An Experimental Investigation of Different Cooling Pad Materials of Desert Coolers for less Consumption of Water and Effective Cooling

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Abstract **Desert cooler is a device that cools air through the evaporation of water. The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapor (evaporation), which 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. In every year, during summer season in most of the regions of Maharashtra (India) approximately, the temperature is above 40ºc. Therefore, in summer season most of the people use desert cooler to cool the given space. In desert cooler, generally wood wool is used as a cooling pad material. But there are certain materials which is having good water holding capacity by which effective cooling can be done. This paper investigates the possibility of using jute texture, jute, and spinning cotton as a cooling pad material. An experiment was carried out by which water holding capacity of each material is investigated and at the same time, cooling ability of each material is also investigated. It is found that Jute texture has taken more time to become dry and maximum cooling is obtained by the same material.**

Keywords — Desert cooler, wood wool, jute, jute texture, spinning cotton, latent heat, evaporative cooling.

I. INTRODUCTION

Desert cooler is a device that cools air through the evaporation of water. The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapor (evaporation), which 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 [1]. Desert cooler work on the principle of evaporative cooling. Water takes heat to evaporate, that heat is called 'latent heat of evaporation'. In the cooler the water that is sprayed over the pads when evaporates takes the required latent heat from the atmospheric air surrounding them which on losing its heat cools down. This cooled air is blown inside the room by the exhaust fan fitted on the cooler and thus the room temperature drops making the ambiance inside comfortable.

In every year, during summer season in Maharashtra temperature is more than 40ºc. In most of the regions of Maharashtra a dry climate is observed. Therefore, in these regions, evaporative cooling can be effective implemented instead of VCR cooling that is used in domestic air conditioning system. Desert cooling which works on the principle of evaporative cooling can be effectively used in such areas. In Maharashtra, in summer season, it faces water crises. So, because of scarcity of water, the desert cooler who are ideal for such dry areas cannot be used as large amount of water is required [2]. So, considering this problem, an investigation is done to identify the suitable cooling pad materials which will hold the water for long period of time so that less amount of water consumption will be done. The cooling pad material, I have used are jute, jute texture and spinning cotton. For each material the water holding capacity and cooling temperature is recorded.

II. LITERATURE REVIEW

Literature review reveals that lots of efforts have been taken to make the desert cooler energy efficient. But from the literature review, it can be said that efforts have not been taken to reduce the consumption of water. Faleh Al-Sulaiman used various fibers like date palm fibers, jute and luffa for wetted cooler pads and evaluated the performance resulted jute has maximum cooling efficiency [3]. Kothare and Borker presented a “Modified Desert Cooler (MDC)” which cools the air more efficiently than the conventional desert cooler as well as provide cold-pure water for drinking purpose. It also decreased moisture content of the air coming through desert cooler upto some extent [4].

 DOI : 10.35291/2454-9150.2023.0010

Poonia M.P. et al. have developed a cooler cum refrigerator which provides air cooling, cold drinking water and stores the vegetables and medicines without affecting the performance of desert cooler. This is energy saver useful equipment [5]. Khond has investigated a performance of Desert Cooler using four different pad materials i.e. stainless steel wire mesh, coconut coir, khus and wood wool. They observed that minimum water consumption was in stainless steel wire mesh [6].

III. COOLING PAD MATERIALS

In order to investigate the possibility of using cooling pad materials other than conventionally using wood wool, I have used jute, jute texture and spinning cotton as a cooling pad material.

A. Wood Wool

Wood wool, known primarily as excelsior in North America, is a product made of wood slivers cut from logs and is mainly used in packaging, for cooling pads in home evaporative cooling systems known as swamp cooler for erosion control mats, and as a raw material for the production of other products such as bonded wood wool boards and used as stuffing for stuffed animals. In the United State the term wood wool is reserved for finer grades of excelsior. The U.S. Forest Service stated in 1948 and 1961 that, "In this country the product has no other general name, but in most other countries all grades of excelsior are known as wood wool. In the United States the name wood wool is reserved for only a small proportion of the output consisting of certain special grades of extra thin and narrow stock."

Fig 1: Wood Wool

Wood wool fibers can be compressed and when the pressure is removed they resume their initial volume. This is a useful property for minimizing their volume when shipping. Due to its high volume and large surface area, wood wool can be used for applications where water or moisture retention is necessary. The width of wood wool fibers varies from 1.5 to 20 mm, while their length is usually around 500 mm [7].

B. Natural Jute

Jute fibers can be used as an alternative cooling media for an evaporative cooler. Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. jute fibers are always known as strong, coarse, environment friendly, and organic. The use of jute was primarily confined to marginal and small manufacturers and growers, but now it is used as important raw materials for several industries. It is unfortunate that jute still lags behind other fibers like silk, wool, and cotton. However, at present time, jute is termed as a favorite fabric for packaging materials and furnishings and as golden fibers for national and international fashion world. Jute fibers are used for making mats, gunny cloth, cordage, hangings, paper, and decorative articles. The cooling capacity of the cooler is obtained between 6173 to 11979 kJ/h for air mass flow rates between 0.3 and 0.4 kg/s. Such cooler will be beneficial where conventional materials like cellulose or wood wool are either scarce or not readily available [8].

