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Experimental Performance Analysis And Cooling Effect Of 360^{0} Air Cooler For Vertical Axis

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***Abstract*:** In India energy demands are expected to be more than double by 2030, and there is a pressing need to develop ways to conserve energy for future generations. Thus energy consumption can be reduced drastically by using energy efficient appliances. In India, the Union Ministry of power's research pointed out that about 20-25% of the total electricity utilized in government buildings in India is wasted due to unproductive design, resulting in an annual energy related financial loss of about Rs 1.5 billion. Conventional Heating Ventilation and Air Conditioning systems (HVAC) consume approximately 50% of the building energy. This type of air conditioning is therefore neither eco-friendly or sustainable. Selection of proper air conditioning system for buildings can not only help the country to save electrical energy but also reduce green house emissions.

As renewable energies become a growing part of the energy, the focus is being put on increased performance and efficiency of proven sources such as horizontal axis air coolers. Generally air coolers are predominantly horizontal-axis, three-bladed with a fixed blade design.

The domestic air coolers, which are cost effective, play a positive role in providing human comfort during hot weather. However the performance is dissatisfactory in the high humid regions. This project paves a way to investigate the performance of air cooler integrated by eliminating the problem of rise in humidity that usually encountered in the conventional air cooler. The objective of the present invention is to provide cooled air to maintain the room temperature according to the requirement.

This paper presents a simplified analysis model for Cooling Effect of 360^{0} Air Cooler for Vertical Axis to make computation tractable with better performance and efficiency by varying speed, number of blades and energy utilization and comparing suitable for cooling effect over a site-specific air cooling distribution.

Keywords- Energy consumption, cooling effect, vertical axis

I. Introduction

Today in the 21th century, the world is facing a major problem of global warming due rapid industrialization. In India, during summer season the average temperature is about 40°C to 45°C. It even reaches up to 48°C to 50°C in the month of June. To maintain comfortable condition in (i.e. temperature & humidity) in the summer season various types of appliances are used such as 'Air Conditioner', 'Coolers', etc. These appliances are easily available in the market. In India, the average income of common man is not so high, so common man cannot afford these appliances because of their high cost.

The Evaporative cooling is one of the earliest methods employed by men for conditioning their houses. Only in recent years, it has been put on sound footing thermodynamically. It is a process of adiabatic saturation of air when a spray of water is made to 360^0 Evaporative into it without transfer of heat from or to the surroundings. The initial investment cost of such a system is low & the operation is simple & cheap. Simple 360^0 cooling is achieved by direct contact of water particles & a moving air stream. If the water is circulated without a source of heat & cooling, dry air will become more humid & will drop in temperature. In a complete contact process, the air would become saturated at WBT of the entering air. The air may be sufficiently cooled by 360^0 Evaporative processes to results a considerable degree of summer comfort in climates of high dry-bulb temperatures associated with low relative humidity. The minimum outdoor temperature required for successful 360^0 Evaporative cooling is above 35^0 C & another requirement is a relatively low.

II. Literature review

Several studies have been reported in the literature**.** Sumit Chandak et al [1] concluded that, not by using pump electricity consumption reduces by 23.5%, water consumption reduces by an average of 59.25% and the efficiency of cooler quite comparable high with conventional cooler. Vibhav Kumar Shrivastava et al [2] investigated that, this method is opted to achieve an economical design which is affordable, eco-friendly and consumes less energy, since evaporation is done by earthen pots and there is no need for compressor. Miss**.** Namrata Govekar et al [3] said that, evaporative coolers are not suitable in humid environment and also their performance is poor in the places where ventilation is not proper. Rahul D. Gorle et al [4] expressed that, the compressor power consumption is decreased by 10 % on average as a result of the decrease in discharge pressure when the air temperature entering the condenser is lowered by circulating the condensate through a pre-cooler. Vipin Das et al [5] analyzed that, in the global warming field of cost of generation of power is very less so the source of power is free and available in plenty and then is no power interruptions. Prasad Agivale et al [6] expressed that, thermoelectric cooling systems are generally only around 5–15% as efficient compared to 40–60% achieved by conventional compression cooling system. Using thermoelectric effect in system the COP of the system also increases. Shahi Satyam et al [7] said that the portable Air conditioner system should satisfy the need of user at the most economical cost, very low manufacturing and maintenance cost. Pratik Bhake et al [8] expressed that, evaporative cooling is more economic, effective and energy saving in hot and dry climates. Farhan A. Khmamas [9] investigated that, the Evaporation Cooling Effectiveness (ECE) reduces by 15% for forced evaporation case, and by 22% for the natural case, as compared with the direct case. Mr. S.N Tripathy et al [10] analysed that to restrict the amount of water droplets mixing with the output air, which is the main reason of moisture generation. Yash R. Bora et al [11] suggested that, to reduce the global warming the use of Evaporative Air Coolers is found to be better option against the air conditioners. Suvarna V.Mehere et al [12] said that, using water for evaporation as a mean of decreasing air temperature is considerably the most environmentally friendly and effective cooling system. Ritesh W. Dhone et al [13] expressed that, the combination of three cooling pads, Cellulose paper pad, Aspen wood wool and Coconut fibers, it is seen that this combination of three different types of cooling pads provides a good cooling efficiency with least increase in humidity

