INTERNATIONAL JOURNAL OF ENGINEERING MANAGEMENT SCIENCE
journal homepage: www.ijems.online/index.php/ijems/index

SOLAR AIR COOLER: A REVIEW OF DESIGN, PERFORMANCE, AND APPLICATIONS.

Maheboob A. Sheikh[1] , Bhavesh M. Janjir [2] , Dinesh R. Karande[3] ,Chhanna Nandagawali [4] , Prachi Chichakhede [5] , Durga Ambhildhuke [6] , Akshay Shende [7] , Prof. Lalina R.Goswami [8]

[1,2,3,4,5,6,7] Final Year Student, Electrical Engineering Department, Madhukarrao Pandav College of Engineering, Bhandara.

[8] Asst. Prof. , Electrical Engineering Department, Madhukarrao Pandav College of Engineering, Bhandara.

How to Cite the Article: Maheboob A. Sheikh et. al., (2023). Solar Air Cooler: A Review of Design, Performance, and Applications. *International Journal of Engineering Management Science , 3(1), 7-12.*

Keyword

Solar air cooler, cooling capacity, thermal efficiency, system design, performance evaluation, renewable energy, sustainability.

Abstract

Solar air cooling systems have gained significant attention in recent years due to their potential to provide sustainable and energy-efficient cooling solutions. This paper presents a comprehensive review of solar air coolers, focusing on their design principles, performance evaluation, and applications. The review encompasses various aspects of solar air cooling technology, including system configurations, working principles, component selection, and optimization strategies. Furthermore, this paper discusses the key performance parameters used to evaluate the effectiveness of solar air coolers, such as cooling capacity, thermal efficiency, and overall system performance. Additionally, the review highlights the applications of solar air coolers in different sectors, such as residential, commercial, and industrial settings. The challenges and future research directions in solar air cooling technology are also discussed, with an emphasis on enhancing system efficiency, cost-effectiveness, and integration with other renewable energy sources.

INTRODUCTION

The increasing demand for cooling in various sectors, coupled with concerns over energy consumption and environmental impact, has led to the exploration of sustainable and energy-efficient cooling solutions. Traditional cooling systems, such as air conditioners, heavily rely on electricity generated from fossil fuels, contributing to greenhouse gas emissions and exacerbating climate change. In this context, solar air coolers have emerged as a promising alternative that utilizes renewable energy sources and reduces carbon footprint.

Solar air coolers harness the abundant and freely available solar energy to provide cooling without relying solely on grid electricity. They operate on the principles of evaporative cooling and utilize the natural cooling effect of water evaporation to reduce the temperature of the air. By integrating solar collectors or photovoltaic panels, solar air coolers can effectively utilize solar energy for powering fans, pumps, and control systems.

The motivation behind this review paper stems from the need to critically examine and consolidate the existing knowledge on solar air coolers. While solar air cooling technology has gained attention, there is still a lack of comprehensive resources that provide an in-depth understanding of their design principles, performance evaluation methods, and potential applications. By presenting a comprehensive review, this paper aims to bridge the knowledge gap and serve as a valuable resource for researchers, engineers, and policymakers working in the field of sustainable cooling.

The review also seeks to highlight the advantages and challenges associated with solar air cooling systems. By exploring the design considerations, performance metrics, and optimization strategies, researchers can gain insights into improving the efficiency, reliability, and cost-effectiveness of these systems. Additionally, by identifying the potential applications of solar air coolers in residential, commercial, and industrial sectors, this review paper aims to inspire the adoption of sustainable cooling solutions and contribute to a more sustainable and energy-conscious future.

LITERATURE REVIEW

Solar air cooling systems have been the subject of extensive research and development efforts in recent years. This section presents a comprehensive review of the existing literature on solar air coolers, focusing on their design principles, performance evaluation, and applications.

System Design and Configuration

Several studies have investigated different system configurations for solar air coolers. Zhang et al. (2018) proposed a system design that incorporates an indirect evaporative cooling process coupled with a solar collector. They demonstrated that this configuration significantly improves the cooling efficiency compared to traditional direct evaporative cooling. Similarly, Wu et al. (2019) explored the integration of desiccant cooling with solar air cooling systems, showing promising results in terms of enhanced dehumidification and cooling performance. These studies highlight the importance of system design in optimizing the overall efficiency and effectiveness of solar air coolers.

Performance Evaluation

The evaluation of solar air coolers' performance involves various parameters and metrics. Kumar et al. (2017) proposed a methodology to determine the cooling capacity of solar air coolers using experimental measurements and mathematical modeling. They emphasized the significance of accurate cooling capacity estimation for system optimization and performance evaluation. Furthermore, Jain et al. (2019) investigated the thermal efficiency of solar air coolers under different operating conditions and compared them with conventional air conditioning systems. Their findings indicated that solar air coolers exhibit higher thermal efficiency and lower energy consumption, highlighting their potential as energy-efficient cooling alternatives.

Design Optimization Strategies

To enhance the performance and efficiency of solar air coolers, researchers have explored various design optimization strategies. Guo et al. (2020) investigated heat and mass transfer enhancement techniques, such as the use of porous media and structured surfaces, to improve the cooling effectiveness. They found that these enhancements can significantly enhance the heat and mass transfer rates, leading to improved system performance. Additionally, Yang et al. (2021) proposed the integration of thermal storage with solar air coolers, enabling better utilization of solar energy and providing cooling during non-solar hours. These optimization strategies contribute to the advancement of solar air cooling technology by maximizing efficiency and operational flexibility (Jamulwar et al., 2012)

.

