ANALYSIS ON “A YEAR ROUND COMFORT SYSTEM”

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Abstract—*In this Paper the two technology has been implemented on an air cooler so as to make the system more functional in both winter and summer. And the Technologies are Indirect Evaporative cooling (IEC)& Direct evaporative cooling (DEC).The functional system is capable to reduce the humidity of air.While doing experimental analysis results on an average about 15% reduction in humidity observed as a result. At the time of summer climate both the primary & secondary duct can as per our comfort requirement. In winter utilized the only one side of duct. While doing the analysis we get to the result that, high performance result can be achieve by using indirect evaporative cooler with cross flow plate heat exchanger. Result shows that system is best suitable to install in hot & humid areas i.e. coastal areas. So far about the financial & eco-nomic aspects we try to build the system with optimum costwhose cost is more effective than existing air conditioners.*

Index Terms—Indirect evaporative cooling, direct evaporative cooling, humidity,wet bulb temperature

1 INTRODUCTION

IN this era the consumption of energy is increasing day by day as a result few of them are going to be extinct after few decades. In fact, worldenergy consumption rate is around 500 Hexa joule and only 3.3% of it we are using.

In the present scenario cooling energy demand is graduallybecoming a serious concern every where, more preferable in buildings where cooling is desired. For achieving this costly cooling system are installed in these areas which directly influences the cost by consuming electricity.This increase of energy consumption has environmental side-effects related to the increased Carbon emissions and to the ozone layer depletion as Chloro Fluoro Carbons (CFCs) are used in air conditioners.The Kyoto protocol
1995 designed to save the ozone layer, has banded the developed countries to reduce the collective emissions of six key green house gases - among which CO_2- at least by 5 %. But this methodology has been implemented in 2003 when Energy conservation act has been passed from parliamentary and to run this actively B.E.E has been formed by the Govt. so as from this point of view our focus is not only in the reduction of humidity but for the optimum consumption of energy too.

The few advantages of the system are cooling comfort, simplicity in design, lowerrunning and maintenance cost, saving energy resource, last but not least eco-friendly emissions.Evaporative cooling is a process in which evaporation of other fluids in the presence of a draught, with a consequent cooling of the air happens and this type of cooling is well suited in those areas where air is hot and humidity is quite low. The evaporative cooling system uses the latent heat of water evaporation i.e. it is a kind of natural energy existing in the atmosphere, to perform air conditioning for buildings.However, in areas where humidity is higher there are many proven cost effective applications available for evaporative cooling that makes it the right choice to be chosen and implemented, for example, industrial plants, commercial kitchens, laundries, spot cooling.Evaporative cooling occurs when the vapour pressure of water becomes higher than the corresponding partial vapour pressure in the auxiliary air.

With this system thermal comfort can be achievable where wet Bulb temperature is low. When the hot air comes in contact with water its start vapourisng into air streams. The heat and mass transfer between air and water take place and as a result low dry bulb temperature of air will occur and leads to increase in humidity while theenthalpy is constant.

There are few drawbacks of an DEC systems if it’s not designed properly than it may leads to excess humidification and causing thermal discomfort but with IEC systems the humidity can be maintained by keeping in mind the thermal comfort conditions

There are few advantages of IEC over DEC systems as-

1. By using this system the operational cost is reduced upto 50-55%.
2. Power consumption is lower as compared to air conditioners.
3. No any harmful emissions i.e eco-friendly.

In this paper, the experimental results are shown, that signifies humidity control or reduction is possible with the help of our experimental set-up keeping in mind the comfort condition.

2THERMAL COMFORTS

Thermal or human comfort it actually means “a state or condition when a person express satisfaction with the environment “thermodynamically a human body feels comfortable when the produced heat in a body by metabolism is equal to the sum

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of the dissipated heat to the surrounding and the heat stored in human body by raising the temperature of body issue or we can say that the total heat exchange by body with the surroundings.
There are some parameters that affect the thermal comfort; Temperature, humidity, airmotion, air purity.Sometime temperature around 19.5- 21.5 degree and relative humidity 30-50 % makes a person feel thermally comfortable. The standard temperature distribution showing the comfort zone according to ASHRAE55/ANSI.