The study will help to understand the gaps and ensure the scope for the research work. Based on the scope, the objectives for the work may be identified. There is a need for the analysis and cooling effect of 360^0 air cooler for various parameters like speed, number of blades, blade angle affecting the performance.

III. Objectives

The objectives of the proposed work are directed to undertake the following Experimental analyzes

- Study of effect of advanced 360^0 air cooler with various speeds for finding out desired cooling effect.
- To find the performance of 360^0 air cooler to improve the cooling effect by replacing the number of blades

IV. Design procedure

In 360^0 cooler we are going to use four direction cooling pads which allow maximum efficiency & cooling more area in short time and also designing special flapper to flow air in all direction with control. When trying to understand 360^0 evaporative cooling, it may be best to think of air as a type of sponge. As the water comes into contact with air, it absorbs the water particles. The amount of water absorbed depends largely on how much water is already in the air. After all, how easily you clean up a spill depend on how dry a sponge you are using. The term ‘humidity’ describes the level of water in the air. If the air holds 20% of its capacity, the humidity would be 20%. A humidity of 100% indicates that the air is holding all the moisture it can.

To check the yield stress for G.S. material

Standard yield stress = 340 N/mm^2	τ = 340N/mm^2
The power of motor = 118 W	P = 118W
Outer Diameter = 20mm	Do = 20 mm
Inner Diameter=17.5mm	Di = 17.5mm

Calculation of Torque

We know that,

$P=2\pi NT/60$

T=1.6097 N-m

=1609.7 N-mm

Calculation of yield stress

For hollow shaft torque is given by

$$T = \frac{\pi * \tau * (Do^4 - Di^4)}{(16 * Do)}$$

$$\tau = 2.4764 N/mm^2$$

Since induced yield stress for material is less than standard , hence the design is safe.

