Cooling Pad in Evaporative System: A Review

Dhanshri Bodile[1] ✉, Vaibhav Garghate[1], Rushikesh Khode[1], Aditya Yedkar[1], Ishika Wankhade[1], Anand Wankhade[1], Shubham Bhagat[1]

[1] UG Student, Department of Mechanical Engineering, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal -445001, Maharashtra, India

✉ Corresponding author email: dhnshri15@gmail.com

Cite this article: Bodile, D., Garghate, V., Khode, R., Yedkar, A., Wankhade, I., Wankhade, A., & Bhagat, S. (2025). Cooling Pad in Evaporative System: A Review, International Research Journal of Scientific Studies, vol. 2, no. 3, pp. 1–6, Mar. 2025, https://doi.org/10.5281/zenodo.15080680

Abstract: *Evaporative cooling is an economical and environmentally friendly method of air conditioning and cooler, especially suitable for hot and arid regions. The cooling pad is a key component in this system, enabling the evaporation process. As warm air flows through the water-soaked pad, heat is absorbed, resulting in a drop in air temperature. The effectiveness of the cooling pad is influenced by factors like its material, thickness, porosity, and ability to retain water. This review examines different types of cooling pads, such as cellulose, wood wool, metal mesh, and synthetic materials, evaluating their benefits and drawbacks. It also explores critical performance aspects, including cooling efficiency, pressure drop, and durability. Additionally, it addresses challenges like clogging, microbial growth, and maintenance concerns while highlighting recent advancements like nano-coatings, antimicrobial treatments, and hybrid material innovations. By analyzing the function and optimization of cooling pads, this study offers valuable insights for improving evaporative cooling systems, making them more efficient and sustainable.*

Keywords: *Evaporative Cooling, Cooling Pad, Cooling Efficiency, Pad Material.*

1.0 Introduction

An evaporative system is a cooling method that uses water to lower air temperature. It works by passing warm air through a wet cooling pad, where the water absorbs heat and evaporates, making the air cooler before it is circulated. The cooling pad is the most important part of this system because its performance directly affects how well the cooling works. Water is continuously supplied to the pad using a pump, keeping it wet. A fan pulls warm air through the wet pad, and as the air passes through, the water absorbs heat and turns into vapour, cooling the air. This cool air is then spread into the room or space. The process continues as long as water is supplied and air flows through the pad. The cooling pad's efficiency depends on its material, thickness, water-holding capacity, and airflow, making it a key part of the system.

Banyat Niyomvas et al. [1] This study give the evaporative cooler efficiency by using different cooling pad. Two Type of cooling pads made of a curtain fabric and a raw cotton fabric were comparatively studied. The Effect of blower speeds at 725, 1015 and 1450 RPM and water flow rate of 26.9 litres per minute were Investigated. The results showed that an average of the different temperature between inlet and outlet Were 2.9 °C and 1.7° C for a curtain fabric and a raw cotton fabric, respectively. Saturation efficiency of the cooling pads made of a curtain fabric was in the ranges of 46.3 to 61.3% or represents an Average of 54.8%, and 29.7 to 39.2% or represents an average of 33.2% for a raw cotton fabric.

Alio Sanda M. Djibrilla et al. [2], this study explores a low-cost cooling pad made from Hyphaene thebaica (wood wool) as an alternative to expensive commercial pads in evaporative coolers. Tests showed that the locally made pad achieved better cooling performance, with a minimum temperature of 20°C, 78.8% efficiency, and a high heat transfer rate. It also had the best cost-to-efficiency ratio, making it a more affordable and sustainable option for wider use.

Metin Dağtekin et al. [3] This study aimed to understand the relationship between air velocity, temperature reduction, and cooling efficiency in a cellulose-based evaporative cooling pad (CELdek R 7060-15). Tests were conducted in two phases with different air velocities, while keeping the water flow rate constant. The results showed that there was no clear mathematical link between air velocity, temperature drop, and cooling efficiency. However, the ideal air velocity for the cooling pad was found to be between 0.5 m/s and 1.5 m/s for the best performance. This research helps in designing and operating more efficient evaporative cooling systems.

Md. Ferdous Alam et al. [4] This study evaluated coconut coir, jute fiber, and sackcloth pads as alternative materials for evaporative cooling. Experiments were conducted in a test chamber using different pad thicknesses (50, 75, and 100 mm), air velocities, and water flow rates.

Figure 1.0: Curtain Fabric and Raw Cotton Fabric

The results showed that coconut coir pads performed the best, achieving 85% cooling efficiency, followed by jute fiber pads (78%) and sackcloth pads (69%). Thicker pads improved cooling efficiency, while higher air velocity reduced saturation efficiency but increased pressure drop. The study concluded that coconut coir pads are a cost-effective and efficient option for evaporative cooling, especially in agricultural regions like Bangladesh.

Adeosun, O. C. et al. [5] This study analysed coconut husk and modified kenaf blast fiber as materials for evaporative cooling pads, focusing on their chemical composition. Coconut husk had higher lignin content (42.79%), while modified kenaf fiber had higher cellulose content (68%). Hemi-cellulose content was similar in both materials. The study found that coconut husk retains more moisture and crude fat, while kenaf fiber has more crude fiber and ash content. Statistical analysis confirmed significant differences in their composition, showing that coconut husk is better for water retention, while modified kenaf fiber has stronger structural integrity. This information helps in selecting better materials for efficient cooling pads.

