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A Review Paper on Comparison of Cooling Pads for Evaporating Cooling Heat Exchanger

Assistant Professor Naveenprabhu | **UG Scholar A. Dinesh** | **UG Scholar K. Gowtham** | **UG Scholar P. Harish Gowtham** | **UG Scholar V. Jayaprakash**
Department of Mechanical Engineering
Sri Eshwar College of Engineering, Coimbatore-603110, India

***Abstract* – This paper investigates the performance study of the different types of cooling pads made from agricultural waste. The usage of air conditioners and heaters in the buildings and working spaces should control the sensible heat to make comfort condition. Evaporative cooling is one of the energy efficient and eco-friendly air conditioning technologies. There are many advantages in evaporative cooling when compared to other cooling process due to their non- polluting nature. It is one of the suitable ways to cool a workplace or living place, because it uses fresh air to replaces the air time to time to maintain room temperature. Due to this process, air and some allergens are expelled out. It is based on the natural process of air cooling using normal water. However, evaporative cooling requires abundant water and is more efficient only when the relative humidity is low. Experimental and theoretical research works on feasibility studies; performance test and optimization are considered and then reviewed in detail.**

***Keywords* – Evaporative cooling, allergens, non-polluting..**

I. INTRODUCTION

cooling has increased sharply, that resulted in over exploitation of natural resources and contributes to global warming. Around 40% -50% of the buildings power consumption is used for air conditioning system using traditional HVAC systems. Nowadays air conditioning in buildings has become a necessity for comfort of people and plays a vital role in indoor comforts. Hence, efficiency can be improved by comparing various cooling pads and analysing their performance parameters, i.e. high performance, low power consumption. Evaporative cooling can be classified into three basic types namely Direct Evaporative Cooling (DEC), Indirect Evaporative Cooling (IEC) and Semi-Indirect Evaporative Cooling (SIEC).

II. LITERATURE REVIEW

[1]Prof. B. A. Shah (2014) made examination of evaporative cooling stack of various materials dependent on climate information of Ahmedabad, India .Immersion effectiveness and cooling limit of different cooling cushion materials were estimated. Impact of air and water stream rate on immersion effectiveness and cooling limit has been explored for various cooling cushion materials like unbending cellulose, PVC, Grass and Fabric material. Immersion effectiveness and cooling limit have been determined for stream paces of air between 0.2 to 0.4 m3/s and for water stream pace of 600 to 1000 LPH. It has been seen that cellulose material gives most elevated immersion productivity of about 93% while texture material gives most minimal immersion productivity of about 44%. The cooling limit increments with wind stream rate and is gotten between 1 to 5 kW for various materials.

[2]Dr. S. C. Kongre et al. (2016) said that draining vitality assets and expanding natural contamination have moved the consideration of all scientists everywhere throughout the world to elective cooling frameworks. Summer cooling frameworks fit for keeping up precisely the required conditions in the moulded space are costly to possess and work. In some cases, mostly successful frameworks may yield the best outcomes as far as solace and cost. Evaporative cooling frameworks are modest and offer an appealing option in contrast to the customary summer air molding frameworks in places, which are hot and dry. Evaporative cooling frameworks additionally find applications in hot modern situations where the utilization of ordinary cooling frameworks turns out to be restrictively costly. The idle warmth of dissipation is taken from water, air or those two. Right now, air loses reasonable warmth however increases dormant warmth due to move of water fume. Along these lines the air gets cooled also, humidified. The cooled and humidified air can be utilized for giving warm solace. In light of exploratory execution of various evaporative cooling cushion material it has been found that there exist water stream rate for which immersion effectiveness is most extreme. For a fixed water stream rate with variety in wind stream rate immersion productivity is practically consistent. Anyway with increment in air stream rate cooling limit increments. It has been seen that cellulose material of thickness 4" gives most elevated immersion productivity of about 92.8% while khus-grass material gives least immersion effectiveness of about 40.13%.

With higher wetted surface region gives higher immersion productivity. The outlet temperature of air is differing between 24°C also, 29 °C. The cooling limit increments with air stream rate and is gotten between 1.1to 6.72 kW for various materials.

