Thermal Analysis of Clay Pot

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Abstract— **Cooling through evaporation is an ancient effective method of lowering temperature. The simple clay pot refrigerator is ideally suited for preserving vegetarian food and water in hot and dry climates. The refrigeration takes place by evaporation through the porous pot material. The present work includes experimental analysis of a clay pot by varying height of water in the pot and by subjecting the clay pot for free and forced convection. Results obtained from experimental analysis shows that Temperature T1 remains almost same when clay pot is filled with 1.5 and 4.5 liters of water and Temperature T1 is highest when the wind speed is 0 m/s and lowest when wind speed is 4.4 m/s.**

Keywords-vaporation,Refrigeration,Temperature,Porous,Free and forced convection

I. INTRODUCTION

Cooling through evaporation is an ancient and effective method of lowering temperature. Both plants and animals use this method to lower their temperature. Trees, through the method of Eva transpiration remain cooler than their environment. [5]

The principle underlying evaporative cooling is conversion of sensible heat to latent heat. The warm and dry outdoor air is forced through porous wall or wetted pads that are replenished with water from cooler's reservoir. Due to low humidity of the incoming air some of the water gets evaporated. Some of the sensible heat of the air is transferred to water and become latent by evaporating some of water. The latent heat follows the water vapor and diffuses into the air. Evaporation causes a drop in the dry-bulb temperature and a rise in the relative humidity of the air. [1]- [7]

Evaporative cooling is dependent on the condition of the air and it is necessary to determine the weather condition that may be encountered to properly evaluate the possible effectiveness of evaporative cooler. On the other hand, the amount of water vapor that can be taken up and held by the air is not constant: it depends on two factors: the first is the temperature of the air, which determines the potential of the air to take up and hold vapor. The second involves the availability of water: if little or no water is present, the air will be unable to take up more amount of water. [5]

An evaporative cooler is made up of a porous material that is fed with water. Hot dry air is drawn over the material. The water evaporates into the air raising the humidity and at the same time reducing the temperature of the air. [5]

The different type of evaporative cooler designs under review includes pot-in-pot, cabinet, statics, and charcoal cooling chamber. The gap between them is either filled with jute, damp cloth, or sand .Water is linked to the cooler at the top, thus keeping chamber cooled. [5]

In literature cited above it was found that experimental analysis has not been carried out on clay pot under forced and free convection environment.

In the present study experimental analysis of a clay pot has been carried out by varying height of water and by varying the wind speed in the range of 0 to 4 .4 m/s.

II. DESCRIPTION OF CLAY POT

The clay pot refrigerator is designed with locally available material that is clay which is excavated from a nearby stream and before casting of its structure it was mixed thoroughly with water to increase its plasticity. The clay was chosen because of its low conductivity of heat and porosity. It is very cheap and abundantly available. The pots are cylindrical in shape and are made by using wheel. Fig 1 and 2 shows the description of clay pot. Clay pot of dimension 16cm in diameter, 31cm in height and thickness of wall 0.6cm is used for analysis. The top and bottom surface of clay pot are insulated using thermo Cole.

