DESIGNING OF NATURAL AIR CONDITIONING SYSTEM

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Abstract - The present research is on designing of novel air conditioning system using natural sources of coolness for desert, rural as well as urban areas. The modes of airflow taken are natural, by natural wind and buoyancy effects. The systems considered and designed is with regards to in hot/arid and in hot/humid climates during summer season. Varying time period ranges are selected during peak summer viz. May and June months and the temperatures of window, room and testing chamber / cube was measured with digital thermometer. A reduction of 9 to 10°C temperature is seen with use of water and a reduction of 10 to 12°C temperature is seen with use of water and calcium oxide i.e. calcium hydroxide solution. Cooling effect is increased with calcium hydroxide. The principle used in cooling is evaporative cooling, which is synonymous to natural pot cooling, where heat and mass transfer takes place. It is also aimed to further reduce to another 10 °C, by further magnifying heat and mass transfer. It can be concluded that through natural air-conditioning system, thermal comfort can be maintained for buildings occupants with substantial savings in the total energy consumption, and a significant reduction in the peak electric power requirements.

I. INTRODUCTION

In today's time air conditioning system use has become a necessity for thermal comfort from increasing atmospheric temperature. People in general spend most of their time indoors. Indoor temperature effect human's efficiency and health. Temperature, humidity, air exchange rate, air movement, ventilation, particle pollutants, biological pollutants, and gaseous pollutants are the major effecting parameters (Graudenz et al., 2005). The system is classified on sources of coolness, the modes of heat transfer and airflow, and the types of material employed for the storage of coolness. The sources of coolness used are the ambient water vapor, ambient air, and the upper atmosphere or the sky. The modes of heat transfer are evaporation, convection, and thermal radiation. It is found that even though existing standards may be met but indoor environment problems still exist in many air-conditioned and mechanically ventilated buildings (Seppanen and Fisk, 2002). Unsaturated hydrocarbons emissions also results in environmental and health problems (Sarwar et al.,2003). Clay pot refrigerator is very much appropriate for storing vegetables and food during hard and dry environments. The cooling effect works on the basis of 'Evaporative cooling'. A steady state performance of cooling paradigms is estimated with the help of 'Reynolds flow model' of the convective heat and mass transfer. For the presumed load of cooling, the temperatures are analyzed under the umbrella of ambient temperature and at respective relative humidities (A. W. Date., 2012). According to a review, a new study in the area of indirect evaporative cooling (I.E.C) technologies which work considered from many aspects such as background, history, concept, configuration, current status, operation mode, industrialization based on research. Review depicts that the I.E.C technology poses the ability to substantiate current mechanical vapor compression systems in the process of air conditioning of buildings. In current, I.E.C systems could develop remarkable enhancement in cooling effectiveness for the period of 10-15 years. It has been observed that I.E.C systems were usually connected with other cooling mechanisms which are I.E.C- Heat pipe system, I.E.C-Dessicat system, I.E.C-Chilled water system, I.E.C-Mechanical compression system, I.E.C- D.E.C system (M. Edalat Pour et al., 2018). The cooling water tower is a kind of heat exchanger, where hard water drops by gravity through the cooling current of ambient air. The effectiveness of different types of cooling towers will vary with regards to height, configuration and flow arrangements. The process of air cooling is dissipation of heat within the system. The working is based on the 'air-flow' or the 'surface area' of the object. The nature of cooling can be increased by increasing the turbulence of air. 'Zeer pot' is considered to be an evaporative refrigerating gadget which doesn't depend on temperature. The cooling depends on relative humidity and outside temperature (Zhiyin Duan et al., 2012). The process of cooling takes place by the proven heat transfer mode i.e conduction and convection. The transfer of heat from a region of high temperature to a region of low temperature in solids is due to vibrations and transfer/ exchange. The phenomenon of conduction is also observed in fluids and gases due to diffusion and collision of molecules. Heat transfer through conduction can be empirically written as

$Q = KA [(T1-T2)/ \Delta x]$
Where 'k' is the thermal conductivity (w/m.k)
'A' is the area in m^2

T1 and T2 are temperature differences across material.
Delta x is the length of material where heat is transferred (meter)
Convection heat transfer may be empirically written as
Q,HIU = hAV(TV − TX) [W],
Where 'As' is the surface area in m^2
'T s' the temperature of surface in K
'T∞' the ambient air temperature K
'h' is the convection heat transfer coefficient (watts/m^2.K)
Convective heat transfer coefficient 'h' can be calculated through 'Nusselts number'
Nu = hLc/k
Where,
'Lc' is the characteristic length{meter}
'Nusselts number ' depends on 'Reynolds &Prandts number'.

