A Review On Experimental and Comparative Analysis of Different Cooling Media In Evaporating Cooling System

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Abstract –This review paper on evaporating cooling system and also know the various benefits of ECS its classification, working principal and also its compare to air condition and formulation of cooling efficiency, When water evaporates from the surface of something, that surface becomes much cooler because it requires heat to change the liquid into a vapor. A nice breeze on a hot day cools us because the current of air makes perspiration evaporate quickly. The heat needed for this evaporation is taken from our own bodies.

Keywords **– ECS, cellulose pad, cooling efficiency, air velocity, jute khus.**

1. INTRODUCTION

If India's energy and environmental scenario is concerned, there is a pressing need of energy conservation and environment preservation. The conventional evaporative cooling system (e.g. water cooler) is used for the cooling purposes in the dry and hot regions. This type of system gives the sufficient cooling, but the increased humidity of the air gives the feeling of discomfort. The other way to overcome the problem of increased humidity is use of indirect evaporative cooling system. This system though handles the humidity properly, but the cooling obtained with the said system is less. On the other hand, vapour compression refrigeration systems consume more electricity and some of the systems carry the potential to pollute the environment. Also cost of such systems is on the higher side.

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2. CLASSIFACTION OF EVAPORATING COOLING SYSTEM

1. Single Stage / Direct evaporating cooling

The direct evaporative systems or Single-stage (direct) evaporative coolers used for cooling rooms consist of at least a humidifier, a fan (generally a centrifugal one, to supply the required pressure with low noise), a tank of water and casing. A recirculation pump is also needed.

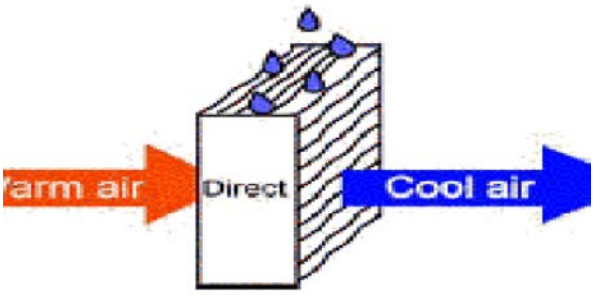

Figure1.1 Direct Evaporative Cooling[1]

The direct evaporative systems aim to increase the area through which the mass-exchange is produced between the air and the humid surface, given that the vapor mass flow in air needed to evaporative cooling that air is directly proportional to that area. Although it is more improbable that drops of water were swept away by the air stream than the presence of aerosols when atomizing, it is always necessary to dispose a proper drift eliminator in the outlet of this air stream.

2.Two-Stage Systems/indirect cooling system

Two stage- Indirect/Direct air flow evaporative coolers in which an indirect cooling stage upstream of the direct stage is added. In the indirect stage air-to-air heat exchanger,cools the outdoor air by evaporative cooling, without moisture addition two stage systems deliver cooler and drier supply air, but at the expense of some added fan and pump energy. Indirect-only evaporative coolers are sometimes used to pre-cool make-up air for larger commercial Buildings, but are not addressed by this proposed standard. There are currently two, two-stage products on the market.

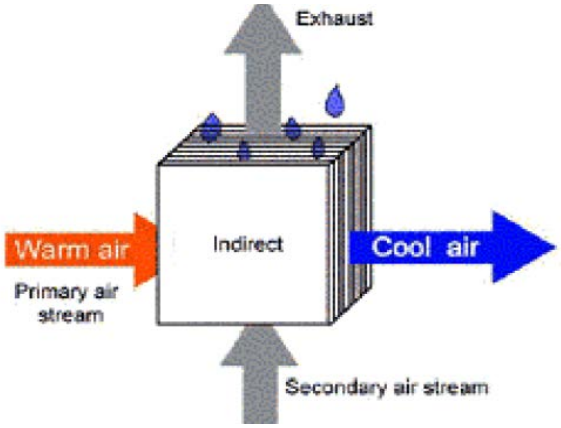

Figure1.2 Indirect Evaporative Cooling[1]

3. Two-Stage Evaporative Cooling/Indirect-Direct: In conventional evaporative coolers use only a part of the energy of vapor-compression or absorption air conditioning systems. Unfortunately, apart from very dry climates they increase humidity to a level that makes occupants prickly in this evaporative cooler do not produce humidity levels as high as that produced by conventional single-stage evaporative coolers.