Fig 2: Natural Jute

C. Jute Texture

A jute texture also known as a "gunny shoe", is an inexpensive bag made of hessian (burlap) usually formed from jute or other natural fibers, although modern texture is often made from polypropylene; Reusable jute texture, typically holding about 45 kg, were traditionally, and to some extent still are, used for transporting grains, potatoes, and other agricultural products. In many of those uses they have been largely replaced by non-reusable paper bags about half as big. Today they are also sometimes used as sandbags for erosion control. Jute texture are also popular in the traditional children's game of sack racing [9].

Fig 3: Jute Texture

 DOI : 10.35291/2454-9150.2023.0010

D. *Spinning Cotton*

Spinning cotton is a measure part in the textile industry. It is part of the textile manufacturing process where the spinning cotton is converted into yarn. which undergo back processes such as singeing, desiring, washing, equalizing bleaching, dying, printing and finishing process to become textiles. For using the spinning cotton as a material in the cooling pad, we used raw material of spinning cotton from the Textile Industry. The yarn used as a material is the product of the doubling process, which consisting of two layers of single yarn. This doubled yarn is wounded in bobbins [10].

Fig 4: Spinning Cotton

IV. EXPERIMENTAL SET UP

Cooling pads have been prepared from wood wool, natural jute, jute texture and spinning cotton as shown in Fig 5.

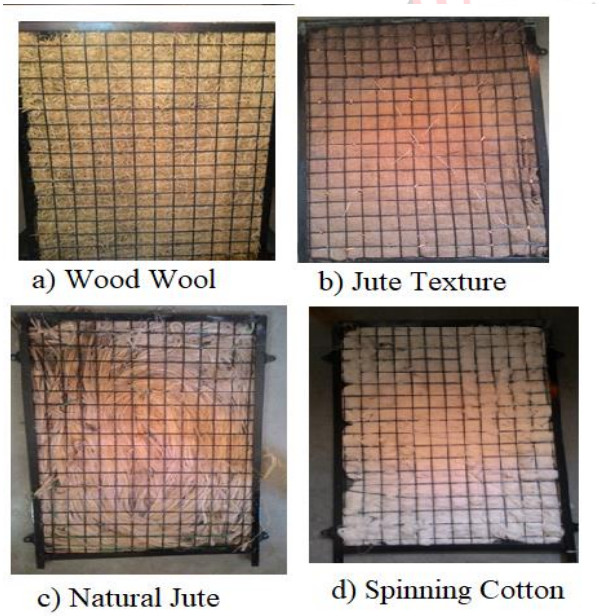

Fig 5: Cooling Pads

One by one cooling pads are attached to the desert cooler and by using 15-liter water, dessert cooler is operated until complete water evaporation. The size of the room I have taken for the experiment was 10x10 Sq. ft. The experiments were conducted in the month May 2022 from 12 noon to 3 pm in 3 days. Initially the cooling pads were made completely wet and then by switching off the water pump, time is measured to become the cooling pad completely dry. The readings are taken sequentially three days on all the cooling pads in the mentioned time. The month May have been selected as the temperature in Maharashtra (India) is very high and the weather is completely dry in that month. Two parameters viz., temperature and time required to complete evaporation of water was noted down for all the cooling pad materials.

V. RESULTS AND DISCUSSION

15-liter water is taken to note down the reading at every day. Initially cooling pads were made completely wet and then water pump is switched off. Time is noted to become the cooling pads completely dry. At the same time temperature were also recorded. The obtained readings are given in Table 1, Table 2, Table 3 and Table 4.

Table 1: Wood Wool

Time(Min)	Temperature(°c)		
	Day 1	Day 2	Day 3
T initial	32	30	30
1	26.2	28	28
2	27	26.5	27.8
3	27	26	27.1
4	27	26	27.1
5	26	26.5	27.1
6	26.4	26.5	27.6
7	26.8	26.8	27.8
8	26.9	27	28.3
9	27	27.2	**28.8**
10	**27.6**	**27.5**	29
11	28	27.8	29.3
12	28.8	28	
13	29	29.2	

Table 2: Jute Texture

Time(Min)	Temperature(°c)		
	Day 1	Day 2	Day 3
T initial	32	30	30
1	28	28	27.9
2	26.9	27	26.9
3	26.5	26.9	26.9
4	26.5	26.9	26.8
5	26.2	26.9	27
6	26.5	27	27
7	26.5	27	27
8	26.5	27.2	27
9	26.5	27.5	27
10	26.5	27.9	27
11	26.8	28	27
12	26.8	28.2	27
13	26.8	28.9	27
14	27	28.9	27.2
15	27.2	28.5	27.5
16	27.6	28.8	27.5
17	27.8	**28.8**	27.6
18	28	28.8	27.6
19	28	28.8	28
20	**28.1**	28.8	28

