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CFD ANALYSIS OF SOLAR OPERATED EARTHEN POTAIR COOLER

C.V. Papade
Mechanical Engineering Department, DBATU University, Lonere
N. K. Orchid Collage of Engineering & Technology, Solapur, Maharashtra, India
cvpapade@gmail.com
Shubham Bollu
Mechanical Engineering Department, DBATU University, Lonere
N. K. Orchid Collage of Engineering & Technology,
Solapur, Maharashtra, India
Sagar Isargunde
Mechanical Engineering Department, DBATU University, Lonere
N. K. Orchid Collage of Engineering & Technology, Solapur, Maharashtra, India
Onkar Pawar
Mechanical Engineering Department, DBATU University, Lonere
N. K. Orchid Collage of Engineering & Technology, Solapur, Maharashtra, India
Vijaykant Swami
Mechanical Engineering Department, DBATU University, Lonere
N. K. Orchid Collage of Engineering & Technology, Solapur, Maharashtra, India

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Abstract: The present air-ventilation methods are evaporative coolers, air conditioning, fans. But running these products need high-rate electricity. The production of electricity is ultimately responsible for hot and humid conditions i.e., global warming. In hot and humid conditions, the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut duration and the high cost of products. Solar power systems being considered as one of the paths towards more sustainable energy systems, considering solar cooling systems in villages would comprise of many attractive features. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air-cooling technology suited to residential. This research CFD analysis of solar operated earthen pot air cooler for domestic applications. Velocity airflow within the Earthen Pot in that air velocity has been increased with reducing the pressure results the temperature variation. In Temperature contour the temperature rate reduces with 8 to 10 OC of room temperature and the analysis gives the temperature difference and air velocity variations.

Keywords: analysis solar cfd operated earthen

I. INTRODUCTION

This research paper reveals the comfort conditions achieved by the device for the human body. In summer (hot) and humid conditions feel uncomfortable because of hot weather and heavy humidity. So, it is necessary to maintain thermal comfort conditions. Thermal comfort is determined by the room's temperature, humidity and air speed. Radiant heat (hot surfaces) or radiant heat loss (cold surfaces) are also important factors for thermal comfort. Relative humidity (RH) is a measure of the moisture in the air, compared to the potential saturation level.

Warmer air can hold more moisture. When you approach 100% humidity, the air moisture condenses – this is called the dew point. The temperature in a building is based on the outside temperature and sun loading plus whatever heating or cooling is added by the HVAC or other heating and cooling sources. Room occupants also add heat to the room since the normal body temperature is much higher than the room temperature. Need of such a source which is abundantly available in nature, which does not impose any bad effects on earth. There is only one thing which can come up with these all problems is solar energy. After analysing this project, the result gives us change in room temperature. The temperature falls down nearly 8-10 ^{O}C which feels comfort to human body.

II. LITERATURE REVIEW

Farhan a. khmamas.[1]:has Improving the environmental cooling for air-coolers by using the indirect-cooling method and also simplified the design and development solar air cooler for different applications. A S Alosaimy[2]: has study application of evaporative air coolers coupled with solar water heater for dehumidification of indoor air also simplified encapsulation of solar cells using glass fibre reinforced polymers. This paper describes the various process used to encapsulate solar cells is explained and from the test results [3].J.K..Jain et al. [4]: have worked on development and testing of regenerative evaporative coolermechanical behaviour. Chetan Papade et al. [5]: have worked on the use of solar dehydration system is limited because of drying is not possible due to frequent clouds in the day or in the evening. If storage of solar energy can provide in solar system, then there are the possibilities of evening time working.Chetan Papade et al. [6]: have worked on performance of an air conditioning system with and without a nanorefrigerant. R134a is most widely adopted alternate refrigerant in refrigeration equipment, such as domestic refrigerators and air conditioners.

III. DESIGN OF SOLAR OPERATED EARTHEN POT AIR COOLER

This research is basically designed for domestic purpose. It reduces temperature of room. Components considered while analysing & designing the system.

Solar Panel- Solar panel which is acting as energy consumer from the sun and it is relevant component which is works on natural energy to reduce global warming. Solar panel is connected to battery which is main energy storage device. It stores the energy in form of DC, then this energy further transfers to inverter.

