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Bamboo based Cooler

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Abstract- *The basic concept of water cooling is to find a medium that can handle and transport heat more efficiently than air. Water has a very ability to retain heat, in the meantime stay in a liquid form.Due to global warming there is a continuous rise in temperature of earth and to overcome such difficulty air cooler or air conditioning is the better option. But the cost of air conditioning system is high and to overcome this, a cooler is developed which is based on material available in nature such as bamboo. The objective of present work is to develop the bamboo based cooler.Concept of an air cooler with additional separate fan is to spread the water into the air for cooling. Air cooler with separate fan is selected for final concept. Color can be chosen to its application to make it aesthetically good. A working model of final concept is made using bamboo.*

Keywords- *Bamboo based cooler, naturally available material, Mechanical, Evaporative cooling, Green technology*

I. INTRODUCTION

Air cooler is one of the devices that keep the atmosphere cool.The basic idea of water cooler of to find the medium that can handle and transport heat more efficiently than air. Evaporative cooling is based on a physical phenomenon in which evaporation of a liquid into surrounding air cools an object or a liquid in contact with it. As the liquid turns to gas, the phase change absorbs heat. Water is an excellent coolant because it is nontoxic, and evaporates easily in most climates.

Evaporative cooler is a device that cools air through evaporation of water. Evaporative cooling differs from typical air conditioning systems, which use vapor-compression or absorption refrigeration cycles. Evaporative cooling works by exploiting water's large enthalpy of vaporization. The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapor (evaporation). This can cool air using much less energy than refrigeration. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants.

The cooling potential for evaporative cooling is dependent on the wet bulb depression, the difference between dry-bulb temperature and wet-bulb temperature. In arid climates, evaporative cooling can reduce energy consumption and total equipment for conditioning as an alternative to compressor-based cooling. In climates not considered arid, indirect evaporative cooling can still take advantage of the evaporative cooling process without increasing humidity.

II. BRIEF LITERATURE REVIEW

R. Boukhanouf, H. G. Ibrahim, A. Alharbi, and M. Kanzari (2014) studied the experimental results of a sub-wet bulb temperature evaporative cooling system for space cooling in buildings in hot and dry climates.

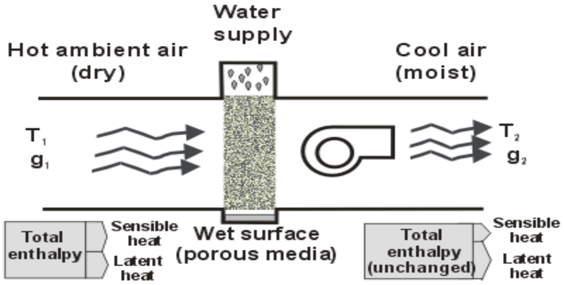


Fig 1. Schematic of a direct evaporative cooling system

Sirelkhatim K. Abbouda, and Emad A. Almuhanna (2012) developed two stage evaporative cooling and the system environmentally clean and energy efficient system, which considered as an alternative to the mechanical, vapour compression systems

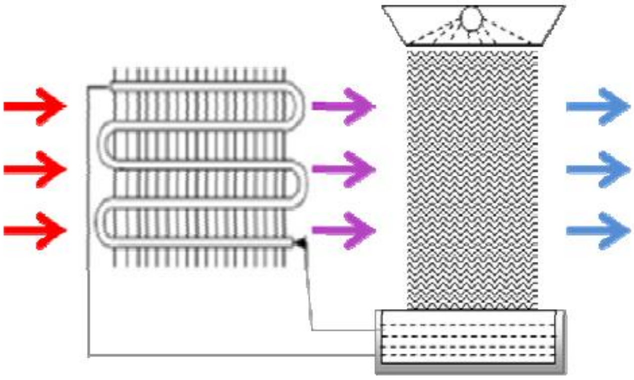


Fig. 2. Schematic diagram of combining cooling system included cooling coil unit (CCU) and direct evaporative cooling system (DEC)

O. Amer, R. Boukhanouf, and H. G. Ibrahim (2015)reviewed the research carried out by other researchers in the area of evaporative cooling.

