iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** XII **Month of publication:** December 2016

DOI:

www.ijraset.com

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Volume 4 Issue XII, December 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Solar Energy Application in Ventilation-A Review

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Abstract: Energy is being used in maintaining indoor environment clean and comfortable. Modern buildings are equipped with the gadgets making indoor environment comfortable to the occupants. There is huge electrical energy consumption associated with these electrical systems. Since the concern over depletion of conventional fuels and environmental impact on their usage is increasing globally, it is needed to search options for reduction of electrical energy usage in several applications. Passive design of buildings does not use the electrical and mechanical systems in providing comfortable indoor environment. In this paper the application of this strategy involving usage of ambient energy in the form of solar energy has been presented in natural ventilation of buildings and spaces. .
Keywords: Passive design, solar chimney, CFD

I. INTRODUCTION

In order to provide the indoor environment clean and comfortable, ventilation is needed. The ventilation requires the flow of air from the spaces removing contaminants and heat. There are two types of strategies followed in making the comfortable environment. They are active and passive design strategies. The active design strategy uses electrical energy in providing the comfortable environment. This strategy is being used in most of the modern building designs. Heating, Ventilation and air Conditioning (HVAC) systems, electric lights, heating and cooling panels are some of the examples of active design strategy of building. A huge consumption of electrical energy is involved in this approach.

The passive design strategy does not use the mechanical and electrical systems in providing comfort to the occupants of the building or space. This strategy uses the natural sources of energy such as solar energy in providing comfortable environment. This includes natural lighting and natural ventilation strategies. Hybrid systems are also being used in some building design strategies involving combination of active and passive design strategies.

II. VENTILATION

The ventilation is a process of removal of indoor air having pollutants and replacing it with the outside air. This is done to control the quality of the indoor air. The purpose of ventilations may also be to provide thermal comfort or dehumidification by achieving desired psychrometric conditions. There are basically three approaches of providing ventilation in a building or space. These are natural ventilation, artificial ventilation and mixed. Artificial or mechanical ventilation and mixed ventilation strategies use the electrical energy for their operation. The natural ventilation is achieved without the use of electrical and mechanical systems and therefore no electrical energy is required for their use.

III. SOLAR ENERGY

Solar energy is one of the types of renewable energy source. This energy is freely and abundantly available on the earth. Solar energy is being used globally in many applications such as residential heating, cooling, cooking, lighting etc. It is also of industrial use. The major usage of solar energy is in generation of electricity. Solar energy can also be used in establishing the flow due to the temperature difference.

IV. SOLAR CHIMNEY

Solar chimney has been used since centuries in providing natural ventilation in the buildings. In the simple form of a solar chimney, the air is heated with the help of solar radiations and an upward flow of air is produced due to suction created by it [1]. Although for the effective working of the solar chimney solar radiations must be available to provide heating. Engineers and designers are making efforts in finding ways of effective ventilation through the usage of solar chimney worldwide. There may be the following major parts of a solar chimney:

A. Solar energy collector area
B. The ventilation shaft, and

C. Openings for the air inlet and outlet.

Solar chimneys are often painted black to improve the absorption of solar radiations. When the solar radiations are absorbed by the absorber the heat so obtained is utilised in heating of air [4]. The hot air then provides the suction of cold air and flow of this air in the upward direction and thus enabling the ventilation. Figure 1 shows a line diagram of solar chimney concept.

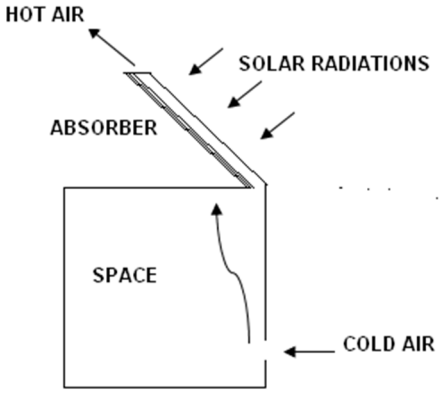

Figure1: Concept of solar chimney

V. SOLAR CHIMNEY STUDIES

Studies on solar chimney technology have been carried out by the researchers globally. These studies include theoretical, experimental and numerical studies. These studies are based on the design concepts of solar chimney, operational parameters, performance and economic aspects of solar chimney.

A set up of solar chimney was built in Florid in 1997 [13]. The chimney was 7.92 m high of diameter 2.44 m at inlet and gradually decreasing to 0.61 m at the top with Laxan roof which was covered collector of 9.15 m diameter. The study was performed on three types of collectors as Type I, Type II and Type III for different material of the collector and arrangement and size of collector. The temperature rise found by them in different cases was 15 °C, 25 °C and 28 °C in Type I, Type II and Type III respectively.

Solar chimney power plant as an option of power generation with the use of renewable energy source has also been developed. The power generation through this technology involves green house, solar energy collector and wind turbine. It has severable potential advantages over conventional technologies involving fissile fuels. The solar radiations in both the forms of direct and diffused can be utilised, no cooling water requirement are the key advantages of this technology of power generation [14].