Fig. 1: Assembly of 360⁰ Air Cooler

V. Results and disscussions

Analysis of Cooling Effect by changing number of Blades

Case-1: Readings for 2 Blades

For Speed = 750 rpm

Table 1: Temperature Measurement for speed 750 rpm

Time in Min	0	5	10	15	Temp. Difference
Temp. in ˚F	92	90.3	90.0	89.8	2.2

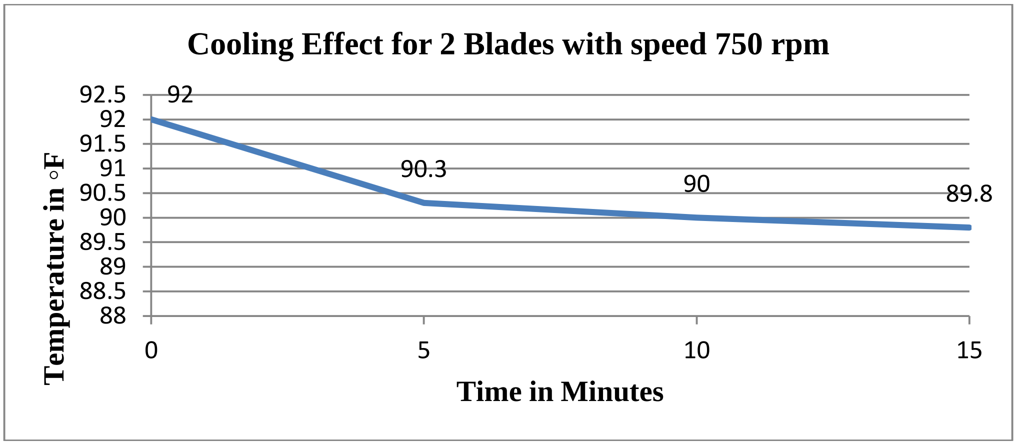

Fig. 2: Graph showing cooling effect for 2 blades at speed 750 rpm

For Speed = 800 rpm

Table 2: Temperature Measurement for speed 800 rpm

Time in Min	0	5	10	15	Temp. Difference
Temp. in °F	92.5	91.8	91	89.8	2.7

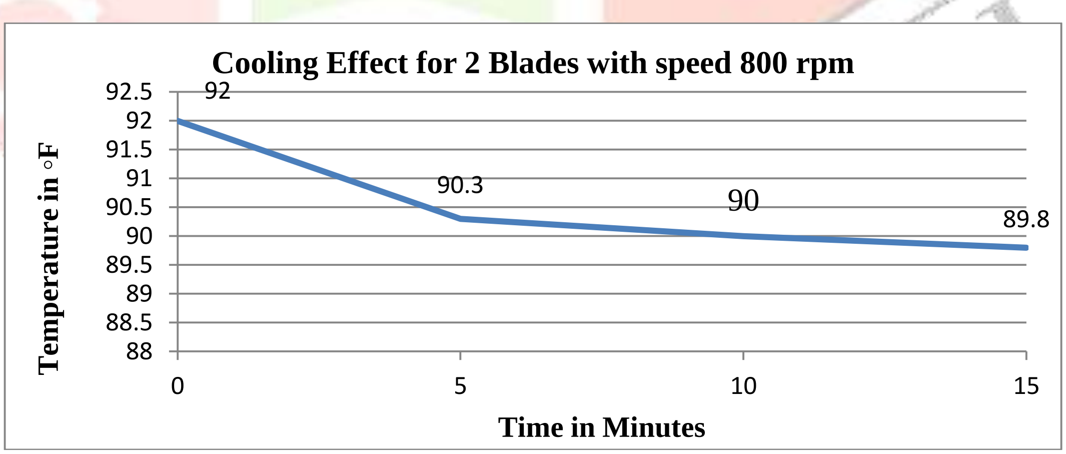

Fig. 3: Graph showing cooling effect for 2 blades at speed 800 rpm

Case-2: Readings for 4 Blades

For Speed=650 rpm

Table 3: Temperature Measurement for speed 650 rpm

Time in Min.	0	5	10	15	Temp. Difference
Temp. in ˚F	92	90.3	90.1	90	2

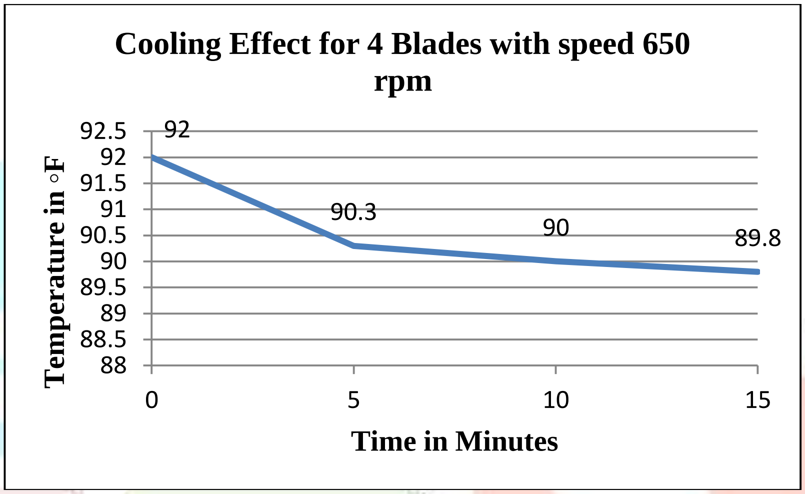

Fig. 4: Graph showing cooling effect for 4 blades at speed 650 rpm

For Speed=700 rpm

Table 4: Temperature Measurement for speed 700 rpm

Time in Min.	0	5	10	15	Temp. Difference
Temp. in ˚F	91.4	90	89.8	89.6	1.8

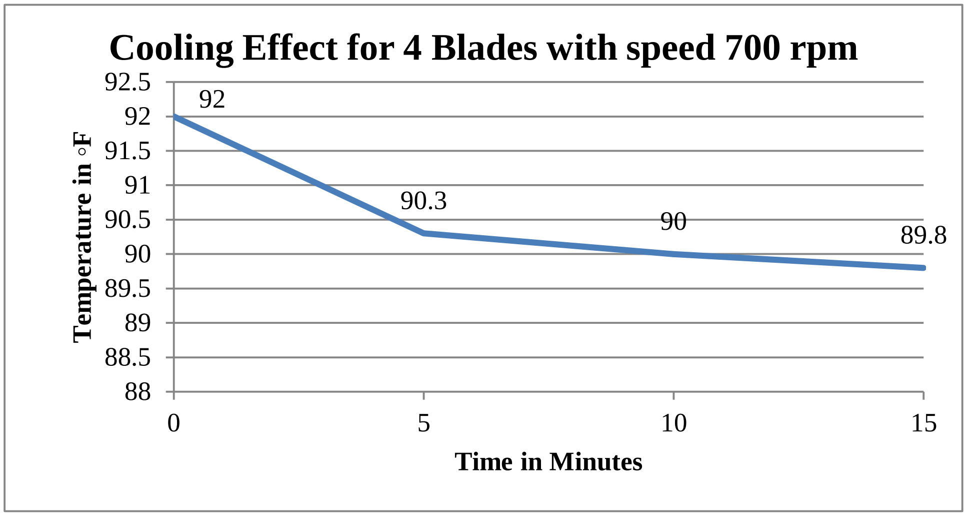

Fig. 5: Graph showing cooling effect for 4 blades at speed 700 rpm

Similarly, the experimental performance Analysis & Cooling Effect of 360^0 Air Cooler for Vertical Axis for various parameters like speed and number of 6 blades, 8 blades have been checked and how it affects the cooling and performance. A comparative study has been made between the numbers of blades with variable speeds.

Table 5: Comparison of Experimental results

Sr No.	Speed	No of Blades	Temperature		
			Maximum	Minimum	Difference
1	400	8	91.0	89.6	1.4
2	450	6	92.0	89.8	2.2
3	500	8	92.0	89.6	2.4
4	550	6	92.0	89.8	2.2
5	650	4	92.0	90.0	2.0
6	700	4	91.4	89.6	1.8
7	750	2	92.0	89.8	2.2
8	800	2	92.5	89.8	2.7

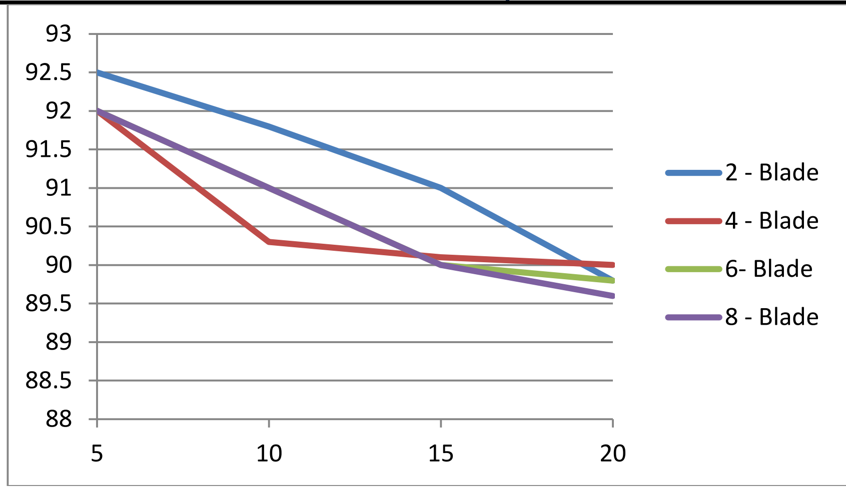