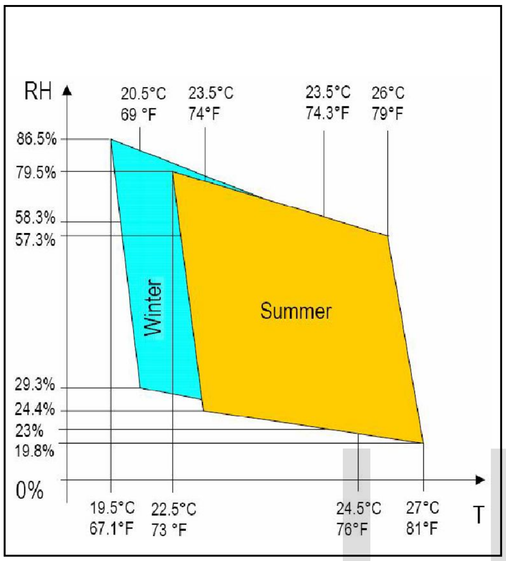

Fig. 1

Here there is chart showing the temperature distribution along with relative humidity of summer as well as winter showing the comfort zone.

3 LITERATURE REVIEW

A wide range of research work have been already done on heat and mass transfer process and performance of different types of flow patterns to optimise the geometries, by suggesting the favourable operational conditions so as to improve the energy efficiency, energy saving, cooling capacity, and reduction in emission related to IEC system with plate heat exchanger. Important technical parameters, research, result and conclusions works have been summarised as follows:

Maclaine-cross and Banks (1981) performance of a wet surface heat exchanger is analysed by simply establishing one – dimensional mathematical modelbut several assumption has been taken such as average temperature and humidity at inlet and outlet of a heat exchanger but surface has to be completely wetted. The results predicted by the model were 20 percent higher than the experimental value.
Navon and Arkin (1994) conducted a feasibility study to evaluate the economic value and thermal comfort level of a wet coil DEC/IEC combined system compared with a conventional air conditioner (AC).[2] A life cycle cost calculation method was exploited to compare the annual equivalent cost (AE) of a wet coil type DEC/IEC to that of an AC in two cities of Israel with extreme summer conditions. The maximum initial cost of the DEC/IEC system was estimated. The results show that the economic potential of the DEC/IEC is very promising considering the significant electricity cost cut compared to AC, although the rise in water consumption cost may undermine this advantage.
Lilly and Misemer (1996) et al. assessed the California market potential of using indirect/direct evaporative cooling and estimated the impacts of key deployment barriers.[3] The assessment covers a wide range of evaluation factors including market potential, market barriers, technology potential and costs, energy savings potential for residential and commercial buildings and applicability factors, i.e., climate, humidity requirements, initial cost, etc.
Tulsidasani et al.(1997) analysed and optimised the pressure drop, power consumption and COP of a tube type IEC in terms of the velocities of primary and secondary airs.[4] The performance of the tube type IEC was studied theoretically and experimentally. It is found that the test results have a satisfactory agreement with the theoretical predictions. The reported maximum COP of the unit was 22 at the primary air velocity of 3.5 m/s and secondary air velocity of 3 m/s with the temperature drop of 10.4^{o}C. The study also suggests that the COP of the IEC increases with decreasing secondary air velocity without significantly affecting the cooling capacity of primary air.
Tulsidasani et al(1997). also studied the thermal performance of a non conditioned building equipped with an IEC system.[5] For the three different climatic conditions of India, i.e. hot, dry, warm, humid and combination, the research investigated the effects of various design parameters of the IEC on the discomfort standards. The analysis shows that the IEC system is effective in providing thermal comfort to buildings in dry, hot and combined climates.
Stoitchkov and Dimitrov (1998) improved the wet surface cross-flow heat exchanger model originally developed by Maclaine-cross and Banks.[6] The effectiveness predicted by their improved model had a better approximation by introducing with flowing water film, determination of mean water surface temperature and derivation of an equation for calculating the ratio of total to sensible heat taking into account the barometric pressure. The corrected model was validated with some published data. The errors between the results of test and model were found satisfactory.
Based on an earlier heat exchanger model (Pescod 1979), Alonso et al. (1998) developed a simplified heat and mass transfer model for calculating the primary air outlet temperature of a cross-flow indirect evaporative cooler.[7] Alonso's model can be applied to simulate the primary air outlet temperature of the cross-flow indirect evaporative coolers with different geometries and operating conditions. In their study, an equivalent water temperature was introduced to include the energy transfer between primary and secondary air, which assumed the global process to an adiabatic saturation process. The model was verified and validated with other experimental data and Pescod and Erens 's models (Pescod 1979; Erens and Dreyer 1993). It is found that a good agreement was obtained between the experimen-

