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A Study on Hybrid Cooling System Involving Passive Cooling Techniques with PV Panel Roof

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Highlights
1) A Hybrid cooling system is proposed.
2) Cooling techniques mainly involve Passive techniques.
3) Rate of Cooling depends on the amount of nano particles.

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 are now collaborated with the electrical systems to provide a pollution free cool environment. 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 is improved more by installing solar panels on the roof which provides additional cooling as well as power source to run the additional equipments.
Keywords: Passive Cooling, Hybrid System, Copper Pipes, Sand Additives, heat absorbing Capacity.

I. INTRODUCTION

The modern lifestyle and growing comfort needs have increased the energy requirements in the developing countries and that too mainly in the summer season.

As per the World watch Institute, buildings consume about 40% of the world's energy production, leading to which, buildings are involved in producing about 40% of the sulfur dioxide and nitrogen oxides that cause acid rain and contribute to smog formation. 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]. As per the BEE, the commercial buildings consume around 8 % of power which is increasing to 11-12 % every year [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].

A. Problem Statement

Before the invention of air – conditioners, natural cooling techniques were used like hanging of wet clothes, drizzling of water sprays ventilation techniques etc. But, to obtain more comfort with less effort, new techniques were developed involving consumption

Now, with rapid rate for the depletion of natural resources and increased global warming because of artificial cooling and heating has forces us to develop new means to reduce the load on nature and save whatever is left.

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.

II. PASSIVE COOLING TECHNIQUES

Passive cooling is a technique that concentrates on heat gain control and heat dissipation in a building in order to improve the indoor thermal comfort with low or no energy consumption.
The various passive cooling techniques are discussed as below:

1) 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].
2) 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].
3) 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].
4) 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].
5) 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].
6) The diode roof eliminates the water loss by evaporation and reduces heat gains without the need for movable insulation. This technique is assumed to reduce the surrounding temperatures by approximately 4^0C [10].
7) The pond is provided on the roof and kept closed during the day to prevent heat entering the system and is kept open in the night to allow heat transfer from the room ceiling by radiation to the atmosphere [11].
8) It has also been estimated that the houses using PV systems on their roofs are around 2.5^0C as compared to those not utilizing it [13].

A. Types of Passive Cooling:

1) *Passive downdraft evaporative cooling (PDEC):* In this method, air is forced to pass through wet pads or meshes where the heat is transferred from the air to the fluid contained in the pads, thus reducing the temperature of the air to be circulated in the buildings [13].
2) *Roof surface evaporative cooling (RSEC):* This method involves cooling 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 [14]. This system has been utilized for the study.

III. EXPERIMENTAL SET-UP

The Experimental Set-up has been designed as follows consisting of copper pipes, sand, water pump and an air blower as shown in Fig(1).

Figure 1: Set-Up of Copper pipes in Sand

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 as shown in Fig (2).

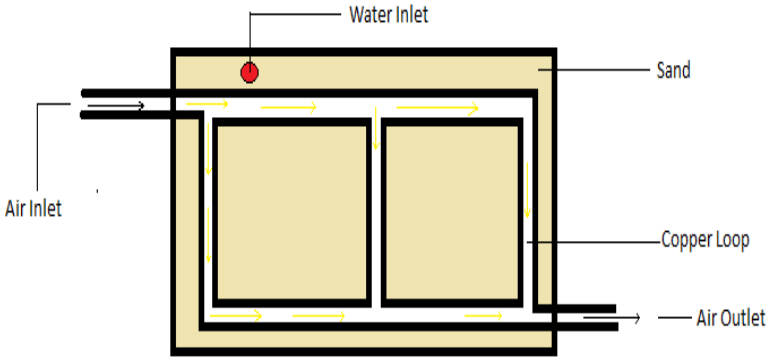

Figure 2: Layout of the Experimental Setup.

The following assumptions have been made during the study:

A. The system is assumed to be closed.
B. There is no heat loss to the surroundings.

IV. RESULTS & DISCUSSION

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 nine cases:

A. Dry Sand
B. Partially Wet Sand
C. Sand with Continuous flowing water

Table 1: Temperature Difference under various cases

Case	Temp. Difference at S1	Temp. Difference at S2	Temp. Difference at S3
Case I	1^0C	1^0C	1^0C
Case II	2.5 ^{0}C	3 ^{0}C	3.5 ^{0}C
Case III	3.0 ^{0}C	3.5 ^{0}C	4 ^{0}C

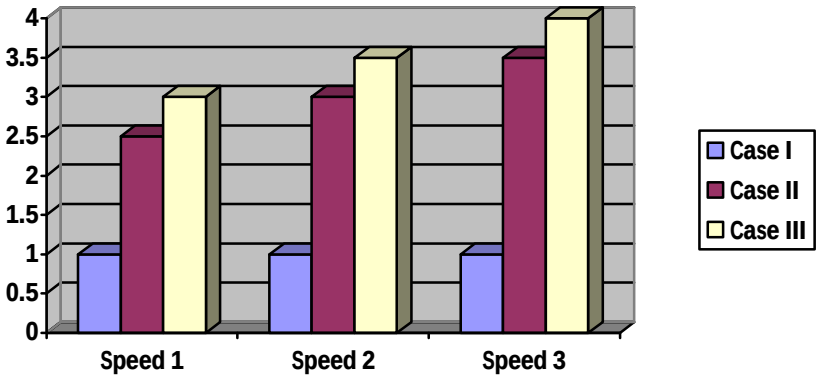

Figure 3: Variation of temperature w.r.t different conditions.