Inverter- It is the device which converts direct current to alternate current. It helps to stabilize the current. It protects the device variations in current. Generally domestic appliances need alternate current.Moreover, the alternate current passed towards controller. Controller is device which controls the variations of current which passes towards the fan. Afterwards fan acts as air medium which is generate air in mud pot. And mud pot is water storage as well as cooling unit. It is generally porous in nature so it helps to reduce the room temperature.

Battery- A battery is device that stores chemical energy and converts it into electrical energy. The chemical reactions in battery involve flow of electrons from one material (electrode) to another, through and external circuit. The flow of electrons provides an electric current that can be used to do work to balance the flow of electron

Fan- For the purpose of air circulation in Earthen Pot, we are using this fan for generating cooling effect to reduce the room temperature. This fan is usually working on AC supply and that supply is given from a Solar panel > Battery > Inverter > Control Unit > Fan.

Earthen Pot- Earthen pot is made up of Slurry Soil made by Craftsman according to our requirements of size and shape. But in this purpose, we are using standard size of earthen pot that is 14-20 litters of water capacity, and this mud pot acts as main component in this project. As well as it works as main cooling medium of this project

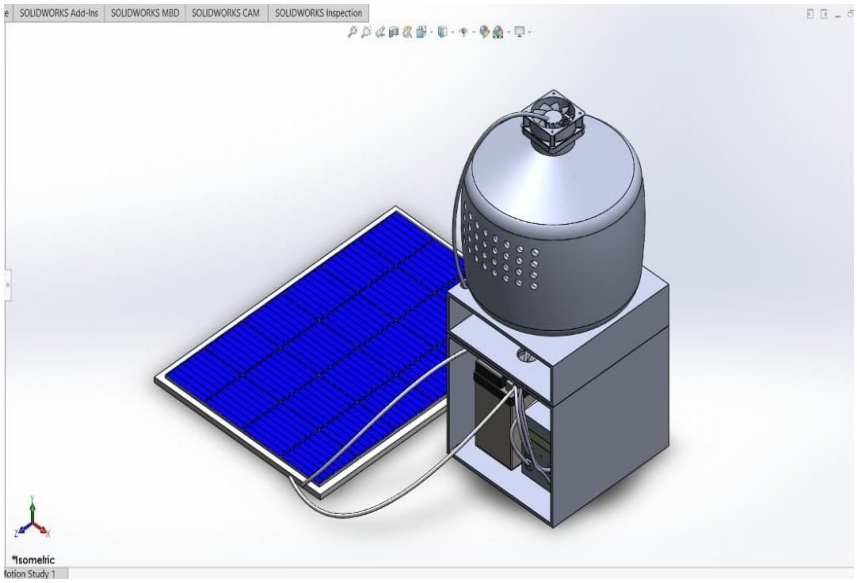

Fig.1 Setup of Solar Operated Earthen Pot Air Cooler

In actual working, there is going to fill the mud pot with water below the ventilation holes, then solar panel consumes sunlight through solar cells. Then this energy will transfer towards battery in the form of DC supply. This DC energy further supply to inverter which alter the energy to AC supply. Then it sends towards the controller (control switch) and it forwards the required amount of current to next system which is fan, then fan starts rotating this results air is generate. Eventually, after the air generation that air will comes in contact with water & water will get converted into small droplets. These small droplets get mix with the air, this mixed air throws outside by given holes. simultaneously outside air gets entered into mud pot which cools the inside stored water which results it delivers chilled air to room. This feels human more comfort in affordable

Heat transfer between water and the air is given by following equation,

$M_w*(T_1-T_2) = v/vs_1[(ha_1-ha_2) -(w_1-w_2) T_2)$ ..... (1)

$V = 2.291\ m^3$ /min ~ 2.5 m3 / min

The fan capacity is 2.5 m^3 / min is selected

Where,

M_w – Mass of water entering in to the mud pot per minute. V – volume of air (m^3) entering into the room per minute V_s – Specific volume of air entering into the cooling room. ha – Enthalpy per kg of dry air at T_1 ha_2 – Enthalpy per kg of dry air at T_2 w_1 - Mass of water vapor per kg of dry air at T_1 w_2 – Mass of water vapor per kg of dry air at T_2