The motivation behind [3] Mahsa Barzegar et al. (2012) examination was to assess the exhibitions of cellulosic cushions made out of Kraft and NSSC folded papers in three woodwind sizes, tentatively. He made various investigations in a air stream so as to assess the cooling effectiveness and water utilization as a component of air speed. The tests were completed at three degrees of air speed for three woodwind sizes of Kraft and NSSC creased papers (2.5, 3.5, and 4.5 mm). His investigation showed that cooling proficiency improves with lessening of air speed and woodwind size of folded papers; nonetheless, water utilization increments with the expansion of air speed. The outcomes were contrasted and one another and it was demonstrated that the cellulosic cushion made out of Kraft paper with 2.5 mm woodwind size has the best (92%) at 1.8 ms-1 air speed in correlation with the other cellulosic cushions.

[4]Moien Farmahini-Farahani et al. (2012) said that, exergy investigation is applied to show the exergy proficiency and irreversibility of normal models of evaporative cooling. Exergy investigation of moulded air depends on the aftereffects of trial examinations on the immediate, aberrant, and two-organize backhanded/direct evaporative cooling for six urban areas in Iran, each having different climate conditions. For this reason, exergy equalizations of three cooling techniques are inferred. The outcomes got uncover that for a far reaching effectiveness examination, both the first and second law of thermodynamics ought to be considered. Moreover, the direct evaporative coolers work best in mild and dry atmosphere with assessed exergy proficiency of 20%. The circuitous evaporative coolers are progressively productive in hot and dry atmosphere with surmised exergy effectiveness of 55%. The backhanded/direct evaporative coolers are better decision for hot and semi sticky atmosphere with exergy productivity of about 62%.

[5]D. Y. Goswami (2016) presented a experimental investigation of the use of indirect evaporative cooling process to increase the performance of an air-to-air vapour compression refrigeration system. The condenser of an existing 2.5 ton (8.8 kW) air conditioning system at the University of Florida's Energy Park in Gainesville was retrofitted with a media pad type evaporative cooler, a water source, and a pump. The system performance was monitored without and with the evaporative cooler on the condenser. The data show that electric energy savings of 20 percent can be achieved by using an evaporative cooled air condenser. The energy savings can pay for the cost associated with retrofitting the condenser in as little as two years.

[6]T. Gunhan et al. (2007) investigated the appropriateness of pumice stones, volcanic tuff and nursery concealing net as elective cushion materials to the generally utilized and business one called CELdek. For this reason, the tests were done at four degrees of air speed (0.6, 1.0, 1.3 and 1.6ms-1) four degrees of water stream rate (1.0, 1.25, 1.5 and 1.75, l min-1) and three degrees of cushion thickness (50, 100 and 150 mm). The tests were made at 300C and 400C.The temperature of water stream was kept steady at 250C during the tests. As indicated by the aftereffects of this examination, it tends to be expressed that the volcanic tuff cushions are acceptable options in contrast to the CELdek cushions at 6ms-1 air speed.

[7]Abdollah Malli et al.(2011) said that in the present work, warm execution of two kinds of cellulosic cushions (5090 and 7090) which were produced using folded papers has been examined
tentatively. Tests were tried in a sub sonic breeze burrow produced using polyethylene. The cushions territories are 0.5 0.5 m2 with 75, 100 and 150 mm thicknesses. Weight drop, moistness variety, vanished water and adequacy have been explored for a few delta air speeds. The outcomes show that general weight drop and measure of dissipated water increment by expanding the delta air speed and thickness in the two sorts of cushions. Then again, adequacy also, mugginess variety decline by expanding gulf air speed.

[8]Manoj Kumar Chopra (2017) talks about the idea of evaporative cooling to give solace to people in a structure isn't new and has been utilized in various pieces of a world by utilizing various ways and materials. Fume pressure refrigeration frame work and Air conditioning utilizing gases like CFCs and HFCs decreases the utility of evaporative cooling however they have limit of ozone layer consumption. Such a large number of producers have accompanied distinctive molded evaporative coolers and various sorts of cushion materials. Right now evaporative cooler is structured which is semi-round fit as a fiddle rather than rectangular shape (typically utilized now a days) and the correlation between rectangular formed cooler and new planned semi-round about formed cooler is made with Khus as a cooling cushion material in terms of temperature drop, moistness rise and cooling proficiency. By utilizing Semi-roundabout molded use of water builds, more volume of air comes in contact because of steam line design, requires less cooling cushion material and become reduced, along these lines requires less space for establishment. Just as execution of various cooling cushion materials like Celdek, Khus, Coconut coir and Bamboo fibre (new material) is investigated as far as temperature drop, stickiness rise and cooling proficiency by utilizing ordinary water and chilled water with recently structured semi-round molded cooler. Concerning human solace Celdek is a best material followed by Coconut, Bamboo fibre and Khus.