A small prototype was built in the campus of RMIT University, Bundoora, Australia in 2002. This prototype was having a experimental solar pond of approximate diameter of 4.2 m with depth of 1.85 m. The solar chimney was 8 m high and 0.35 m in diameter [15] & [16]. The results of measurements showed the temperature rise of entering air from 17 C to 28 C at exit. The velocity of air flow measured was 1 m/s.

VI. CONCLUSION

Use of renewable energy in passive building design is the need of the modern buildings. This provides our environment clean and comfortable without the cost of electricity. This paper provides the use of solar energy in ventilation of buildings and spaces. The strategy of ventilation through solar energy is based on the heating of the air with the use of solar radiations. The temperature difference between the air entering the space and that leaving the space produces draft. This draft removes the indoor air and the indoor environment is ventilated. No need of electricity in the solar chimney reduces the overall consumption of energy of conventional form and save the environment also. The literature reviewed and presented in this paper shows that the worldwide concern over application of solar chimney in ventilation and electricity generation is increasing. Numerical study with the use of Computational Fluid Dynamics (CFD) may also be implemented to design and predict the performance of solar chimney.

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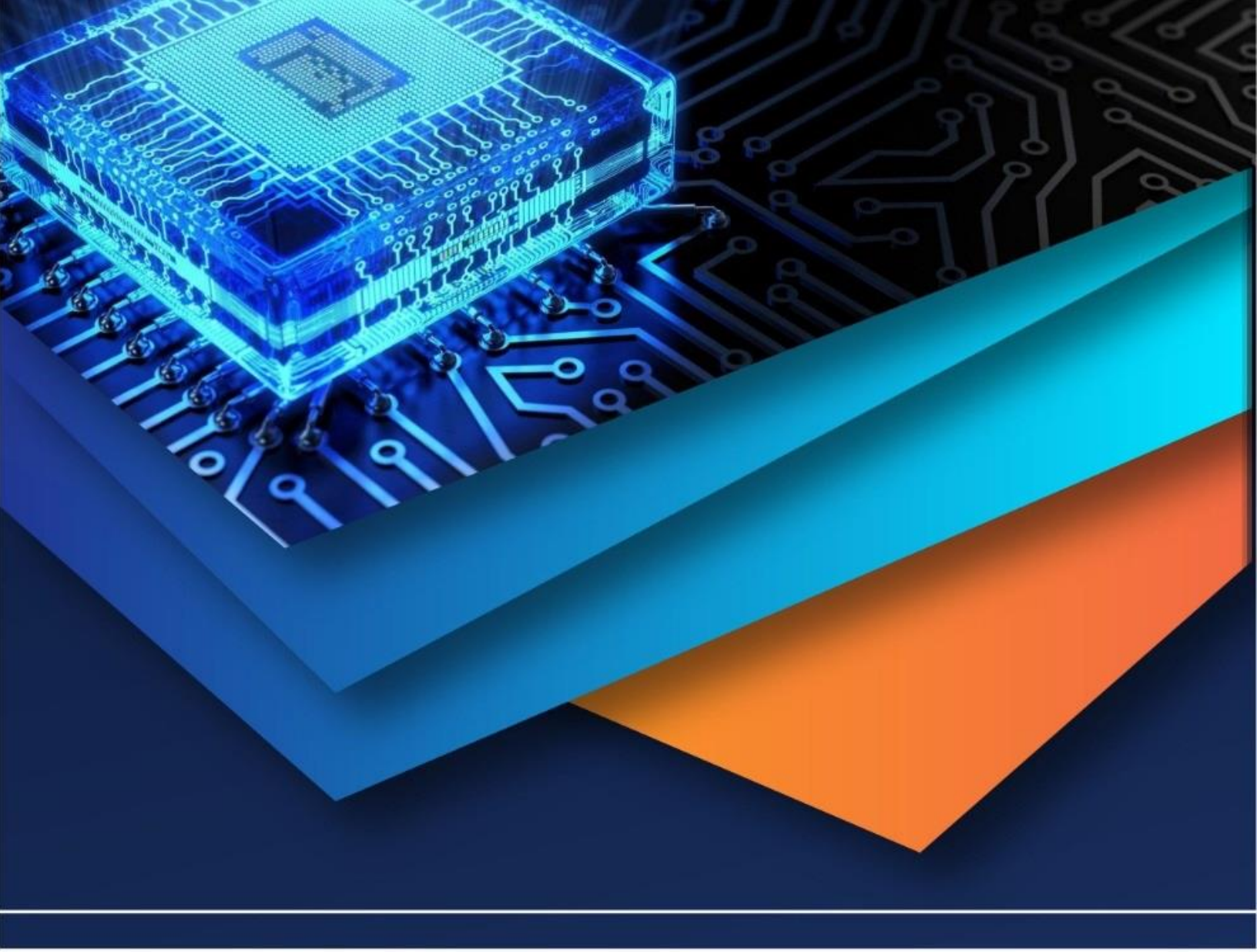

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