E. Velasco Gómez, F.C. Rey Martínez, A. Tejero González (2010) suggested the thermodynamic analysis of evaporative cooling also proposed three different experimental devices based in evaporative cooling are described.

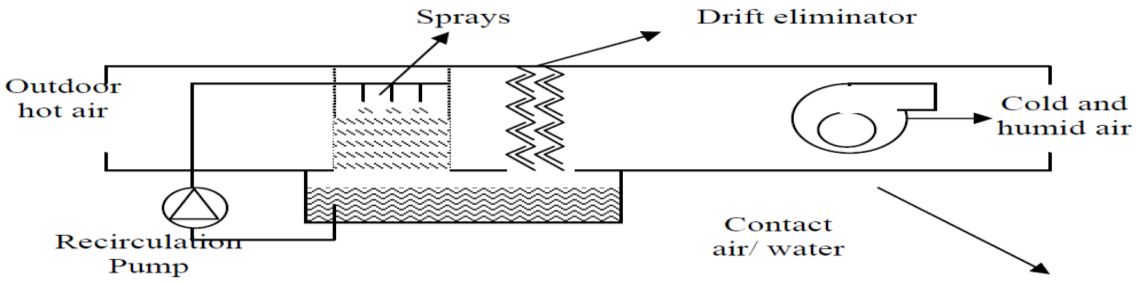


Fig. 3 Direct pulverization evaporative cooler

III. OBJECTIVE

- To make aware of non-conventional energy sources to reduce environmental pollutions.
- To provide solution for power cut problems in villages.
- To replace existing costlier and high energy consumption cooling methods.
- Hence main emphasis of this study is to redesign and improve air cooler and simplicity in design with little adjustments.
- So the finally the objective of present work is not only to develop an air cooler which is moisture free but it is efficient too in terms of cooling and cost.

Psychometric Processes

In the domestic and industrial air conditioning applications some psychometric processes have to be performed on the air to change the psychometric properties of air so as to obtain certain values of temperature and humidity of air within the enclosed space. Some of the common psychometric processes carried out on air are: sensible heating and cooling of air, humidification and dehumidification of air, mixing of various streams of air, or there may be combinations of the various processes.

Illustrating and analyzing the psychometric properties and psychometric processes by using the psychometric chart is very easy, convenient and time saving. In the next few paragraphs we shall see some of the most commonly employed psychometric processes in the field of HVAC and how they are represented on the psychometric chart.

1. Dry bulb temperature lines: The dry bulb temperature lines are vertical i.e. parallel to theordinate and uniformly spaced. Generally, the temperature range of these lineson psychometric charts is from -6ºC to 45ºC. The dry bulb temperature lines are drawn with difference of every 5ºC and up to the saturation curve as shown in the figure. The values of dry bulb temperatures are shown on the saturation curve.

2. Specific humidity or moisture content lines: The specific humidity (moisture content) lines are horizontal i.e. parallel to the abscissa and are also uniformly spaced. Generally, moisture content range of these lines on psychometric chart is from 0 to 30 g / kg of dry air (or from 0 to 0.030 kg / kg of dry air). The moisture content lines are drawn with a difference of every 1 g (0.001 kg) and up to the saturation curve.

3. Dew point temperature lines: The dew point temperature lines are horizontal i.e. parallel to the abscissa and non-uniformly spaced. At any point on the saturation curve, the dry bulb and dew point temperatures are equal.

4.Wet bulb temperature lines: The wet bulb temperature lines are inclined straight lines and non-uniformly space . At any point on the saturation curve, the dry bulb and wet bulb temperatures are equal.

5. Enthalpy (total heat) lines: The enthalpy (or total heat) lines are inclined straight lines and uniformly spaced. These lines are parallel to the wet bulb temperature lines, and are drawn up to the saturation curve. Some of these lines coincide with the wet bulb temperature lines also.

6. Specific volume lines: The specific volume lines are obliquely inclined straight lines and uniformly spaced. These lines are drawn up to the saturation curve.

7. Relative humidity lines: The relative humidity lines are curved and follow the saturation curve. Generally, these lines are drawn with values of relative humidity 10%, 20%, 30% etc. and up to100%. The saturation curve presents 100% relative humidity.