tal data and the model. Compared with the Pescod's model, the results of Alonso's model were much closer to that of Erens's model.
Guo and Zhao (1998) investigated the thermal performance of a cross-flow heat exchanger by analysing the effects of various parameters, i.e. primary and secondary air velocities, channel width, inlet relative humidity and wettability of plate. A numerical method was used to solve differential equations.[8] However, the accuracy of the numerical model was not validated with the experimental data or other models. Therefore, the model has nouniversality and only can be used as an approximate guidance for the direction of system or product design. Their study suggests that a smaller channel width, a lower inlet relative humidity of the secondary air, a higher wettability of plate, and a higher ratio of secondary to primary air can result in a higher effectiveness.
Brooks and Field (2003) invented a type of cross-flow indirect evaporative cooler. The cooler is made from extruded, twin-walled, corrugated, fluted plastic sheeting.[9] The corrugated sheets were stacked vertically together to form the primary and secondary channels of the heat exchanger. The reasons for causing the poor cooling effectiveness were analysed which include the poor water distribution, poor air distribution across the inlet and the insufficient heat transfer surface area. It allows the water falls directly to the bottom area of the heat exchanges passages. The mesh also can be used as the pre-cooling of the secondary air to increase cooling effectiveness of the system. The study also suggests that heat transfer and surface area can be increased by roughening the surface of sheets.

4 DESIGN - WORKING OF SYSTEM

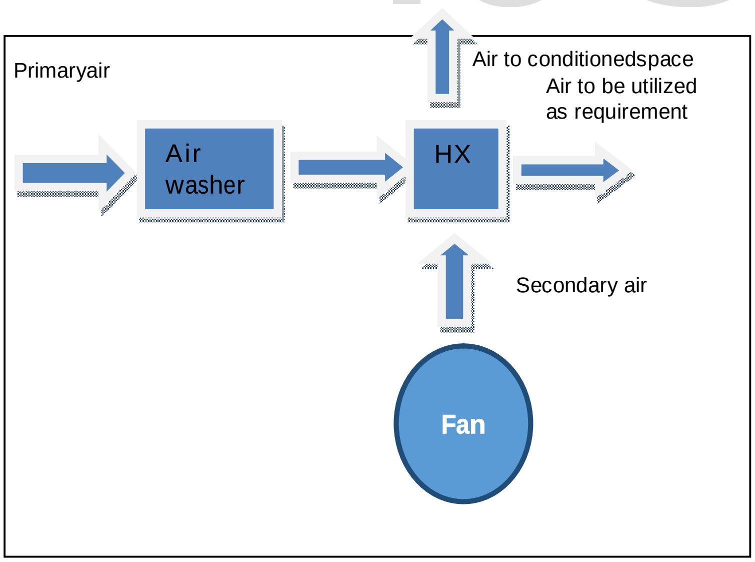

Fig. 2

4.1 DESIGN / CONFIGURATION-

The system consists of a coolerwith some modification i.e.(A rod is placed in-Side the cooler or whose fun- ctioning is like as an air washer unit.)And a flow parallel heat exchanger Unit which is one of the vital or key unit of this system consist many ducts so as to increase heat transfer rate. A secondary fan is mounted over the heat exchanger unit.

4.2 WORKING SYSTEM IN DIFFERENT WEATHER CONDITION

The working of system is divided in two phase or unitsfirst Unit consist cooler and the second one having a heat exchanger unit.
As I earlier mentioned that two technologies have been implemented here on this system simply cooler with having DEC and the heat exchanger having IEC' system it

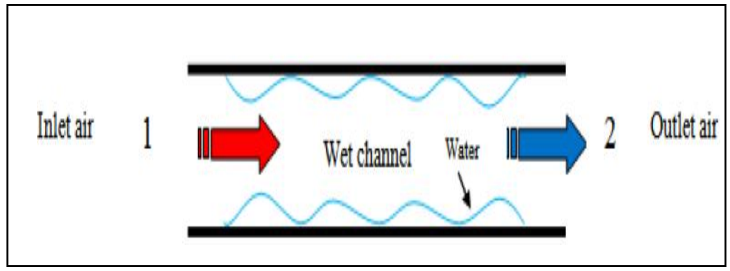

Fig .3 DEC' system

And the second one in heat exchanger unit is IEC' system i.e

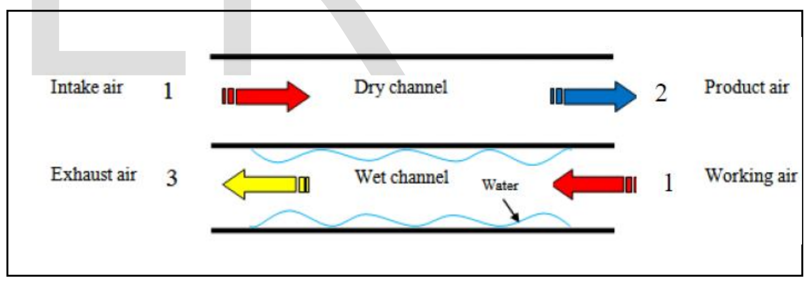

Fig.4 IEC' systems

4.3 Performance evaluation standards of IEC -

There are certain paramerters such as supply temperature of air and its flow rate, secondary to primary air ratio, powerconsumption, wet-bulb effectiveness, cooling capacity, energyefficiency, water consumption etc by such these parameters we can evaluate how much IEC'system are efficient.

