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A Study on Hybrid Cooling System Involving Passive Cooling Techniques

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ABSTRACT

It had been a major emphasis on the utilization of old natural techniques of cooling a house. Those passive techniques included the utilization of natural components which causes any harm neither to the human beings nor to the environment or atmosphere.

The passive cooling techniques were merged with modern electrical system to provide high efficiency hybrid systems. The passive cooling techniques involving both downdraft cooling and rooftop cooling systems could be utilized effectively to reduce the harm being caused to the nature.

Since one of the major heating sources for a house is its roof, hence, efforts were made to reduce the heat from roof by providing an artificial roof which can provide both cooling in summer and heating in winter.

The efficiency of the above system consisted of copper pipes and sand can be further improved by using sand additives which can improve the heat absorbing capacity of sand.

Key words: Passive Cooling, Hybrid System, Copper Pipes, Sand Additives, heat absorbing Capacity.

I.INTRODUCTION

The day by day increasing needs of human for more comfortable life has lead to increase in the energy needs as well. This problem increases to a very large extent during summer, when cooling requirement is the most important concern.

The world watch institute also states that, buildings use about 40 % of the total energy produced in the world. Apart from this, the usage of cooling instruments and balancing power requirements has also lead to the formation of oxides of sulphur and nitrogen which are the most important factors for acid rain and smog formation. This is very known fact that the severe smog formation has lead to many life taking accidents throughout the world. It has been also found that building energy use also produces 33% of all annual carbon dioxide emissions, significantly contributing to the climate changes brought about by the accumulation of this heat-trapping gas [1]. The energy requirements are almost similar to that of the world calculations, whwre the

building sector consumes about 33% of the total energy produced with commercial sector accounting for 8% and 25 % respectively [2].

Since we know that the regular use of fossil fuels and air conditioners are leading to severe damage to the environment, we can switch to the use of natural techniques as our ancestors achieved thermal comfort by natural means [3].

II.OBJECTIVE

In the ancient times when there were no artificial cooling methods, natural cooling techniques were used to keep the houses cool using methods like damp cloths hung in draughts, proper ventilation ,utilization of shading from trees . The increasing lifestyle and ease of work has lead to the development of new techniques to overcome the heating problem during summer.

Since, now we have started to realize that the new techniques are leading to the extinction of natural fossil fuels as well as polluting the environment. Now to prevent the existing problems new techniques have to be developed, which can be surely replaced by ancient techniques which our ancestors used without any harm to nature. Hence to reduce the emission of greenhouse gases, extinction of fossil fuels to compensate the power for cooling requirement of the buildings has stimulated the interest towards adoption of passive cooling techniques for buildings.

III.PASSIVE COOLING TECHNIQUES

Passive cooling is an ancient approach of building cooling using natural techniques. These natural techniques can be used in buildings to reduce their peak time cooling load and the system required for cooling. This system can be used for both cooling in summer and heating in winter. Some of the concepts of passive cooling are discussed as below:

- Solar shading is one of the best methods which can be used for both thermal comforts as well as to maintain balance in nature. It has been observed that shading with tree leads to reduction in ambient temperature near outer wall by 2°C to 2.5°C and an average depression of six degree centigrade in room temperature has been observed when solar shading techniques are adopted [4]. In modified studies the indoor temperature by about 2.5°C to 4.5°C is noticed for solar shading. Results modified with insulation and controlled air exchange rate showed a further decrease of 4.4°C to 6.8°C in room temperature [5].
- Another inexpensive and effective device is a removable canvas cover mounted close to the roof. During daytime it prevents entry of heat and its removal at night. Painting of the canvas white minimizes the radiative and conductive heat gain [6].
- Trees have also been proven to reduce the surrounding temperatures by approx. 5^0C by evapotranspiration (the process by which a plant actively releases water vapor) [7].