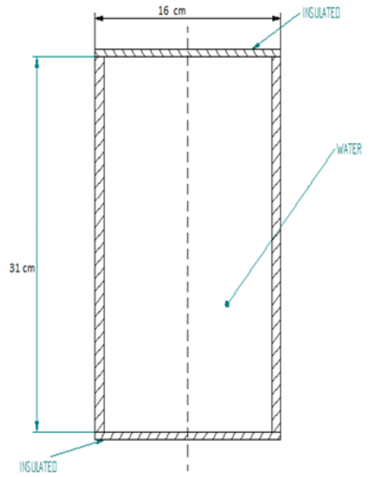

Fig 1: Schematic clay pot

Fig 2: A prototyped developed clay pot

III. EXPERIMENTAL SETUP

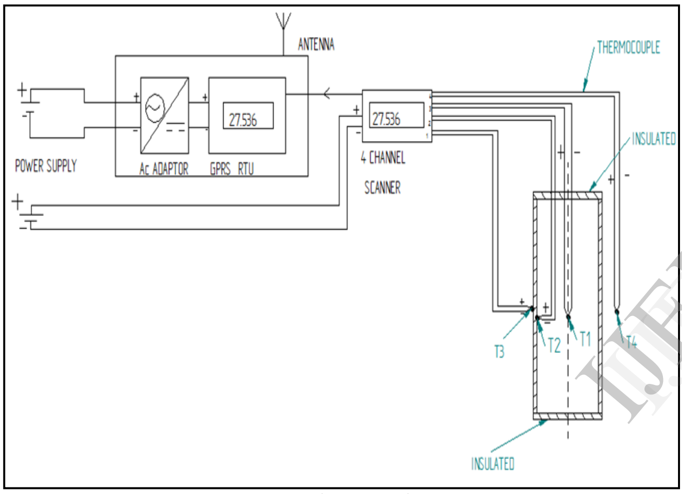

Fig 3: Experimental setup of clay pot for natural convection

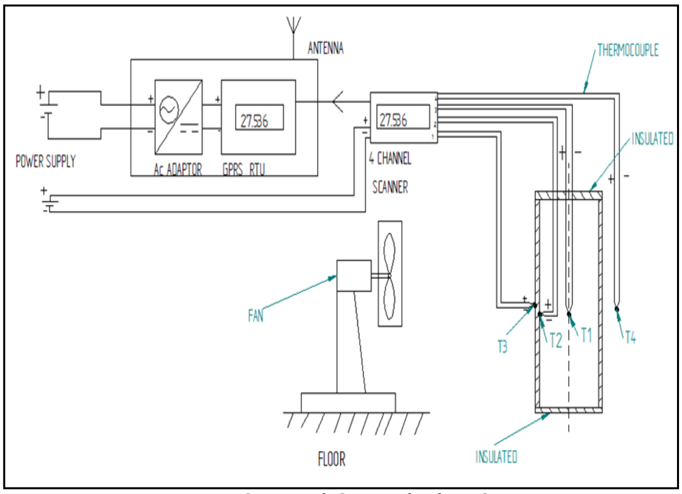

Fig 4: Experimental setup of clay pot for forced convection

Fig 3 shows the experimental setup of a clay pot which is kept for natural convection. It consists of a clay pot, thermocouples (T1, T2, T3 and T4), 4 channel scanner, GPRS RTU, AC adaptor, and a power supply. Thermocouple T1 with a reading accuracy 1°C from 0 to 100°C and % F.S. error +/- 0.6 % F is used to measure the temperature at the of centre of the clay pot, T2 is used to measure inner wall temperature of the clay pot, T3 is used to measure outer wall temperature of the clay pot and T4 is used to measure the temperature of the air at a distance slight away from the clay pot. 4 channel scanner with reading accuracy ±0.1% of FS ±1 Count scans and display the temperature which is sensed by the thermocouple. It consists of a voltmeter which converts small voltage variation into temperature. Serial Communication with RS 485 is also provided for the scanner through which data of temperature are sent to GPRS RTU.

GPRS connected Remote Terminal Unit which has been used in experiment monitors the analog inputs like temperature from various sensors and also does all the signal processing and digitizes the signal. The collected data using GPRS RTU are sent to cloud through secured protocol using GPRS technology; we can view and download sensor wise analytic and graphs on centralized monitoring system using desktops, laptops, mobiles etc. anywhere and anytime. Experiment is conducted and data's are collected by varying quantity of water in the clay pot. Dry bulb and wet bulb temperature of the atmosphere at regular interval of time is measured by using psychrometer having 20°F to 120°F measuring range.

Fig 4 shows the experimental setup of a clay pot which is kept for forced convection. The experimental setup is similar to natural convection but in this case experiment is conducted and data's are collected by varying velocity of air which is blown by the fan kept at a distance of 1.5 meter from the clay pot. Velocity of the wind is measured by using digital vane type anemometer with a reading accuracy of ± (2% +1d).