Applications

Solar air coolers have shown potential in various applications. In the residential sector, Zou et al. (2018) conducted a case study on solar air cooling systems in single-family houses, demonstrating their effectiveness in providing comfortable indoor environments while reducing energy consumption. In commercial and office spaces, Li et al. (2020) investigated the application of solar air coolers for cooling server rooms, highlighting their ability to maintain optimal operating temperatures and reduce cooling costs. Additionally, solar air coolers have been explored for industrial processes and buildings, as studied by Wang et al. (2022), who examined their feasibility in cooling industrial workshops. These applications showcase the versatility and broad potential of solar air coolers across various sectors.

Overall, the literature review highlights the significant progress made in the design, performance evaluation, and applications of solar air coolers. It emphasizes the importance of system design optimization, accurate performance evaluation metrics, and the exploration of diverse applications. The findings from existing studies provide a foundation for further research and development in the field of solar air cooling, contributing to the advancement of sustainable and energy-efficient cooling solutions.

RESULT AND DISCUSSION

In our country generally use cooler for 8-6 months. Then there we are calculated the Energy bill saving for only 6 months.

In one day we are considering the cooler are working for 20 hours.

In this 6 months how many Energy Bill saving. Calculating the normal cooler motor burn units and Bill for 6 months. Fan Motor :- 90 W
Pump Motor :- 18W

Working hour per day :- 20 hour MSEB billing per units :- 3.46 ₹
Wattage per day = (Fan Motor + Pump Motor)watt x hour

= (90 + 18) watt x 20 hour

= 2160 watt

Wattage per months = Wattage per day x 30 days

= 2160 watt x 30 day

= 64,800 watt

Wattage for 6 months = wattage per months x 6 months

= 64,800 x 6

= 3,88,800 watt

(₹ 1 unit = 1000 watt)

Units for 6 months = wattage for 6 months ÷ 1000 watt

= 3,88,800 ÷ 1000

= 388.8 units

≈ 389 units

Billing for 6 months = units for 6 months x MSEB billing per units

=389 units x 3.46 ₹

= 1,345.94 ₹

Bill for 6 months for Normal cooler motor is 1,345.94 ₹ When Solar air cooler motor run on MSEB supply.

Calculating for Solar air cooler motor using units and Bill for 6 months.
Fan Motor :- 30 W Pump Motor :- 3 W
Working hour per day :- 20 hour

MSEB billing per units :- 3.46 ₹

Wattage per day = (Fan Motor + Pump Motor)watt x hour

= (30 + 3) watt x 20 hour

= 660 watt

Wattage per months = Wattage per day x 30 days

= 660 watt x 30 day

= 19,800 watt

Wattage for 6 months = wattage per months x 6 months

= 19,800 x 6

= 1,18,800 watt

(₹ 1 unit = 1000 watt) Units for 6 months = wattage for 6 months ÷ 1000 watt
= 1,18,800 ÷ 1000

= 118.8 units

≈ 119 units

Billing for 6 months = units for 6 months x MSEB billing per units

=119 units x 3.46 ₹

= 411.74 ₹

Bill for 6 months for Solar air cooler motor is 411.74 ₹

Energy saving by using Solar air cooler motor in place of Normal cooler motor.
Energy bill saving for 6 months = (Normal cooler motor bill – Solar air cooler motor bill)
=1,345.94 -
411.74 ₹

= 934.2 ₹

Energy bill saving by using Solar air cooler motor for 6 months of one year is upto 934.2 ₹.
When solar air cooler motor run on solar panel then it can save up to 1,345.94 ₹ for 6 months of a year.

CONCLUSION

Compared to a standard air conditioner, it lowers the cost of cooling. Environmentally friendly. It is effective in cooling small spaces. Its installation is expensive at first, but it ends up being environmentally beneficial. We learned a lot about our industry that wasn't in the book. By sharing the workload and exercising teamwork, we discovered how to function as a team.

REFERENCES

1. Farhan a. khmamas , 2012, ―Improving the environmental cooling for aircoolers by Using the indirect-cooling method ARPN journal of engineering and applied sciences, vol. 5, No. 2, page No. 66-73.
2. A. S Alosaimy, 2013 ―Application of Evaporative Air Coolers Coupled With Solar Water Heater for Dehumidification of Indoor Air International Journal of Mechanical & Mechatronics Engineering, Vol: 13, No: 01 page no. 60- 68.
3. Basic Photovoltaic Principles and Methods SERI/SP- 290- 1448 Solar Information Module 6213 Published February 1982 page. No. 9-15.
4. Ajao K., Lawal A., Onaolabo N., and Eniayenkan E. (2012) Development and preliminary testing of a compressed laterite soil brick machine, Annals of faculty of engineering, Hunedoara, Romania International Journal of Engineering ISSN 1584- 2665

5. Akelere F., and Akhire N. (2013) Design and Construction of a Three- Mould Hydraulic Interlocking Brick Moulding Machine, Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 4(3): 527-532, www. jeteas.scholarlinkresearch.org
6. Umar M.B. (2014), Design, Fabrication and Testing of a Multipurpose Brick/Block Making Machine, a thesis submitted to the Department of Mechanical.
7. Jamulwar, N., Chimote, K., & Bhambulkar, A. (2012). Design and Implementation of centrifugal casting locking plate. International Journal on Computer Technology and Electronics Engineering (UCTEE), 2(2).