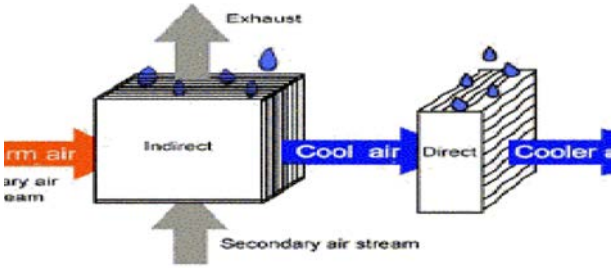

Figure1.3 Direct and indirect Evaporative Cooling[1]

3. PREVIOUS WORK

Rajesh Maurya*, et al [1] [2014] Three types of cooling pad made of a cellulose, aspen fiber, and coconut coir were comparatively studied. This study is performed primary air velocity considered varies between 0.5 m/s to 3.0 m/s and the performance of the cooling pads are analyzed based on the saturation efficiency, leaving air temperature, specific humidity, relative humidity, cooling capacity and water consumption. Saturation efficiency of the cooling pads made of cellulose was in the ranges of 64.55 to 55.29 %, for aspen it was 80.99 to 68.86%, and for coconut coir 68.15 % to 50.79 % was observed. **Krishna Shrivastava, et al[2014][2]** this paper show that the coconut coir fiber pad had similar saturation (cooling) effectiveness of near about 60% while the Relative humidity drop was observed from 80-85% of Aspen wood pad to 50-60% of Coconut coir pad. Also the water consumption rate for coconut coir fiber pad is less than aspen wood pad. **R. K. Kulkarni and S. P. S. Rajput [2013][3]**The evaporative cooling, also known as the adiabatic saturation of the air is a thermodynamic process. When the warm humid air passes over a wet surface, the water evaporates and air loses heat sensitive and gains equal amount of latent heat of the water vapor, thus reducing its temperature. The greater the amount of evaporation, the greater is the cooling effect. As well, the system is more effective in the hot dry climates that is to say when it is most needed. **Vivek W. Khond[2013][4]** This papers represent the performance of desert cooler using four different cooling pad materials in terms of the efficiency of cooling, the consumption of water and the speed of the air. Pads of stainless steel wire mesh, the coconut fiber, coconut Khus and wood wool have been manufactured and tested using a experimental arrangement at the laboratory scale. Maximum water consumption was observed in the wool, wood wool pad (0.24 liter/min). Coconut (coir 0.134 liter/min) and Khus cooling pad (0.21 lit/min) has also shown less consumption of water, while the rates of cooling pad in the wool of conventional wood. The minimum consumption of water has been observed in stainless steel wire mesh pad(0.066 lire/min) to even the speed of the fan. Cooling pad of stainless steel wire mesh (4.5 m/s) and coconut coir pad (5.2 m/s) listed above which provides the speed of the air good distribution of the air in the room while the wool, wood wool pad (4m/s) and Khus cooling pad (3.4 m/s) were shown lower velocity. Effectiveness of maximum cooling minimum and have been found in the Wood wool pad and stainless steel wire mesh pad. **Seth I. Manuwa1 & Simon O. Odey[2012][5]** cooling pads and forms to build evaporative coolers. Materials studied include the jute, latex foam, charcoal and wood chips. The forms of cooling systems deemed Hexagonal and Square cross sections. Some physical properties of the pad that could affect the materials of the effectiveness of the evaporative coolers have also been determined. **Abdollah Malli , Hamid Reza Sey [2011][6]** The thermal performance of the two types of cellulosic pads (5090 and 7090) which have been made from corrugated paper has been studied experimentally. The samples were tested in a sub wind tunnel made of Sonic of polyethylene. The platelets are 0.5×0.5 m2 with 75, 100 and 150 mm of thickness. Pressure drop, moisture and water evaporated, variation of efficiency have been studied for several speeds of intake air. The results show that on the whole, the pressure drop and the amount of water evaporated, increase by increasing the speed of the air inlet and thickness in the two types of platelets. **J.K. Jain , D.A. Hindoliya [2011] [7]** The evaporative cooling pads are usually made of aspen and khus fibers. These two materials with new materials to know the coconut fibers and palash fibers have been tested in a laboratory using properly test manufactured commissioning. Air flow has been maintained constant. The evaporative cooling efficiency has been obtained and compared with that of aspen and khus pads. The