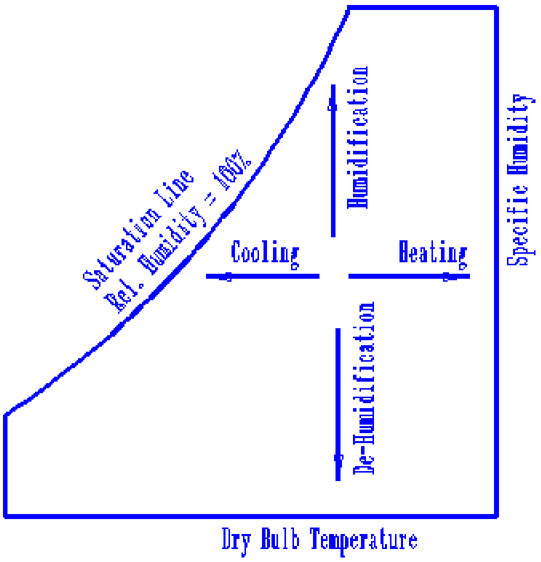


Fig 4 Psychometric Processes

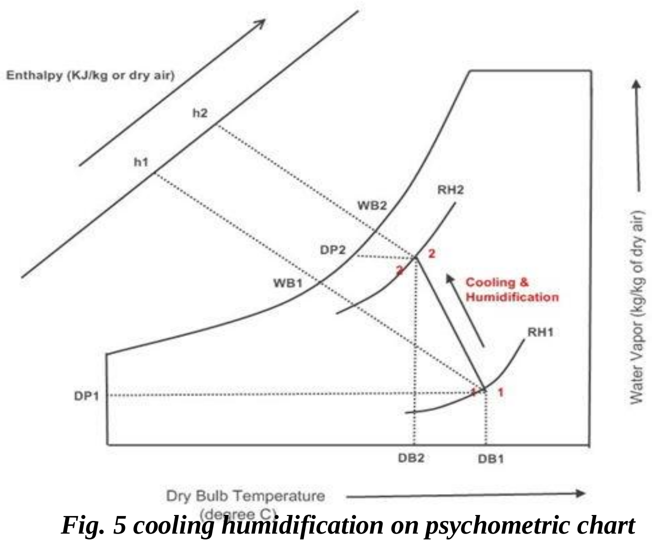


Fig. 5 cooling humidification on psychometric chart

HUMIDIFICATION:

Humidification is the artificial regulation of humidity in home environments, industrial environments, and health care applications such as artificial respiration. To be comfortable, people require a certain amount of ambient moisture in the air — not too high, and not too low. Adequate humidification in a manufacturing environment stabilizes moisture in wood, paper, and textiles, while preventing warping in glue joints. In all environments, it reduces fire risk and static while making the area feel comfortable.

Humidification is simply the addition of water to air. However, humidity exerts a powerful influence on environmental and physiological factors. Improper humidity levels (either too high or too low) can cause discomfort for people and damage many kinds of equipment and materials. Conversely, the proper type of humidification equipment can helps to achieve effective, economical and trouble-free control of humidity.

Dry air can cause a variety of costly, troublesome and sometimes dangerous problems, especially when you are processing or handling hygroscopic materials such as wood, paper, textile fibers, leather or chemicals. Dry air or fluctuating humidity can cause serious production problems or material deterioration.

A humidifier is a device that increases humidity (moisture) in a single room or an entire building. Industrial humidifiers are used when a specific humidity level must be maintained to prevent static electricity build up, preserve material properties, and ensure a comfortable and healthy environment for workers or residents.