- Insulation is another great method to reduce heat transfer into the buildings thus reducing the cooling loads. One of the best examples in India is the RETREAT building in Gurgaon which came up with a cooling load reduction of about 15% [8].
- The solar chimney is used to exhaust hot air from the building at a quick rate, thus improving the cooling potential of incoming air from other openings [9].
- The diode roof eliminates the water loss by evaporation and reduces heat gains without the need for movable insulation. By this means, it is possible to cool the roof to 4°C below the minimum air temperature [10].
- The pond is covered in night to reduce the thermal losses from the roof and the hot water in the pond transfers heat into building [11].

Types of Passive Cooling:

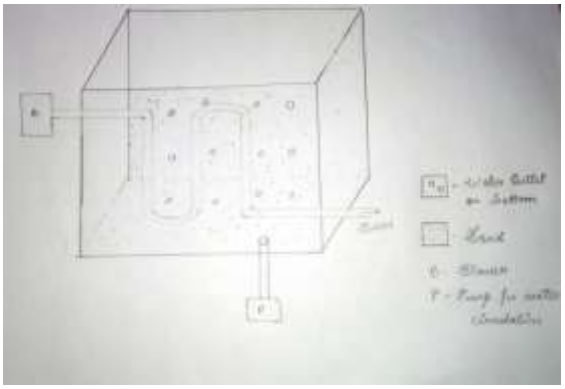
- Passive downdraft evaporative cooling (PDEC)-

  Passive downdraft evaporative cooling systems consist of a downdraft tower with wetted cellulose pads at the top of the tower. Water is distributed on the top of the pads, collected at the bottom into a sump and re-circulated by a pump[12].
- Roof surface evaporative cooling (RSEC)

  In a tropical country like India, the solar radiation incident on roofs is very high in summer, leading to overheating of rooms below them. Roof surfaces can be effectively and inexpensively cooled by spraying water over suitable water-retentive materials (e.g., gunny bags) spread over the roof surface. Wetted roof surface provides the evaporation from the roof due to unsaturated ambient air [13]. this system has been utilized for the study.

IV.EXPERIMENTAL SET-UP

The Experimental Set-up has been designed as follows consisting of copper pipes, sand, water pump and an air blower.



Air is made to flow using an air blower through the copper pipes surrounded by sand. Water is made to circulate over the sand which leads to heat transfer through the pipes thus cooling the air flowing through the pipes.

V.ASSUMPTIONS

The following assumptions have been made during the study:

1. The system is assumed to be closed.
2. There is no heat loss to the surroundings.

VI.RESULTS

The results have been calculated for water at 40^0C with three different blower speeds of 22m/s, 12.5m/s, 7.5m/s under three categories:

1. Dry Sand
2. Partially Wet Sand
3. Sand with Continuous flowing water

Temperature difference for dry sand –

At S1 = 1^0C

At S2 = 1^0C

At S3 = 1^0C

Temperature difference for partially wet sand –

At S1 = 2.5^0C

At S2 = 3^0C

At S3 = 3.5^0C

Temperature difference for continuous water –

At S1 = 3.5^0C

At S2 = 4.5^0C

At S3 = 5^0C

VII.CONCLUSION

Passive solar energy-efficient building design should be the first aim of any building designer, because, in most cases, it is a relatively low-cost exercise that will lead to savings in the capital and operating costs of the air-conditioning plant. In today's architecture, it is now essential for architects and building engineers to incorporate passive cooling techniques in buildings as an inherent part of design and architectural expression and they should be included conceptually from the outset. Incorporation of these passive cooling techniques would certainly reduce our dependency on artificial means for thermal comfort and minimize the environmental problems due to excessive consumption of energy and other natural resources and hence will evolve a built form, which will be more climates responsive, more sustainable and more environmental friendly of tomorrow.

Apart from that of the passive roof, if proper shading, arrangement of trees and building design will be implemented, then there would be no requirement of harmful air-conditioners which pollute the environment releasing harmful CFC's.

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