According to climate information of Bhopal, the atmosphere of Bhopal in summer is sweltering and dry so best material prescribed for the evaporative cooling in the atmosphere of Bhopal is Celdek.
The proficiency of an evaporative cooler on various cooling cushions have been examined by [9] Banyat Niyomvas (2013) Two sort of cooling cushions made of a window ornament texture and a crude cotton texture were nearly considered. The impact of blower speeds at 725, 1015 and 1450 RPM and water stream pace of 26.9 litres every moment was researched. The outcomes demonstrated that a normal of the distinctive temperature among channel and outlet were 2.9oC and 1.70C for a window ornament texture and a crude cotton texture, individually. Immersion effectiveness of the cooling cushions made of a window ornament texture was in the scopes of 46.3 to 61.3% or speaks to a normal of 54.8%, and 29.7 to 39.2% or speaks to a normal of 33.2% for a crude cotton texture.

[10]Vikas Bansal et al. (2012) illustrated that earth–air–burrow heat exchanger (EATHE) frameworks are deficient to meet the warm solace prerequisites in summer conditions. Hence, vanishing cooling has been incorporated with EATHE to improve the warm solace hours. Financial aspects of coordinated EATHE–evaporative cooling framework to diminish/stay away from the utilization of forced air system and electric radiator is examined by assessing basic Internal Rate of Return (IRR) on venture. For this examination a transient and verifiable model dependent on computational liquid elements has been utilized for assessing the vitality sparing got by the utilization of EATHE framework incorporated with evaporative cooling.
Four base instances of existing frameworks, for example forced air system and electric radiator have been considered for completing the financial investigation. Additionally, three unique kinds of blower (for example vitality effective blower, standard blower and wasteful blower) have been considered for assessing the vitality sparing and budgetary reasonability of the proposed framework. These aftereffects of IRR count shows that any place, the current climate control system and warmers are productive, their supplanting with proposed EATHE framework is definitely not an actually and monetarily reasonable choice. It is seen that the IRR esteem is significantly subject to the electric tax and the vitality productivity of the blower utilized in the proposed EATHE framework.

[11]R. Rawangkul (2015) reported an exhibition examination for another supportable building application to valuably reuse an bounteous farming waste, coconut coir (Cocos nucifera), in evaporative cooling cushions. Two little coconut coir stack of various setups were created and tried utilizing a research center scale exploratory plan. The air supply speed was controlled and fluctuated somewhere inthe range of 1.88 and 2.79m s21. Warmth and mass exchange coefficients, evaporative cooling productivity and weight drop over the two sorts of coconut coir cushion were broke down and contrasted and those of a business inflexible media paper cushion. Results show that the cooling proficiency of the fabricated coconut coir evaporative cooling cushion was genuinely acceptable (about half) and near that of the business paper cushion (about 47%). The normal weight drop over the two coconut coir cushions was 1.5 and 5.1 Pa separately. Relationships for warmth and mass exchange coefficients communicated utilizing Nusselt and Sherwood numbers are likewise revealed. Also, the cooling capability of the coconut coir cushions was broke down utilizing the normal climatic states of the focal area in Thailand consistently. The investigation appeared that the air temperature leaving the coconut coir cushion fluctuated from 23 to 28uC. Business advancement shows up plausible given the coconut coir cushion's acceptable execution, lower cost and its accessibility all through the nation.

III. VAPORATIVE COOLING SYSTEM TYPES

The evaporative cooling (EC) technology is based on heat and mass transfer between air and cooling water.
Evaporative coolers could be classified into:

1. Direct evaporative coolers, in which the working fluids (water and air) are in direct contact.
2. Indirect evaporative coolers, where a surface/plate separates between the working fluids.
3. Combined system of direct and indirect evaporative coolers with other cooling cycles.
4. Direct evaporative cooling (DEC) is based on mechanical and thermal contact between air and water, while indirect evaporative cooling (IEC) is based on heat and mass transfer between two streams of air, separated by a heat surface with a dry side where only air is cooling and a wet side where both air and water are cooling.
5. Both DEC and IEC are characterized by very high energy efficiency but it is also by significant water consumption rates.