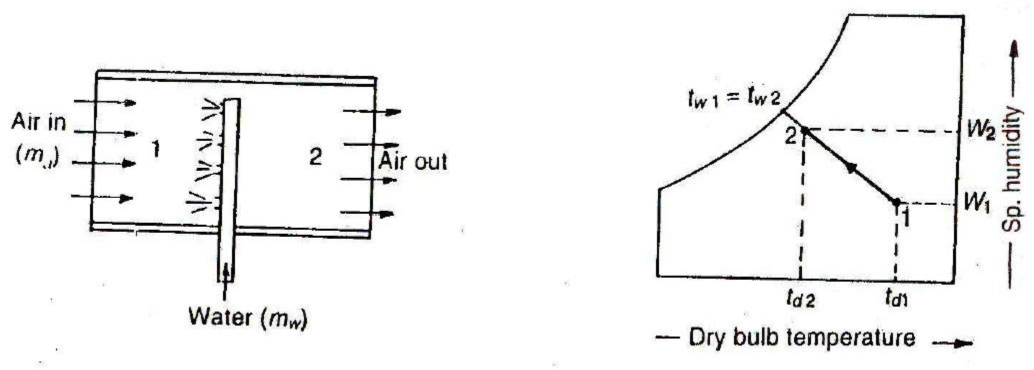


Fig. 6 Cooling and Humidification by water injection

Cooling and Humidification by Water Injection (Evaporative Cooling)

Let water at a temperature tl is injected into the flowing stream of dry air as shown in Fig.1.6.The final condition of air depends upon the amount of water evaporation. When the water is injected at the temperature equal to the wet bulb temperature of the entering air (t_{w1}), then the process follows the path of constant wet bulb temperature line, as shown by the line 1-2.