 DOI : 10.35291/2454-9150.2023.0010

21	28.5	28.8	28
22	28.0	28.8	28
23	28.5	28.9	28
24	29	28.9	28.1
25		28.9	28
26		29	28
27		29.1	28
28			28.1
29			28.3
30			28.3
31			**28.5**
32			28.5
33			28.5
34			28.5
35			29
36			29

Table 4: Natural Jute

Time(Min)	Temperature(°c)		
	Day 1	Day 2	Day 3
T initial	32	30.5	30
1	29.9	29.8	28.6
2	29.2	29	28
3	29	29.5	28
4	29	29.8	28
5	29	29	27.9
6	28.9	29	27.9
7	28.9	29.5	27.9
8	29	29.9	27.9
9	29	29.9	28
10	29	29.9	28.5
11	29	30	28.5
12	29	30	28.7
13	29	29.9	28.7
14	28.8	29.9	28.7
15	28.6	29.8	28.7
16	28.9	29.8	28.5
17	29	30	28.5
18	29	30	28.2
19	28.9	30	28.2
20	29	30	28.9
21	29	30	28.9
22	29	30	28.9

Table 4: Spinning Cotton

Time(Min)	Temperature(°c)		
	Day 1	Day 2	Day 3
T initial	32	30	31
1	28.5	28	31
2	28.5	28	31
3	28.5	28.3	31
4	28.5	28.3	31
5	28.8	28.5	31
6	28.9	28.5	31
7	28.9	28.8	31
8	28.9	28.8	31
9	28.9	28.8	31
10	28.9	28.9	31
11	28.9	28.9	31
12	29	29	31
13	29	29.2	
14	29		
15	29		

Fig 6 shows consolidated results which were obtained during the experimentation. It clearly shows that the time taken for jute texture cooling pad to become completely dry is more.

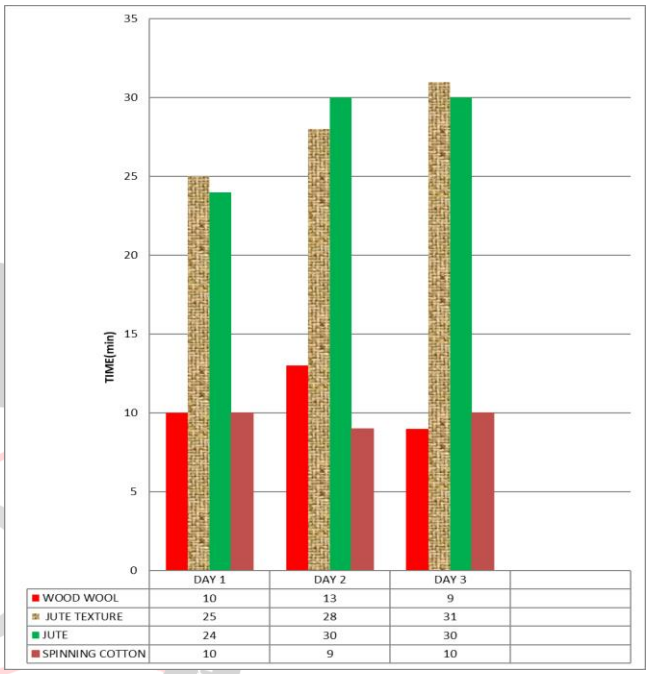

Fig 6: Consolidated results of time to become cooling pads completely dry

Fig 7 shows the decrement in the temperature achieved for each cooling pads. It shows that with wood wool cooling pads there is highest temperature reduction up to 26.4, but with jute texture, the temperature reduction is up to 26.5. So, there is very small difference between minimum temperature achieved in wood wool and jute texture.

So, it is seen that, from the above figures, with the use jute texture instead of wood wool, almost same temperature reduction is possible but the jute texture has taken almost 10 minutes more to become completely dry.

So, it can be concluded that, jute texture can be used effectively and efficiently as a cooling pad material in the areas where crises of water are there.

VI. CONCLUSION

In this paper, four types of materials were used as a cooling pad materials. The materials were wood wool, natural jute, jute texture and spinning cotton. The purpose

 DOI : 10.35291/2454-9150.2023.0010

of experimentation was to check the water consumption of the cooler when these four cooling pad materials are used. The experiment is conducted in May-2022 for three days. During the experimentation, two parameters, I have checked viz., time required to become the cooling pad complete dry and minimum temperature obtained. Wood wool was dried within 11 to 13 minutes, natural jute was dried in 22 minutes, jute texture was dried in 26 to 36 minutes and spinning cotton was dried in 13 to 15 minutes. Minimum temperatures were obtained for wood wool, natural jute, jute texture and spinning cotton were 26°C, 26.2°C, 28.6°C and 28.5°C respectively. So, considering both the parameters, it can be concluded that jute texture can be effectively used as a cooling pad material in the areas where water crises are facing. So, it is recommended that, in the regions of water crises, jute texture can be used as a cooling pad material instead of conventional wood wool.

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