M_w = Mass of water per minute (assume)

Design for solar panel and battery

Fan specification: 220v ,50Hz, 35W, 1400 rpm , 0.35 Amps

Fan Capacity:

$P = (V) * (I)$ ..... (2)

$P = 480$ wh

Fan Runs Given By,

hr. = (P) / (Fan capacity) ..... (3)

13.71 ~14h

To calculate the energy, it can supply to the battery, multiply watts by the hours exposed to sun light, then multiply the result by 0.85(this factor allows for natural system losses)

E= (P) * (hr.) * (system losses) ..... (4)

Material used: Polycrystalline, Capacity: 40 Watt-12 Volt, Output voltage: 12, Length of panel: 40 cm, Width of panel: 65 cm, Weight of panel: 2 Kg

Battery capacity: 12v-10Ah

Inverter: Weight: 15 Kg 800 g / Capacity: 12 Volt

IV. RESULT AND DISCUSSION

After getting the result to reduce the 10*10 room temperature, by using solar panel capacity of 40-watt 12 volt which is having weight 2 kg. For consuming the energy from the sun. This energy can be stored in 12-volt battery. To run the 220-volt fan it requires AC supply which is converted by inverter capacity of 12 volt.This all parameters from the given components which helps to reduce room temperature in summer with 8 to 10 ^{O}C.