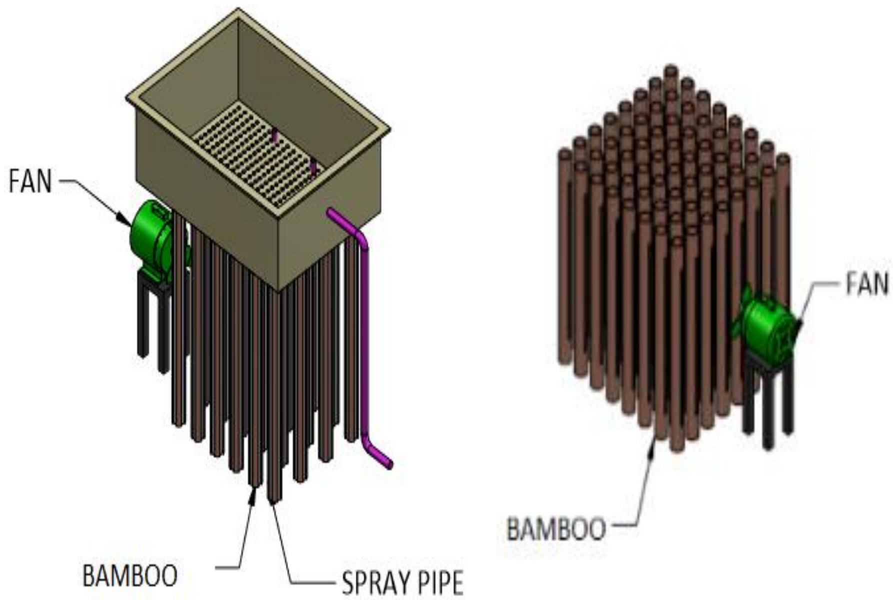


Figure. 7 3D Model

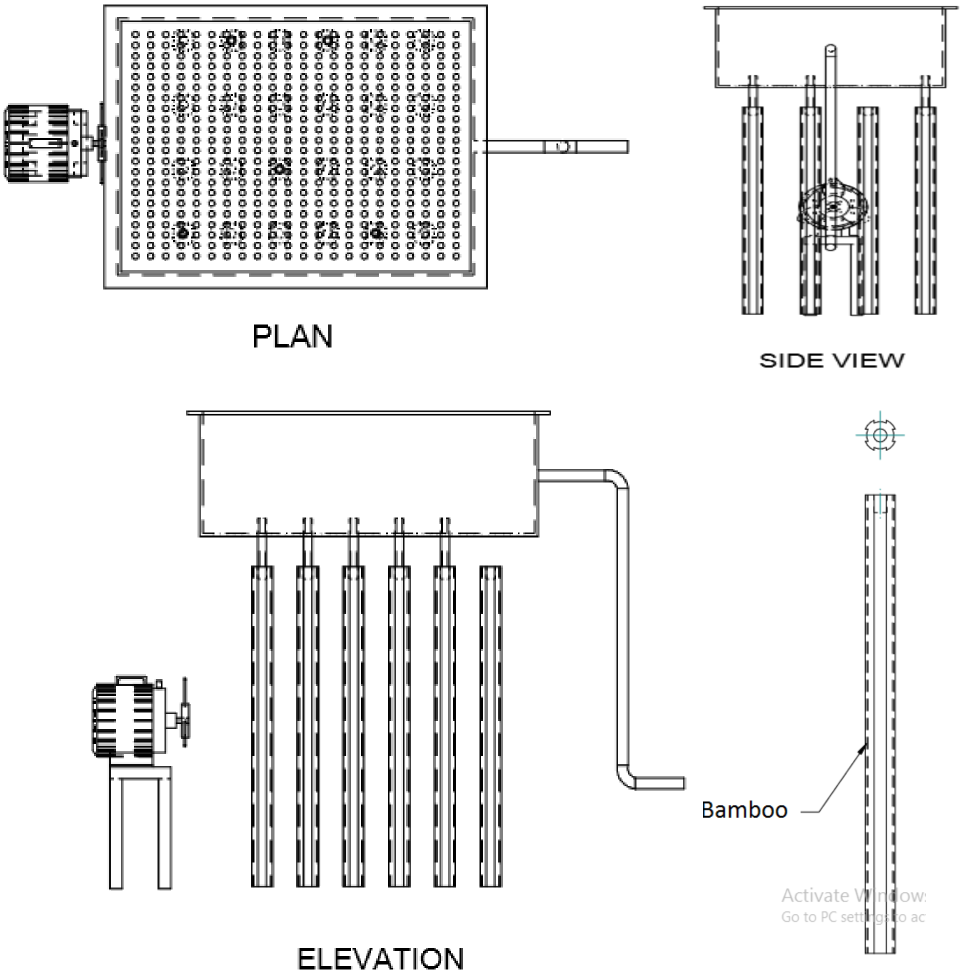


Fig. 8 2D Model

Instrument used:

- A small pump less bamboo cooler whose specification is shown below in table 1.
- Thermometer for measurement of temperature.
- Psychometric chart for calculation relative humidity and specific humidity.
- A velocity measurement instrument Anemometer.

IV. DETAILED SPECIFICATION OF BAMBOO BASED COOLER

- Bamboo has a length of 2ft and 1 inch diameter and knot is placed below 20mm and slits on outer diameter of bamboo are of depth 3mm for allowing water to flow, there is 1 mm hole horizontal just above the knot.

COMPONENTS	SPECIFICATION
Bamboo	2ft length
Pipe	2 mm diameter
Tank	20 L
Fan	230 V, 45 W
Effective cooling area	10x10 ft

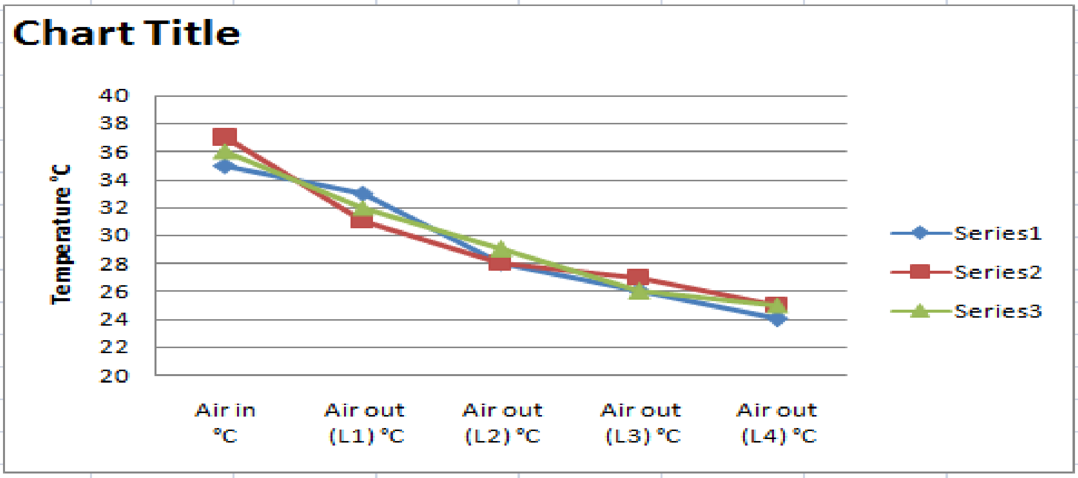
Side View **Top View**

Fig. 9 Working Model

V. RESULT AND DISCUSSION.

These readings are taken at different temperature and keeping different layer on this is very useful when low cooling is required.

