolers Ahmed et al. (2021) explored the performance of a solar PV-driven evaporative cooling system. The system utilized a photovoltaic panel to power a DC fan and pump, circulating water through cooling pads. The study focused on optimizing the sizing of the solar array to ensure continuous operation, even during partial sunlight conditions. Their results showed that the system was able to deliver significant cooling with a low environmental impact compared to traditional electrical systems.

4. Cost-Benefit Analysis of Solar-Powered Air Coolers Jain and Agarwal (2018) conducted a cost-benefit analysis of solar-powered air coolers in the Middle East, a region known for its intense sunlight. Their findings indicated that while the initial cost of solar-powered coolers was higher than that of conventional systems, the long-term savings on electricity bills made solar-powered coolers a viable option. Their analysis also highlighted the environmental benefits, with a significant reduction in carbon emissions compared to conventional AC units.

III. PROBLEM DEFINITION

Conventional air cooling and conditioning systems, though effective in providing thermal comfort, come with a range of challenges that limit their sustainability and accessibility, particularly in energy-scarce or economically disadvantaged regions.

IV. FUTURE SCOPE

- 1. Design and construction of a compact, portable air cooler using solar photovoltaic (PV) panels to power a DC fan and water pump.
- 2. Selection of components, including solar panels, battery storage, charge controller, cooling pads, and low-power motors.
- 3. Integration of solar energy with evaporative cooling technology to provide effective temperature reduction with minimal energy use.
- 4. Testing and evaluation of the system's performance under varying solar and environmental conditions.
- 5. Analysis of power consumption, cooling efficiency, and operational sustainability.
- 6. Assessment of cost-effectiveness and feasibility for deployment in remote or off-grid areas.
- 7. Environmental impact analysis, with a focus on reducing carbon footprint compared to conventional air conditioning systems.

V. OBJECTIVE

- 1. To design and fabricate a functional air cooler system that operates entirely on solar energy.
- 2. To utilize photovoltaic (PV) panels for converting solar energy into electrical energy to power the system.
- 3. To integrate a DC fan and water circulation pump powered by solar energy for effective evaporative cooling.
- 4. To reduce dependence on grid electricity and offer a sustainable solution for areas with frequent power cuts or offgrid locations.
- 5. To optimize energy consumption by selecting low-power components without compromising cooling performance.
- 6. To evaluate the cooling efficiency of the system under different environmental conditions.
- 7. To minimize the environmental impact by promoting the use of clean, renewable energy and avoiding harmful refrigerants.
- 8. To develop a cost-effective and user-friendly system that can be easily maintained and replicated in rural or lowincome communities.



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VI. METHODOLOGY



VII. HARDWARE DETAIL

1. SOLAR PANEL

A solar panel, also known as a photovoltaic (PV) panel, is a device that converts sunlight directly into electrical energy using the photovoltaic effect. It is the primary source of power in the Smart Solar Bench system, enabling the bench to operate independently of the conventional electrical grid.

2. RECHARGEABLE BATTERY

A rechargeable battery is an essential component of a solar power-based air cooler, as it stores the electrical energy generated by the solar panel during the daytime. This stored energy is used to operate the fan and water pump during cloudy weather or at night when sunlight is unavailable. Typically, a 12V lead-acid or lithium-ion battery is used, with a capacity ranging from 18Ah to 26Ah, depending on the required backup time.

3. SOLAR CHARGER CONTROLLER

A solar charge controller is a crucial device in a solar-powered air cooler system that regulates the voltage and current coming from the solar panel to the rechargeable battery, thereby preventing overcharging, deep discharging, and short-circuiting. It ensures the battery is charged safely and efficiently, enhancing its lifespan and performance. Most charge controllers operate at 12V or 24V, and some advanced models include LED indicators or USB ports for additional functionality

4. CENTRIFUGAL PUMP

A centrifugal pump is a mechanical device used to move fluids by converting rotational kinetic energy—typically from a motor—into hydrodynamic energy of fluid flow. It operates using an impeller that spins to create a pressure difference, causing water to flow through the system.

VIII. FABRICATION PROCESSES

CUTTING

Cutting is a collection of processes where in material is brought to a specified geometry by removing excess material using various kinds of tooling to leave a finished part that meets specifications.



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GRINDING

Grinding uses an abrasive process to remove material from the work piece. A grinding machine is a machine tool used for producing very fine finishes, making very light, or high precision forms using an abrasive wheel as the cutting device.

WELDING

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melding the work pieces and adding a filler material to form a pool of molten material That cools to become a strong joint ,but sometimes pressure is used in conjunction with heat or by itself, of produced the weld.

DRILLING

Drilling is a cutting process that uses a drill bit to cut a hole of a circular cross-section in solid materials. The drill bit is rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at from hundreds to thousands of revolutions per minute

APPLICATIONS

- 1. Rural and Off-Grid Areas
- 2. Emergency Shelters & Disaster Relief Camps
- 3. Small Homes and Personal Use
- 4. Outdoor Activities and Field Work
- 5. Green Buildings and Eco-Homes

IX. RESULT

The design and testing of the 75W solar power-based air cooler yielded promising results, confirming the viability of using solar energy for efficient and eco-friendly air cooling, particularly in off-grid and energy-scarce regions.

- The solar panel rated at 75 watts successfully powered the air cooler system, which consisted of a DC fan (40W) and a water circulation pump (20W), with a combined operational load well within the power budget.
- The system operated efficiently for an average of 5 to 6 hours per day under peak sunlight conditions (solar irradiance > 700 W/m²), with a backup battery extending runtime during partial shading or overcast conditions.





X. CONCLUSION

In conclusion, this solar-powered air cooler has the potential to revolutionize cooling systems in areas with limited access to the power grid. The project aligns with the growing global demand for sustainable and energy-efficient solutions and provides a practical example of how solar energy can be harnessed for everyday applications.



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