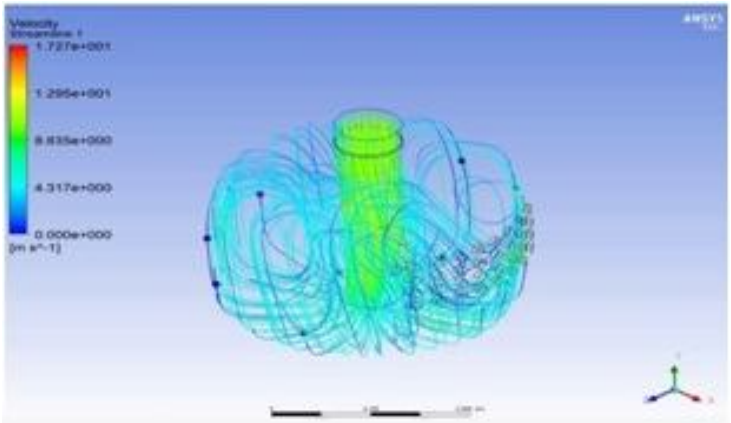

Fig. 2 Velocity Air Flow

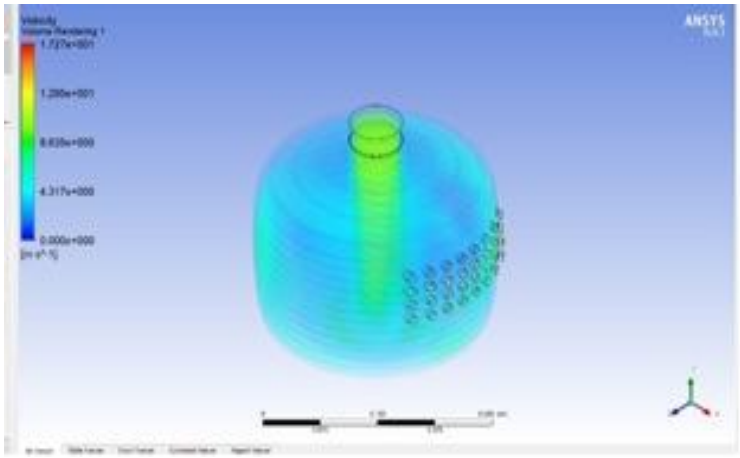

Fig.3 Velocity Rendering

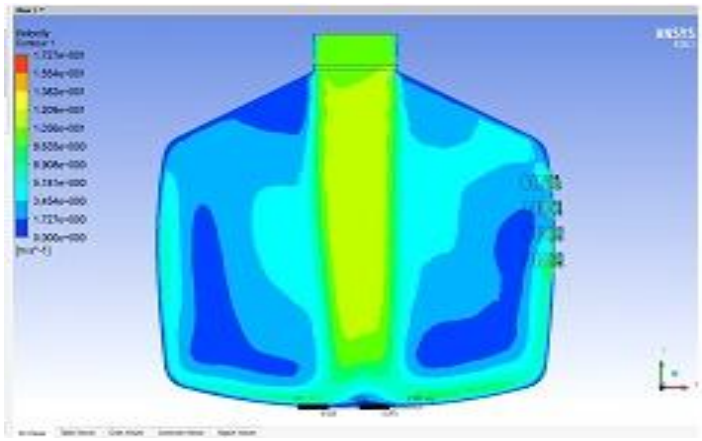

Fig.4 Temperature Contour

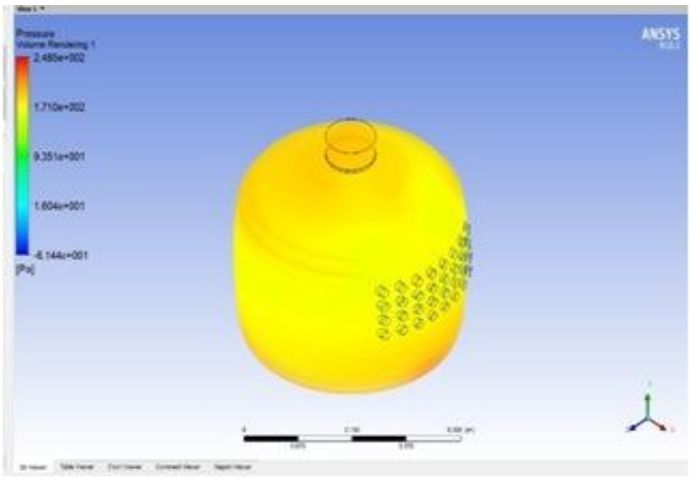

Fig.5 Pressure Volume Rendering

Above figures shows CFD analysis of Earthen Pot with respect to room temperature. The figure of velocity air flow within the Earthen Pot in that air velocity has been increased with reducing the pressure results the temperature variation. In Temperature Contour the temperature rate reduces with 8 to 10 ^{O}C of room temperature and the analysis gives the temperature difference and air velocity variations.

V. CONCLUSION

Comparing the cost of this product with the existing products in the market is solar product appeals better and affordable by common people. This solar product perfectly suits for villages, schools and offices and thus an alternate to the power cut problems. It comprises of many attractive features such as usage of solar energy, cooler and cooling cabin at lower cost. It is eco-friendly and natural, electricity savers. Durability of the product is more thus minimizing the cost. No electricity is used so this product saves the energy and saves environment from getting polluted.CFD analysis is done. Which helps to reduce room temperature in summer with 8 to 10 ^{O}C.

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REFERENCE

1. F. A. khmamas, "Improving the environmental cooling for air-coolers by using the indirect-cooling method" ARPN journal of engineering and applied sciences, vol. 5, No. 2, pp. 66-73. 2012.
2. A.S Alosaimy,"Application of Evaporative Air Coolers Coupled With Solar Water Heater for Dehumidification of Indoor Air" International Journal of Mechanical & Mechatronics Engineering, Vol:13 No:01,pp. 60- 68,2013.
3. "Basic Photovoltaic Principles and Methods" SERI/SP290-1448 Solar Information Module 6213 Published February 1982 pp. No. 09-15.1982.
4. J.K..Jain and Hindoliya D.A, "Development and Testing of Regenerative Evaporative Cooler", International Journal of Engineering Trends and Technology, Vol.3, No. 6, Pp 694-697,2012
5. C. V Papade, M. A Boda,"Design and development of indirect type solar dryer with energy storing material", International Journal of Innovative Research in Advanced Engineering, Vol.1, pp109-114,2014.
6. C.V.Papade, R.S.Wale, "Performance improvement of air conditioning system by using nano refrigerant Engineering, International Journal of Advances in Engineering ResearchVol.1,0 ISSN: 2231-5152,2010.