Air in °C	Air out (L1) °C	Air out (L2) °C	Air out (L3) °C	Air out (L4) °C
35	33	28	26	24
37	31	28	27	25
36	32	29	26	25



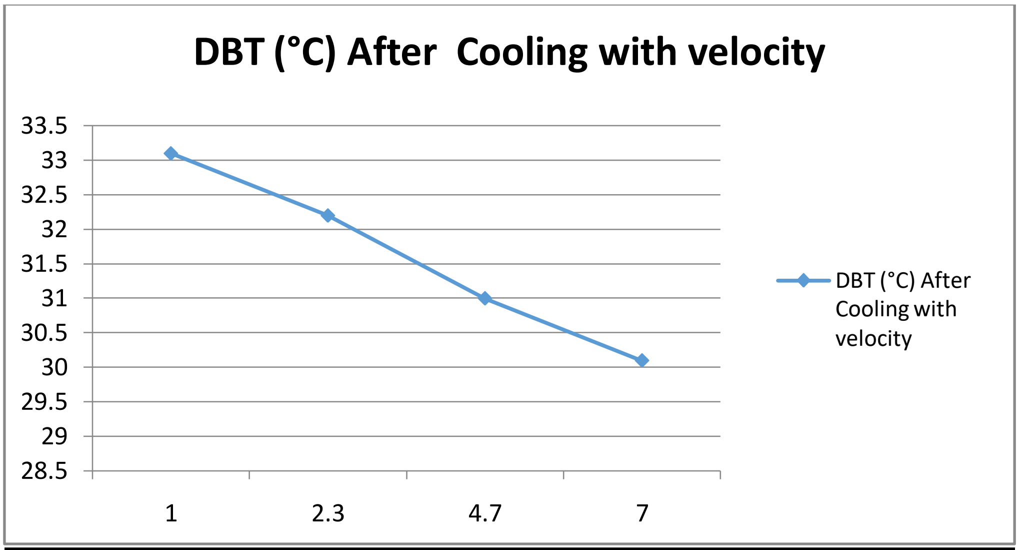
Analysis and observation

Observation is done in summer season at Navsari, Gujarat, India, which has climate with a hot summer and a humid monsoon season. Summer starts in mid march and go on till June, the average temperature being around 35°C, with the peak of summer in May, when the highs regularly exceed 42°C.

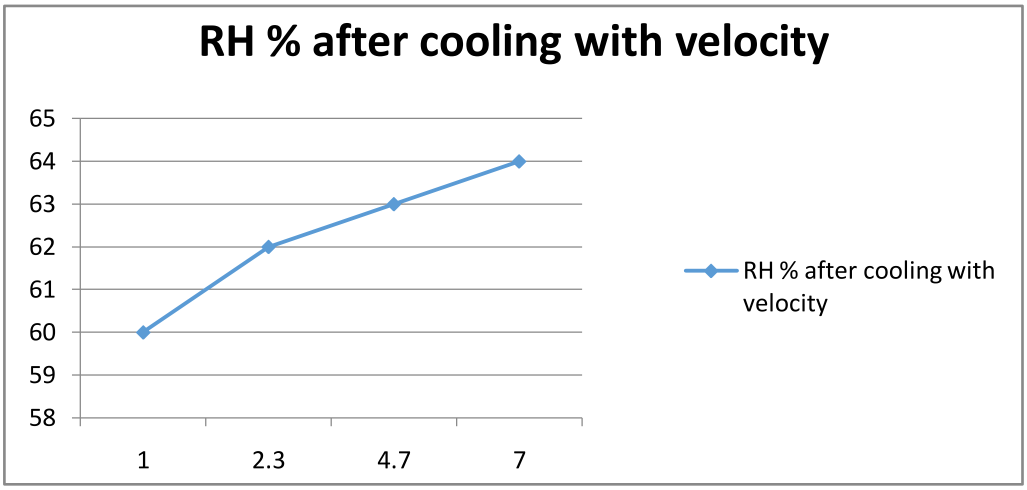
(1) Outdoor DBT 37.1 °C at 02:00 pm

Fan air Velocity (m/sec)	DBT (°C) After Cooling	WBT (°C) After Cooling	RH % After Cooling
1	33.1	26.2	60
2.3	32.2	26	62
4.7	31	25.7	63
7	30.1	25	64