On the basis of above results, from figure 3 and table no. 1, we can find that, a temperature difference of about 4 ^{0}C can be obtained and the cooling system can be used as an artificial roof and provide an environmental friendly cooling system.

V. CONCLUSION

Passive solar energy-efficient building design should be replaced by the conventional air conditioning systems as they will help in the reduction of damage being caused to the nature because of the artificial methods. In today's crucial era of environment issues, our architects should involve the passive techniques as they will be one time investment but long time running equipments. Incorporation of these passive cooling techniques will increase our results in improving the environment conditions as well as utilizing the resources available naturally without any harm tour nature and other natural resources and hence will provide us a system which can be used for both cooling as well as heating purposes.

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.

With the Inclusion of PV panels on the roof can bring a temperature decrement of around 8^{0}C as well as the power thus generated will be utilized to run the air and water pumps with no extra cost as well as harm to the nature.

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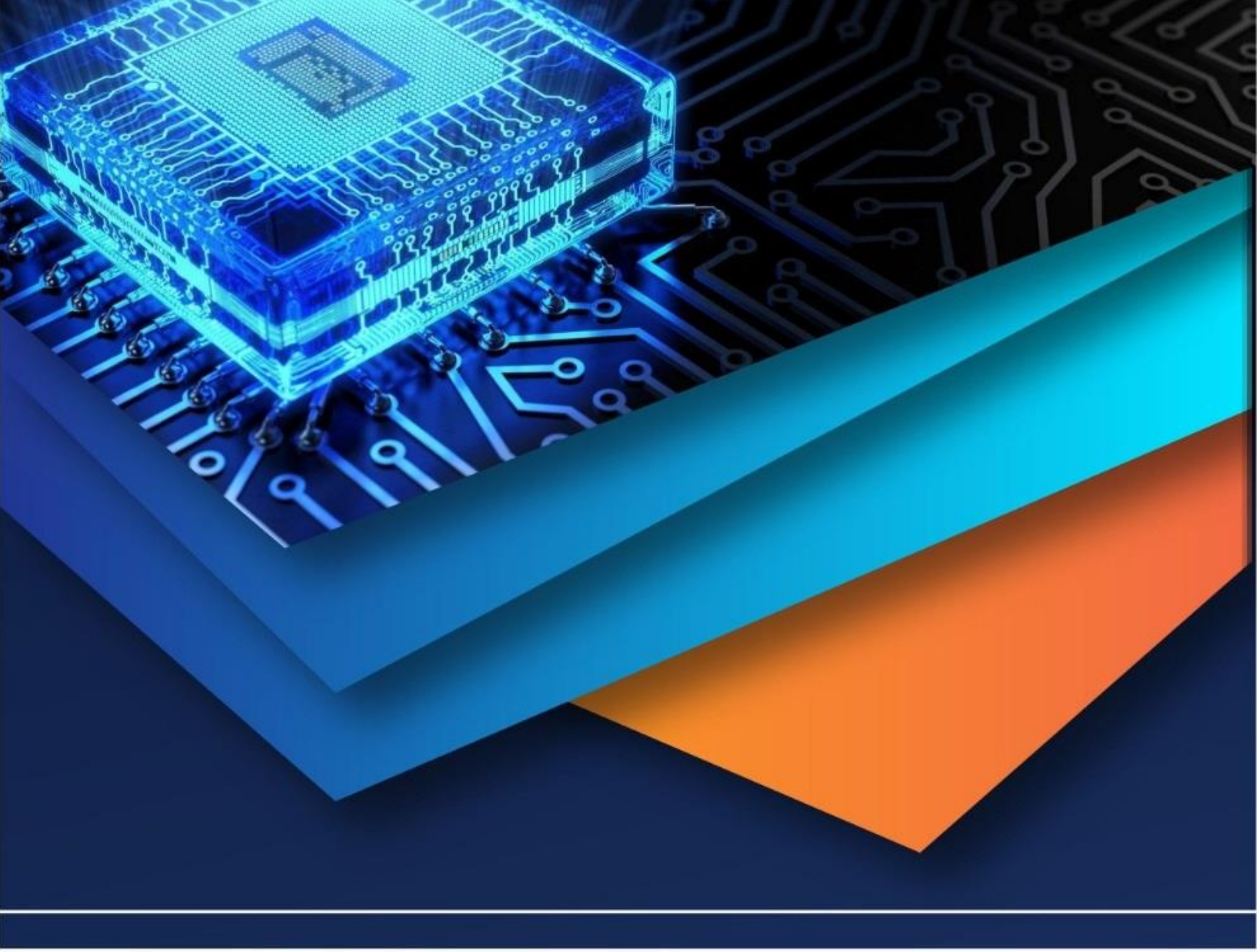

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