A Result and Discussion on Evaporative Cooling Methods

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Abstract- *An experimental performance investigation on evaporative cooling pads of different materials based on weather data of Wardha, Maharashtra, India has been carried out. Saturation efficiency and cooling Capacity of various cooling pad materials were measured. Effect of water flow rate on saturation efficiency and cooling capacity has been investigated for different cooling pad materials like rigid cellulose, wool wood, khus pads. Saturation efficiency and cooling capacity have been calculated for flow rates of air between 3 to 5m3/s and for water flow rate of 75 to 95 cc/sec. It has been observed that khus pad material gives highest saturation efficiency of about 77.77% while wood wool pads material gives lowest saturation efficiency of about 66.67%. The cooling capacity increases with air flow rate.*

Keywords- Saturation efficiency, Wood wool.

I. INTRODUCTION

Depleting energy resources and increasing environmental pollution have shifted the attention of all researchers all over the world to alternative air conditioning systems. Summer air conditioning systems capable of maintaining exactly the required conditions in the conditioned space are expensive to own and operate. Sometimes, partially effective systems may yield the best results in terms of comfort and cost. Evaporative air conditioning systems are in expensive and offer an attractive alternative to the conventional summer air conditioning systems in places, which are hot and dry. Evaporative air conditioning systems also find applications in hot industrial environments where the use of conventional air conditioning systems becomes prohibitively expensive.

Evaporative cooling system is based on the principle that when moist but unsaturated air comes in contact with a wetted surface whose temperature is higher than the dew point temperature of air, some water from the wetted surface evaporates into air.

The latent heat of evaporation is taken from water, air or both of them. In this process, the air loses sensible heat but gains latent heat due to transfer of water vapour. Thus the air gets cooled and humidified. The cooled and humidified air can be used for providing thermal comfort.

II. CASE STUDY [I]

This paper investigates the performance analysis for a new sustainable cooling pad for evaporative cooler. The first one is related with the cooling pads which are used in evaporative cooler by comparing the different types of pads like Wood wool pad, khus pad, and cellulose pad to evaluate the saturation efficiency.

From the above experimentations and analysis on evaporative cooler we have found that,

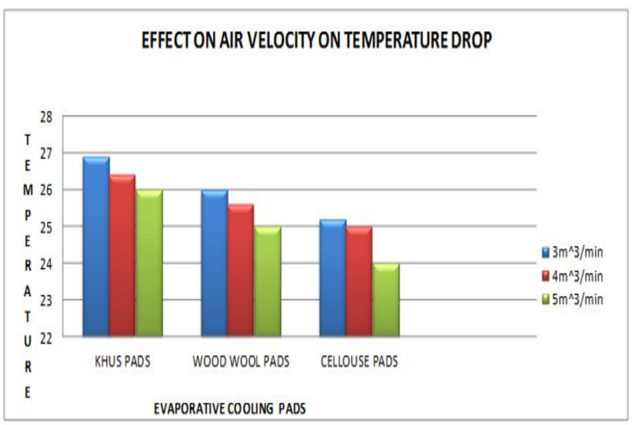
1] Wood wool fibers can be compressed and when the pressure is removed they resume their initial volume. This is a useful property for minimizing their volume when shipping. Due to its high volume and large surface area, wood wool can be used for applications where water or moisture retention is necessary. The width of wood wool fibers varies from 1.5 to 20 mm, while their length is usually around 500 mm depending on the production process and water absorption capacity is 12.3%.

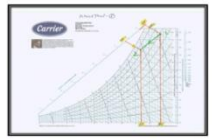
2] Khus pads are generally made from the roots of khus plant that is usually found along the canals. Water absorbing capacity is more than the khus pads. This pads has one advantage that it gives Pleasant smell when used in desert cooler. Water absorbing capacity is 16 %.

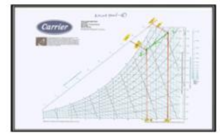
3] Callous evaporative pads is a special cellulose material and a unique glass fiber paper which is impregnated and treated to resist biological and mechanical degradation. This provides a media longevity and high adsorption rates for optimum system efficiency. The cross fluted design of the pads media results in two important effects. First, it optimizes the amount of surface area available to hold the water where the air flows over and second, the angles cause the air to change directions in a way that it ensures all of the air which will touch a wetted media surface before leaving the pad. Therefore, the air leaves the pad with the greatest amount of cooling and or humidification process is possible. Pads also act as a natural filter that purifies the inlet air. The carefully designed flute angle directs water towards both the air inlet and outlet side; the water then intrinsically flushes away dust, algae, and mineral build up on the evaporation surfaces. Pad is designed tough with proper water bleed off and regular maintenance, it can be used in imperfect water and air conditions. Exact and consistent humidity control can be obtained through evaporative cooling with callous pads. Its Water absorbing Capacity is 25%.