effectiveness of the pad with the fibers has been found for palash be 13.2% and 26.31% more compared to the trembling aspen and platelets khus respectively. While the effectiveness of coconut fibers has been found to be 8.15% more than that of khus and comparable to that of aspen pad. **J.T. Libertya*, B.O. Ugwuishiwua [8] [2013]** evaporative cooler operates on the principle of cooling resulting from the evaporation of the water from the surface of the structure. The cooling obtained by this device is also reflected by a high relative humidity of the air in the House of cooling from which the evaporation is place by report to the ambient air. The atmosphere of the House therefore becomes more conducive for the storage of fruit and vegetables. Therefore, this paper examines the concept, principle, method and types of evaporative cooling.

Xiaoli Cangzhou Haoa, Zhua[2012][9] In order to maximize the potential for energy savings of a chiller evaporation cooled by air (EACC), which consists of an air cooler of evaporation and a cooler of cooled by conventional air, a mathematical model has been developed and a new index, the increase in the rates of seasonal energy efficiency ratio (ISEER), has been proposed to evaluate the energy saving potential of the evaporative chiller cooled by air. **Faleh Al-Sulaiman [2002][10]** the performance of materials and the effectiveness of the cooling of the degradation. The results show that the effectiveness of cooling medium is the highest for the jute to 62.1%, compared to 55.1% for the fibers of Luffa, 49.9% for the commercial cooling pad of reference and 38.9% for the fibers of the date palm.

Khedari Rawangkul R, J.[2008][11] A performance analysis for a new application of sustainable engineering as beneficiary a abundant of agricultural waste reuse, coconut coir in the evaporative cooling pads. Two small plates of coco coir of different configurations have been manufactured and tested using a experimental arrangement at the laboratory scale. The speed of air supply has been controlled and ranged between 1.88 and 2.79 m S21. The coefficients of heat and mass transfer, the evaporative cooling efficiency and pressure drop across the two types of coconut coir HAPS have been analyzed and compared with those of a paper brochure rigid support commercial. The results show that the effectiveness of the cooling of the coconut coir evaporative cooling pad manufactured was good enough (approximately 50%) and close to that of the plate of commercial paper (approximately 47%). The average pressure drop in the two pads of coco coir was 1.5 and 5.1 Pa, respectively .

Dai and Sumathy[12][2002] has developed a mathematical model to predict and discuss the temperature of the interface of falling film in a cross-flow evaporative cooler direct. The results of the analysis has indicated that the performance of the system could be improved by the optimization of the mass of water flows of power and for the treatment of the air, as well as the different dimensions of the pad.

J. R. Camargo, EGodoy and Ebinuma[13] 2007-2008 [13],This paper is about an evaporative and desiccant cooling system for air conditioning in moist climates**.** This paper introduce some process parameters such as: reactivation temperature, correlation (reactivation air flow/ process air flow) and the thermodynamic situation of the entering air flow shows still the situation for the best operation point with regard to the thermal relieve situation and to the energy used in the process.