Fig. 6: Graph showing Resultant cooling effect

From Table 5 the experimental results have been obtained with the best cooling effect. The Fig. 6 shows the resultant cooling effect. It is observed that maximum notable difference in temperature for number of blades with variable speeds can be found at 2 blades with 800 rpm. This may be due to the less weight acting on the shaft and high flow rate of air circulation, thus playing a significant role in the results.

From the analysis it is clear that the more cooling effect is observed for 2 blades with speed of 800 rpm.

VI. Conclusion

The work is to be carried for the Performance Analysis & Cooling Effect of 360^0 Air Cooler for Vertical Axis for various parameters like speed and 2, 4, 6 and 8 numbers of blades affecting the cooling and performance. A comparative study has been made between the numbers of blades with variable speeds.

From the results and discussion it is concluded that less cooling effect will be obtained for low speed and more cooling effect will be obtained for high speed. As the speed increases, more cooling effect will be observed, that is the cooling effect is directly proportional to speed

Also less cooling effect will be obtained for maximum number of blades and more cooling effect will be for minimum number of blades. As the number of blades increases, less cooling effect will be observed, that is the cooling effect is inversely proportional to speed.

From the analysis we understood that maximum notable difference in temperature for number of blades with variable speeds can be found at 2 blades with 800 rpm and the less cooling effect obtained for 8 blades with speed of 400 rpm. This may be due to the less weight acting on the shaft and high flow rate of air circulation, thus playing a significant role in the results.

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