IV. RESULTS AND DISCUSSION

By using the same pot in all cases, the size of the pores in the clay, as well as thickness of its wall are held constant.

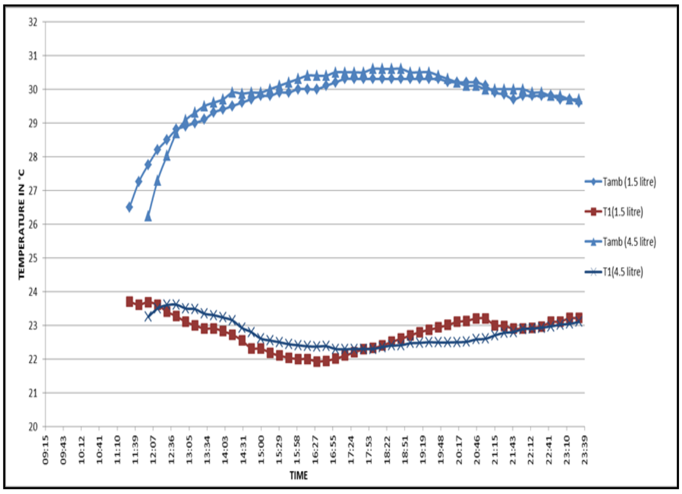

Fig 5: Variation of Temperature T1 with height

Investigation is carried out by varying height of water in the clay pot by 1.5, 2.5, 3.5 and 4.5 liters. Where in all cases clay pot is kept for natural convection. Fig 5 shows the variation of temperature T1 when clay pot is filled with 1.5 and 4.5 liters of water. WhereT1 is the temperature at the center of the pot and T_{amb} is an ambient temperature. Graphs shows that temperature T1 remains same for both the cases that is when clay pot is filled with 1.5 and 4.5 liters of water. The main advantage of this observation is water in the clay pot can be cooled to same temperature irrespective of its load.

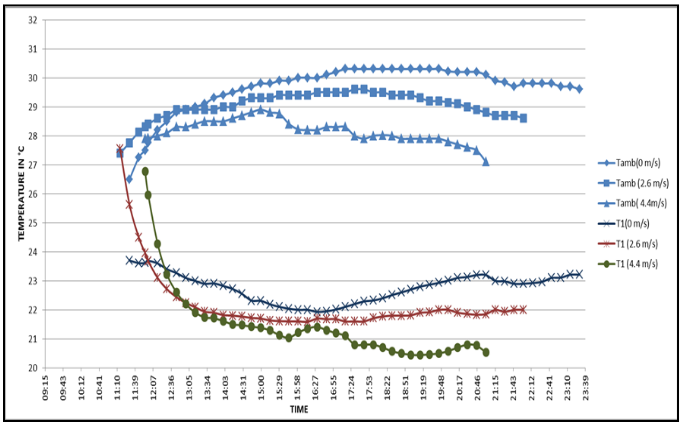

Fig 6: Variation of Temperature T1 with wind speed

Experimental analysis is done by varying wind speed by 0, 2.6, 3.4 and 4.4 m/s. Water in the clay pot is 1.5litres and it is constant for all the cases. FIG 5 shows the variation of T1 with wind speed. From the graph it can be observed that temperature T1 is highest when the wind speed is 0 m/s and lowest when wind speed is 4.4 m/s this is because of low rate of evaporation during natural convection and high rate of evaporation during forced convection. From graph we can also observe that temperature T1 at the end of the experiment increases when clay pot is kept for natural convection and remains lower when it is kept for forced convection because of high rate of evaporation.

V. CONCLUSIONS

Experimental analysis of a clay pot has been carried out by varying height of water in the pot and by subjecting the clay pot for free and forced convection. The following conclusions have been drawn.

1.) Water in the clay pot can be cooled to same temperature irrespective of its load.

2.) Temperature T1 is highest when the wind speed is 0 m/s and lowest when wind speed is 4.4 m/s for a clay pot indicating the effect of forced convection.

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