4.3.1 IN WINTER

In winter the surrounding temperature in quite low so our system has to perform like a heater in such conditions.
The cooler is hydrated with water due to heating rod which is partially immersed into it in a cooler the water temperature start rising and blower fan of cooler blow the hot humidified air into the ducts of heat exchanger unit. The flow of hot humidified air start in streams in ducts during this cool air from surrounding is blow by the secondary fan which is mounted on heat exchanger unit as both came in contact,

from law's of energy the energy will transfer from higher to lower source. here the hot humidified air flowing in ducts gave its heat (latent heat) to the cool air and become liquid and flow out from the ducts while the cool air gets hot and less humidified can be collected from the other side and the water coming out from the ducts can be reusable and feeded to the cooler again in simple language the heat exchanger unit working as rectifierhere. Soheating can be easily obtained by doing few modifications on a cooler.

4.3.2 IN SUMMER

One of the major drawbacks of using a cooler in summer is simply the humidity can't be controlled when we increase the cooling effect and our focus is either is to control it or reduced it up to desirablelimit.

So in this case instead of a hot water we use a normal liquid like water in the container of the cooler here there is no any need of rod. As the fan of cooler start it blows off the cool humidified air from the cooler to the ducts of the heat exchanger unit .as the surrounding temperature is already high the secondary fan of the H.E unit blows hot air of low humidity inside the chamber. as the ducts are made of conductive material i.e. aluminum the heat transfer will occur in between the hot air in the chamber the cool air flowing in ducts due to evaporative cooling the hot air gets cooled and due to cooling phenomena air will be humidified but with less percentage of RH (relative humidity).

The cooled air flows out from the chamber while from the ducts we will get water plus hot air which flows from the duct as a waste. This wastage of hot air is less as compared to the wastage heat from an A/C unit.

5EXPERIMENTAL SET UP AND IT'SSPECIFICATIONS-

Components	Power rating(W)
1.Air cooler	133
2.secondary fan	105
3.Heat Exchanger	-
4.Aluminium pipes	Thermal conductivity-247 w/m-k
5.Immersion rod	500
6.Duct	-

As the specification include the dimension of the heat exchanger i.e. length, breadth, height for an efficient and effective heat transfer take place and the power consumption devices like immersed rod all has to be calculated earlier so the net power saving can easily determine. here the exchanger is equipped with cross flow plate so the diameter and the length is the great concern as we are using aluminum pipe whose thermal conductivity is 247 W/m-k denoted by **k**".

The power consumption rate is given below is with no any losses.

6POWER (RATED)CALCULATIONS

a) In Summer

Primary fan- 105 W
Secondary fan- 105 W
Pump (in cooler)-18 W
Total Power Consumption: - 228 W
Since, Energy = Power * time
Total Energy= 228*10 hr./day*30 days = 68.4 KWh
Since we know, 1 unit = 1 kWh; i.e. 68.4 units Will be consumed during summer per month.

b) In winter

Primary fan- 105 W
Heating Coil- 500 W
Total Power Consumption: - 605 W
Total Energy = 605*10 hr./day*30 = 181.5 kWh
i.e. 181.5 units will be consumed in winter per month
Assumptions: - Air washer operate for 10 hrs./day.

C) But For an Air Conditioner (Domestic purpose):-
Power Consumption: -1460 W
Total Energy = 1460*10 hr./day*30= 438 kWh
i.e. 438 units will be consumed for cooling per month.

7 FINANCIAL ASPECTS

The cost of this system is around 1/3rd of a regular Air conditioner system which means it's very cheaper in comparison of cost while talking about its operation cost or power saving around 75 % in summer and 50 % in winter.

8 FUTUREMODIFICATIONS ON OUR SYSTEM

(i)By using the more conductive material of ducts we can increase the heat transfer rate as a result time taken by the process will be less and the efficiency of the system will increase.

(ii) The system is equipped with cross flow plate that's means the duration of contact is not so much as per the expectations here but results are favorable so we can modify H.E either by changing to parallel or counter to get& to achieve desired result.

(iii) By roughening the surfaces of ducts heat transfer and surface area both will increase.

9 CONCLUSION

System has a huge capacity of energy saving with no any harmful emission like in other A/C conditioner.i.e eco-friendly

Only Water participate in cooling process rather than any refrigerant (pollutant)

Easier & simple in construction,easy to implement and use
More effective in coastal areas where the humidity is in great extent our system will be more effective and results are favorable .so it can work throught the year with optimum cost.

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