Amrat Kumar Dhamneya et al. [6] This study experimentally analysed five types of cooling pads made from agricultural waste: banana fibres, sugarcane fibres, coconut fibres, khus fibres, and honeycomb paper. All pads were tested at the same packing density (44.44 kg/m³) and different airflow rates. The results showed that coconut fibres had the highest saturation efficiency (73.44%), followed by banana fibres (67.73%), khus fibres (67%), sugarcane fibres (65.65%), and honeycomb paper (40.29%) at 1.3 m/s air velocity. Sugarcane fiber pads performed better than honeycomb pads but were less efficient than khus fiber pads. Coconut and banana fibres worked better than khus fibres, making them promising materials for improving direct evaporative cooling (DEC) systems. This research helps in developing cost-effective and eco-friendly cooling solutions.

Egbal Elmsaad et al. [7] This study evaluated Celdek, Luffa, Straw Fiber, and Sackcloth pads as alternative evaporative cooling materials for greenhouses. Experiments measured factors like temperature, humidity, air velocity, and pressure drop using different pad thicknesses (50, 100, and 150 mm) and water flow rates. Results showed that Luffa pads had the highest saturation efficiency (73.67%), followed by straw fiber (71.87%), Celdek (70.33%), and sackcloth (69%). Thicker pads improved cooling efficiency, while higher air velocity reduced efficiency but increased pressure drop. The study concluded that Luffa pads performed best and have strong potential as an effective evaporative cooling material for greenhouses.

Radhiyah Abd. Aziz et al. [8] This study examined the cooling efficiency of natural-based materials for evaporative cooling systems, focusing on activated carbon foam (ACF) and luffa pads. Since the cooling pad is crucial to system performance, these materials were tested for their effectiveness. The experiment measured temperature and humidity using a data logger, while varying airflow rates to analyse their impact on cooling efficiency. The results showed that the ACF cooling pad performed better than the luffa pad, making it a more efficient choice for evaporative cooling systems.

Parmeshwar Dubey et al. [9] This study investigates the performance of desert coolers using six different pad materials: cellulose, jute, aspen, coconut coir, stainless steel wire mesh, and another type of cellulose pad. The aim was to evaluate cooling efficiency at various speeds and times.

Experiments were conducted on a laboratory-scale setup, and results showed that cellulose pads had the highest efficiency, while stainless steel wire mesh had the lowest. The highest efficiency was observed between 2:15 PM and 4:30 PM at a constant speed. Among the tested pads, aspen showed the least drop in cooling efficiency across different speeds.

2.0 Conclusion

After the above review we conclude that, the performance of an evaporative cooling system is largely dependent on the type of cooling pad used, with various studies highlighting the effectiveness of different materials. Coconut coir emerged as the most efficient material, achieving 85% cooling. The choice of cooling pad material significantly affects the efficiency of an evaporative cooling system. Coconut coir, luffa, and cellulose-based pads are the most efficient, offering high saturation efficiency and moisture retention. Thicker pads enhance cooling performance, while higher air velocity reduces saturation efficiency but improves airflow. Eco-friendly and cost-effective materials like banana fibers, jute, and activated carbon foam also show good potential for sustainable cooling solutions. This review highlights that selecting the right cooling pad material can optimize cooling efficiency, making natural fiber-based pads a viable alternative to conventional cellulose pads for energy-efficient and eco-friendly evaporative cooling systems.

References

[1] Banyat Niyomvas And Bunjerd Potakarat, Performance Study of Cooling Pads Advanced Materials Research, Vol. 664 (2013) pp 931-935 doi:10.4028/www.scientific.net/AMR.664.931

[2] Alio Sanda M. Djibrilla , Atto H. Abdoulkader , Karimoun M. Illyassou Drame Yaye Aissetou D, And Adamou Rabani Investigation of Evaporative Cooling Pad Material From Hyphaene Thebaica FibersJournal of Engineering Research and Reports DOI: 10.9734/JERR/2021/v21i917491

[3] Metin Dağtekin , Cengiz Karaca , Y ilmaz Yildiz , Ali Baçetinçelik And Ömer Paydak The effects of air velocity on the performance of pad Evaporative cooling systems African Journal of Agricultural Research Vol. 6(7), pp. 1813-1822, 4 April, 2011 DOI: 10.5897/AJAR10.1110

[4] Md. Ferdous Alam , Ahmad Sharif Sazidy, Asif Kabir, Gowtam Mridha Nazmul Alam Litu And Md. Ashiqur

Rahman .An Experimental Study on the Design, Performance and Suitability of Evaporative Cooling System using Different Indigenous Materials doi: 10.1063/.4984704

[5] Adeosun, O. C. And Olabinjo, O.O. Characterization of Some Evaporative Cooling Pad Materials International Journal of Trend in Research and Development, Volume 8(5), ISSN: 2394-9333 Sep – Oct 2021

[6] Amrat Kumar Dhamneya ,S P S Rajput Alok Singh Experimental performance analysis of alternative cooling pad made by agricultural waste for direct evaporative cooling International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 7, July 2017

[7] Egbal Elmsaad and Abdelnaser Omran Evaluating the Effect of New Local Materials of Evaporative Cooling Pads American-Eurasian J. Agric. & Environ. Sci., 15 (1): 78-84, 2015 ISSN 1818-6769 DOI: 10.5829/idosi.aejaes.2015.15.1.12494

[8] Radhiyah Abd. Aziz, Nurul Farahin Zamrud, Nurrina Rosli Comparison on cooling efficiency of cooling pad materials for evaporative cooling Journal of modern manufacturing systems and technology DOI:10.15282/jmmst.v1i1.199

[9] Parmeshwar Dubey and Arvind Kumar Patel Experimental Analysis of Various Cooling Pads in Evaporative Cooling System International Journal of Latest Trends in Engineering and Technology (IJLTET), Volume 9, Issue 5, November 2018.

Article History:

Submitted: 2025-03-13

Reviewed: 2025-03-20

Accepted: 2025-03-21

Published: 2025-03-27