Camargo et al 2005 [14],Says that evaporative cooling : water for thermal relieve. They used three method for the use of efficient use of evaporative cooling system, apply it to several Brazilian city, characterize by unlike climates. Evaporative cooling system have a very huge impending to propitiate thermal relieve and still used in conventional system in the regions where the design wet bulb temperature is under 24°c.

Ghasem Heidarinejad, Mojtaba Bozorgmehr 2007[15],In this paper heat and mass transfer model of two phase indirect/direct evaporative air coolers. Modeling of a cross flow two stage evaporative cooler has been presented. The indirect stage is well described by the numerical solution of energy and mass balance equations while the direct stage effectiveness is determined by an analytical simple equation which is suitable for cellulose paper pads. Two phase evaporative cooler could provide relieve conditions in some major cities of Iran where direct cooling system is unable to meet requirements.

You and Zhang 1999[16] By deliberate the performances of the stainless steel pad and the perforate aluminum pad by assuming the adiabatic humidify process. The most favorable mass flow rate of the air and the water were1.5–3.5 kg m/ s and 0.8–1.4 kg m/ s, respectively. Moreover investigated the cooling and dehumidification performances of five types of perforated aluminum pads with different sizes at various circulation water temperatures.

Yang et al2007[17].By this paper experienced the cooling performance of the aluminum pad with explicit surface area under the higher air velocity, the cooling efficiency of the pad tested was about 60%.

4. PROPOSED METHODOLOGY

4.1 Parameter of cooling pad

The inlet temperature of air t_1 and wet bulb temperature of air t_w the saturation efficiency of cooling pad is calculated based on the following relation [3]

$$\eta \text{ sat} = \frac{t1-t2}{t1-tw} \times 100 \text{ .....(1)}$$

η_{sat} = Saturation efficiency

t_1 = Ambient temperature

t_2 = outlet temperature from pad

t_w = bet bulb temperature of outside air

4.2 Cooling capacity of evaporative cooling pad

$$Qc = Ma \times Cpa \times [t1 - t2] \times 3.6 \text{ .....(2)}$$

Qc = Cooling capacity, Ma = Mass flow rate of air, Cpa = Specific heat of air.

5. APPLICATION

1. Less expensive to install.
2. Estimated cost of the facility is about half that of the refrigeration center with air conditioning. Cheaper to run • Estimated cost of the operation is 1/8 that of refrigerated air.
3. Power consumption is limited to the fan and the water pump. Since water vapor are not recycled, there is no compressor that consumes most of the power closed-cycle refrigeration.
4. The refrigerant is water. No special refrigerants such as ammonia or CFCs are used that could be harmful, expensive to replace, contributing to the ozone layer and / or be subject to strict licensing and environmental regulations.
5. The only two mechanical parts in most basic evaporative coolers are the fan motor and water pump, both of which can be repaired at low costs and often by an owner mechanically inclined. The ventilation air Frequent and high volume flow of air through the building reduces the spectacular "the age of the air" in the building.
6. Evaporative cooling system increases humidity. In dry climates, this can improve comfort and reduce static electricity problems.
7. The pad itself acts as a fairly efficient air filter when it is well maintained; it is capable of removing a variety of contaminants in the air, including urban ozone caused by pollution, independently from the very dry conditions. based refrigeration-lose this capacity cooling systems each time that there is not enough moisture in the air to maintain the wet evaporator while providing a common net condensation washing the dissolved impurities removed .

6. CONCLUSION

In this review paper the direct evaporating cooling system is economical and cheap as compare to air conditioning system and also give us human body comfort conditions.

7. FUTURE SCOPES

As the number of energy resources are limited and primarly aim of the government is to reduce the consumption of electricity by promoting energy efficient equipments.Our project gives an effective alternative which consumes As no kind of C-F-C gases such as R-22,R12 are used which are one of the reason for ozone depletion layer thus the equipment is enviroment friendly less electical energy.

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