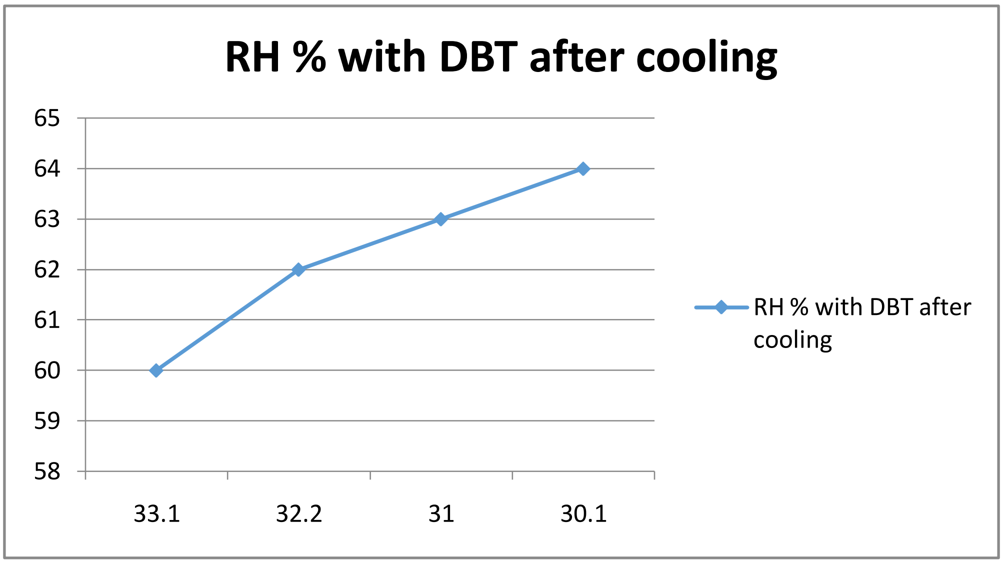
At 02:00 pm



Between DBT (°C) After Cooling with velocity (m/sec)



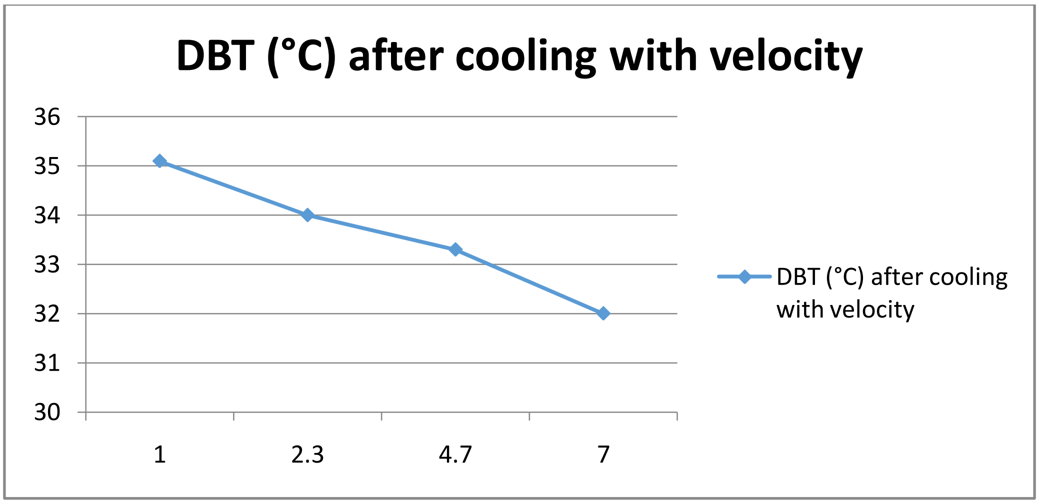
Between DBT (°C) After Cooling with velocity (m/sec)