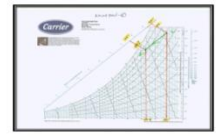
Analysis on Evaporative Cooler using varrying cooling material (Pad), are as follows,

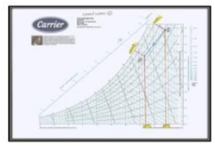
PADS	D.B.T (BEFORE)	W.B.T (BEFORE)	TIME (IN MIN)	D.B.T (AFTER)	W.B.T (AFTER)	FLOW RATE (CC/SEC)	Φ1 %	Φ2 %	HEAT REMOVED (H1-H2) (KJ/KG)	SATURATION EFFICIENCY
1. Khus pads	34 °C	29 °C	30	27 °C	25 °C	75	69	85	18	77.77%
			30	26.8 °C	24.7 °C	85	69	83	20	77.41%
			30	26.8 °C	24.2 °C	95	69	82	22	73.46%
2.Wool wood pads	34 °C	29 °C	30	27 °C	23.5 °C	75	69	75	24	66.67%
			30	26.5 °C	23.5 °C	85	69	78	24.5	71.42%
			30	26 °C	23 °C	95	69	77	26	72.72%
3.Cellouse pads	34 °C	29 °C	30	26 °C	23 °C	75	69	78	26	70.83%
			30	25.5 °C	22 °C	85	69	75	30	70.83%
			30	24 °C	21 °C	95	69	78	34	76.92%

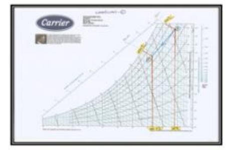



Performance of Khus Pads after 30 min


Performance of Khus Pads after 60 min


Performance of Khus Pads after 90 min


Performance of Wood wool Pads after 30 min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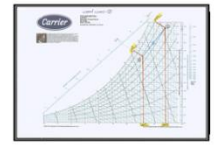
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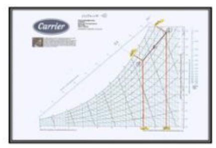
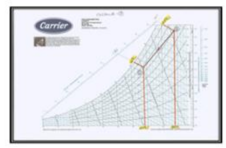

Performance of Callous Pads after 30 min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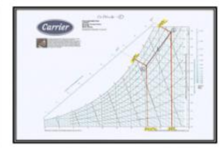
Performance of Callous Pads after 90 min

III. CASE STUDY [II]

This case study makes a wide knowledge of selection of motors and blowers for an evaporative cooler, which play very vital role in evaporative cooling system. Excess capacity of fan, blower not only raised the capital cost but also creates the discomfort.

Here an attempt is made to optimize the components of evaporative cooler ultimately to produce comfortable environment. Calculations on heat load in confined space is very essential parameter to clear the idea about cooling to be produced for efficient working environment.

3.1. Total heat gain from (1+2) solar heat gain by glass and transmission heat gain by walls and roofs

Sr. No.	Item	Area (Sq.ft.)	Temperature Difference (F)	U-Factor	Heat BTU/Hr
1	All Glass	100.420	45.9	1.1	5070
2	Wall	835.38	38.17	0.106	3380
4	Ceiling	323.47	33.8	0.40	4373.31
5	Floor	323.37	33.2	0.40	4321
				Safety Factors 5% On heads 1-5	**857.21**
				Total Heat	**18001.52**

3.2. Internal Heat (Sensible Heat)

Sr.No.	Item	Quantity	Heat/Person Or Quantity/BTU	Total BTU/Hr
1	People	75	260	19500
2	Lights	8	116.008	928.064
3	Ceiling Fan	8	255.9	2047.2
4	Desktop Computer	1	1535.4	1535.4
5	Laptop	1	341.2	341.2
6	Projector	1	1023.6	1023.6
			Safety Factors 5%	1268.77
			Total (SH)	27913

3.3. Internal Heat (latent heat)

Sr.No.	Item	Quantity	Heat/Person Or Quantity/BTU	Total BTU/Hr
1	People	75	205	15375
			Safety factor 5%	768.75
			Total (LH)	16143.75

Figure: 3.3.1. Seminar Hall (Capacity 70 Peoples)

Figure: 3.3.2. Duct System in Seminar Hall

Figure: 3.3.3. Evaporative Cooler

IV. RESULT AND DISCUSSION

1. From the above analysis, we come to know that for minimum water flow rate i.e. at 75 cc/sec khus pads has maximum saturational efficiency i.e. 77.77 %.
2. For minimum water flow rate i.e. at 75cc/sec wood wool has minimum saturational efficiency i.e.66.67%.
3. As velocity of air goes on increasing temperature drop also goes on decreasing and at velocity of 5 m^3/min callous pads gives minimum temperature drop i.e. 24°C dry bulb temperature.
4. Heat removed by the callous pads is maximum i.e. 34 KJ/KgK at 95cc/sec, and heat removed by the khus pads is minimum i.e. 22 KJ/Kg K at 75cc/sec.
5. From the experimentation analysis we conclude that callous pads is most suitable pads for the hot and dry climate of Wardha (Vidharbha) region, Maharashtra,India.

V. CONCLUSIONS

As from the above Heat Load Calculations, we have found that, the C.F.M. of our Evaporative Cooler used in Seminar Hall is 6267.64 Ft^3/min. The Evaporative Cooler used in Seminar Hall is an Axial flow fan which having a characteristics of low pressure high volume discharge, and can be used for cooling purpose in (up to 100 sq.m. area) but, cannot be efficient for the large rooms. The evaporative cooler installed in seminar hall having a high budget for purchasing and installing (Approx. 1.5Lakh). Now instead of this we can used Double Inlet Centrifugal Fan, it is extensively used to control air pollution system and dust fume extraction system due to this property it leads to increase our comfort factor. It is efficient about 89%. As all of their moving parts are enclosed and they also have particular reduction properties that makes them ideal for use in filtration system.

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