- **Direct Evaporative Cooling (open circuit)**

Direct evaporative cooling brings water straight forwardly into the stockpile airstream (for the most part with a splash or a wetted media). As the water retains heat from the air, it vanishes and cools the air. In direct evaporative cooling the dry bulb temperature is brought down however the wet bulb temperature stays unaltered. In activity, a blower gets air through a penetrable, water-drenched cushion. As the air goes through the cushion, it is sifted, cooled, and humidified. A distribution siphon keeps the media (cushion of woven filaments or ridged paper) wet, while wind streams through the cushion. To guarantee that the whole media is wet; more water is normally siphoned than can be vanished and overabundance water channels from the base into a sump.

A programmed top off framework replaces the dissipated water. The proficiency of direct cooling relies upon the cushion media. A decent quality inflexible cellulose cushion can give up to 90% productivity while the free aspen wood fibre cushion will bring about 50 to 60% contact efficiencies.

Fig.1. Direct evaporative cooling.

- **Indirect Evaporative Cooling (closed circuit)**

Circuitous evaporative cooling brings down the temperature of air by means of some sort of warmth exchanger course of action, in which an auxiliary airstream is cooled by water and which thus cools the essential airstream. The cooled air never comes in direct contact with water or condition. In circuitou
evaporative cooling framework both the dry bulb and wet bulb temperatures are decreased. Circuitous evaporative coolers don't add dampness to the air, yet cost more than direct coolers and work at a lower effectiveness. The proficiency of round about cooling is in the scope of 60-70%.

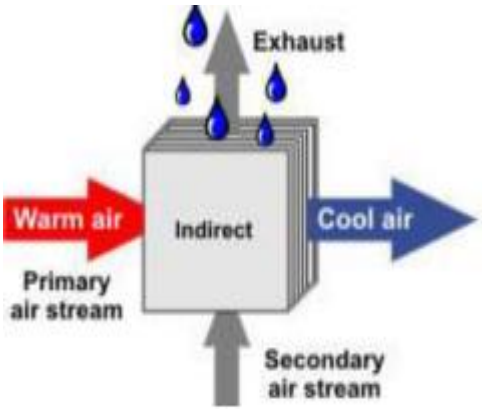

Fig.3. Indirect evaporative cooling.

- **Two-stage Indirect/direct Evaporative Cooling**

Two phase evaporative coolers join circuitous with direct evaporative cooling. This I achieved by passing air inside a warmth exchanger that is cooled by vanishing outwardly. In the subsequent stage, the pre-cooled air goes through a water-absorbed cushion and picks stickiness as it cools. Since the air supply to the second stage evaporator is pre-cooled, less stickiness is added to the air, whose fondness for dampness is legitimately identified with temperature. The two-arrange evaporative cooling gives air that is cooler than either an immediate or roundabout single arrange framework can give separately. Much of the time, these two-arrange frameworks give better solace than a blower based framework, since they keep up a progressively ideal indoor moistness run. A propelled two-organize evaporative cooler uses 100 percent open air and a variable speed blower to circle cool air. Two-organize evaporative coolers can lessen vitality utilization by 60 to 75 percent over regular cooling frameworks, as per the American Society of Heating and Specialists (ASHRAE). However this family member improvement relies upon area and application.

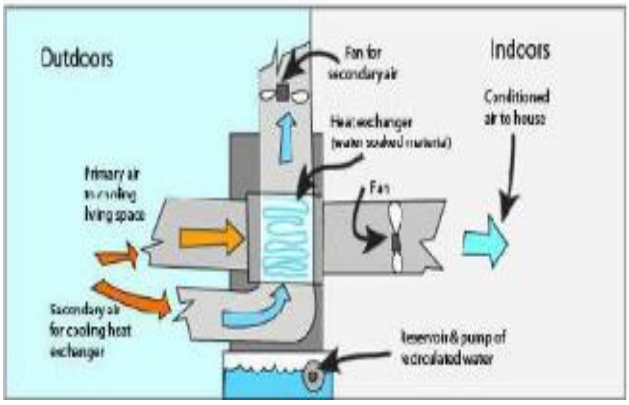

Fig.2.Two stage direct/indirect cooling.

IV. CONCLUSION

By surveying all the papers mentioned above, it is came to know that the performance of evaporative cooling heat exchanger varies with the introduction of cooling pads made of different materials. The main aim of this paper is to compare the performance characteristics of evaporative cooling heat exchange with different cooling pads.

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