Reynolds number= (ρVLc)/, μ; Prandts number= (Cpμ)/k
Where

ρ; density {kg/meter*meter*meter}
V;velocity of air {meter/second}
μ;dynamic viscosity{kg/meter –second}
Cp; specific heat{joule/kg/Kelvin}

It's the amount of saturated air with water vapour can be estimated from RH = Ppartial/Pestimated (Katarina Gustafsson and Hanna Simson, 2016). Thick cotton cloth has been chosen based on the feasible properties like Thermal conductivity of clay is 1.5 watts/meter-Kelvin where as cotton is 0.04, Thermal conductivity of air is 19 mm^2/second, Thermal diffusivity of cotton is 0.09 mm^2/second, Thermal diffusivity of clay is 1.4 mm^2/second.
In the present research work author has tried to develop natural air conditioner system which has no harmful effect on atmosphere and human beings. In desert and rural areas, it has high significance in providing convenient living conditions to the mankind.

II. MATERIALS AND FABRICATION

As shown in schematic diagram (Figure 1.) Fabrication of present natural air conditioning unit involves making of cast iron pipes frame of 7 feet height with 3 feet plus 4 feet dimension, which was designed keeping in view for easy transport, through simple assembling and dismantling.. Further U Channels are used to join iron pipes using nuts and bolts. All the cast iron pipes are fixed in cube. A 20 litre tank is arranged connected with polyvinyl chloride pipes (PVC) on the top of the cube. The frame is covered with cloth, which serves as a heat transfer medium. Tank is filled with water, and allowed to pass through PVC pipes having holes to completely wet the whole cloth of cabin, through water droplets, via small pores of PVC pipes. To increase the cooling effect further experiment is conducted with calcium oxide with water. Concentration of CaO in H_2O is 10,000 ppm. Calcium oxide with water forms calcium hydroxide which has increased cooling effect.

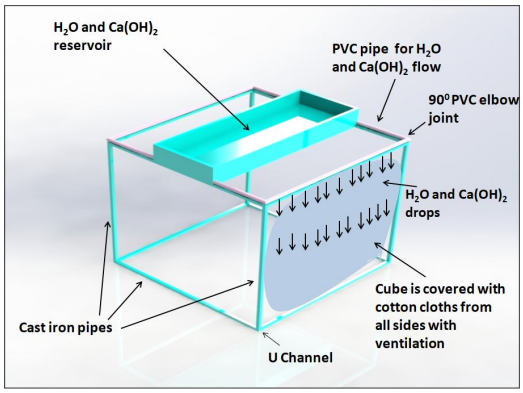


Figure 1 Schematic diagram of natural room air conditioner

III. RESULTS AND DISCUSSION

A time range during peak room temperature ie from 12 to 2.45 pm, of month of June is selected and window, room and cube temperature was measured with digital thermometer respectively and average of 10 readings are reported as shown in Table 1. Temperature measured of the window area, inside room area and inside natural air conditioner (cube) area at different time intervals shows variation in temperature. It was observed that a significant temperature can be reduced by natural room air conditioner. A reduction of 9 to 10°C temperature is seen with use of water and a reduction of 10 to 12°C temperature is seen with use of water and calcium oxide. Cooling is increased with calcium hydroxide. A uniform flow of water drops is maintained in the cloth which either evaporates naturally or sucked by the cloth itself without falling to the ground. Concentration of calcium oxide is also taken to below as 10,000 ppm in water which can further be increased.

Table 1: Data of temperature measured

Time range of June month	Temperature measured (°C)			
	Window	Room	Cube	
			With H_2O	With H_2O and CaO
12.00-12:05 pm	35.2 ± 0.8	32 ± 0.6	26 ± 0.4	25.5 ± 0.3
12.20 - 12.25pm	35.4 ± 0.8	32 ± 0.6	26 ± 0.4	25.6 ± 0.3
12.40 -	35.6 ±	32 ±	26 ±	25.6 ±

12.45pm	0.6	0.6	0.4	0.3
1:00 - 1:05 pm	37.1± 0.7	36 ± 0.7	26.7 ± 0.3	24.5 ± 0.4
1:20 - 1:25 pm	37.1± 1.0	36 ± 0.7	26.7 ± 0.3	24.5 ± 0.4
1:40 - 1:45 pm	38.1 ± 0.5	32 ± 0.6	25 ± 0.4	25.9 ± 0.3
2:00 - 2:05 pm	39 ± 0.8	34 ± 0.6	26.4 ± 0.4	24.5 ± 0.2
2:20 - 2:35 pm	39 ± 0.9	34 ± 0.6	26.4 ± 0.4	24.5 ± 0.2
2:35 - 2:40 pm	39 ± 0.9	34 ± 0.6	26.4 ± 0.4	25.5 ± 0.2

CONCLUSIONS

It can be summarised that the natural air-conditioning system satisfies the basic cooling purpose. The natural air conditioner had been tested to its functions and reliability of its design. A drop in ambient temperature upto 12°C was observed. This set up, not only suffices the Indian requirement but also expected to suffice, some of the countries with equatorial climate such as south East Asia have high temperature climate. Human being wishes to have comfort especially during summers, and natural air conditioner becomes one of the important components, that help people to feel comfortable with reducing temperature in their surroundings. The percentages of savings are higher in hot/arid regions than they are in moderate and hot/humid climates. It is concluded that the natural air-conditioning system, will be a best fit to promote thermal comfort and can be maintained for buildings occupants with substantial savings in the total energy consumption, and a significant reduction in the peak electric power requirements.

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