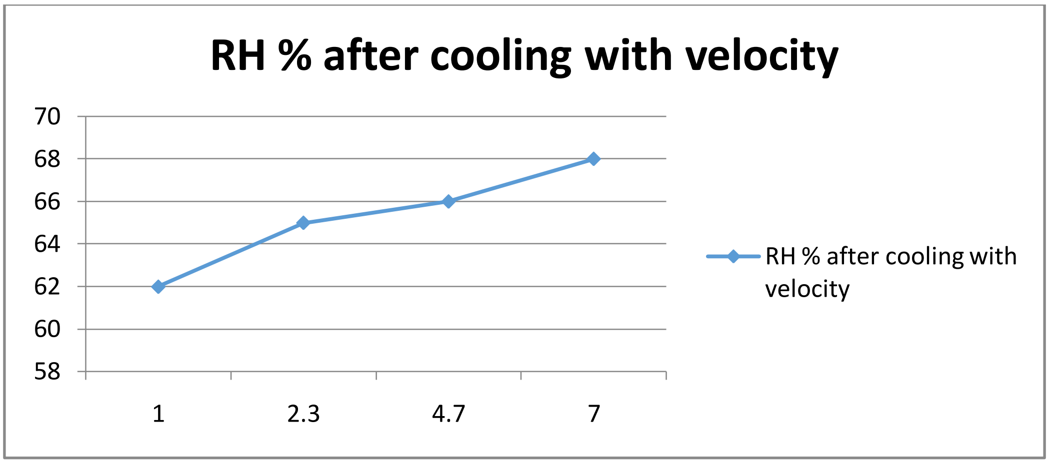
BetweenRH % after cooling and DBT (°C) after cooling

(2) Outdoor DBT 39 °C at 04:00 pm

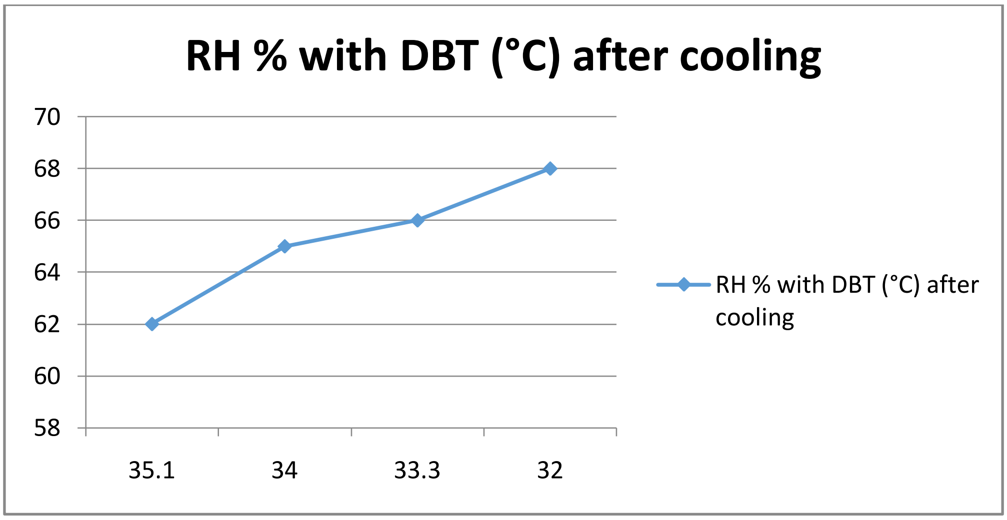
Fan air Velocity (m/sec)	DBT (°C) After Cooling	WBT (°C) After Cooling	RH % After Cooling
1	35.1	28.3	62
2.3	34	28	65
4.7	33.3	27.7	66
7	32	27	68



Between DBT (°C) after cooling and velocity (m/sec)



Between RH % after cooling and velocity (m/s)



Between RH % with DBT (°C) after cooling

V. CONCLUSION

We have concluded that bychangingmaterial of the cooler, we can get costreduced that can be affordable to the rural area population. With this kind of system which is low in cost, better cooling can be achieved with minimum water required in tribal areas.

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