DESIGN AND PERFORMANCE ANALYSIS OF WALL MOUNTED AIR COOLER

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ABSTRACT

Air cooling is a method of dissipating heat. It works by expanding the surface area or increasing the flow of air over the object to be cooled, or both. An example of the former is to add cooling fins to the surface of the object, either by making them integral or by attaching them tightly to the object's surface (to insure efficient heat transfer). In the case of the latter, it is done by using a fan blowing air into or on to object one wants to cool. The addition of fins to a heat sink increases its total surface area, resulting in greater cooling effectiveness. It is observed that the evaporative air cooler takes more floor space also by using wood wool for cooling purpose the consumption of water is more. On the other side, due to continuous running of cooler, the moisture generates inside the room is more and feels uncomfortable during summer. So to overcome these problems, we are designing the wall mounted air cooler using cellulose pads which will be mounted on wall with good air ventilation, so the moisture inside the room will be maintained and can used the floor space for other purposes. Also we can reduce the consumption of water by using the cellulose pads for cooling of water.

Keyword : - *Cooling Fins, Fan, Heat Sink, and Cellulose Pad Corrugated Paper, Evaporative Cooling, etc.*

1. INTRODUCTION

Commercially for human comfort vapor compression refrigeration system is used in an air conditioning system. Which has a high running cost due to the compressor? The cost of this type of air conditioning system is also high as compare to the evaporative cooling system.

Now a days the temperature goes on increasing and water level gradually decreasing and this problem mostly seen in summer season when the temperature is more due to which air present in atmosphere is dry which makes environment hot as compare to other season, to have more comfort environment humans mostly depends upon fans, evaporative cooler and air conditioners which mainly used to create suitable environment for us.

Evaporation is the conversion of liquid substance into the gaseous state. When water Evaporate from the surface of something, that surface become much cooler because it requires heat to change the liquid into vapor. A nice breeze on a hot day cools because the current of air makes perspiration evaporate quickly. The heat needed for this evaporation is taken from our own bodies and we perceive a cooling effect.

When air moves over a surface of water it causes some of the water to evaporate. This evaporation results in a reduced temperature and an increased vapor content in the air. The bigger the area of contact between the air and water the more evaporation occurs, resulting in more cooling and the addition of moisture. In order for water to evaporate, heat is required. A British Thermal Unit, or BTU, is a unit used to measure heat. To evaporate one gallon of water requires almost 8,700 BTU's of heat. For evaporative cooling, this heat is taken from the air, cooling it as it evaporates.

Due to the increase in energy demand there is more and more urgent need to save energy. As we all know the evaporative cooling is one of the best options amongst them, these ancient techniques used for cooling purpose. This technique has a wide number of applications in residential, commercial, agricultural and food storage etc. So in this paper, he studied various evaporative cooling methods to find out the best suitable and environmentally friendly way of cooling.

1.1 Evaporative Cooling System:

Evaporative cooling is one of the types of thermodynamic process. It works on the simple principle of the evaporation i.e. cooling effect is occurred when water is evaporated from the surface. Thus evaporative cooling is a natural process in which dry atmospheric air passed from one side of the wet porous cooling pad and due to evaporation process cool air is obtained from another side. The pad with good heat transfer characteristics and good water absorbing capacity can give maximum efficiency.

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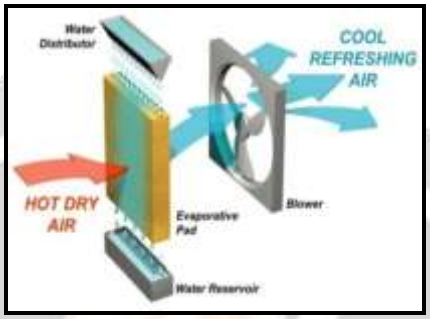

Fig. - 1: Evaporative Cooling

2. AIM AND OBJECTIVES

2.1 Aim:-. To Design Wall Mounted Air Cooler and its Performance Analysis.

2.2 Objective:

- To Improve Evaporative Cooling System Efficiency by providing alternative cooling medium.
- To eliminate the chances of electric shocks and minimize the requirement of power by providing DC power supply to the cooler.
- To minimize the utilization of floor space by mounting the assembly on wall.
- To improve the performance of cooler by passing the dry air to the cooling medium through wall ventilation

2.3 Problem Identification

- Wood wool cooling pad need to replace every year to increase the cooling effect as well as required more maintenance.
- Domestic cooler require more floor space.
- Domestic cooler require 150 – 200 liter of water per day.
- Weight of domestic cooler is more.
- There is possibility of corrosion in domestic cooler due to direct contact of water with cast iron frame.
- In conventional cooler there is possibility of electric shock.

3. COMPONENTS

Wall Mounted Cooler Parts:

The main components of wall mounted cooler are as follows:-

- Fan
- DC motor

- Cooling pad
- Submersible DC pump
- Frame
- Water Tank
- WPC sheet (Wood Plastic Composition)
- Temperature and humidity sensor
- Water Level Indicator (Float gauge)
- SMPS

4. CONSTRUCTION AND WORKING OF WALL MOUNTED AIR COOLER:

4.1 Construction of Wall Mounted Air Cooler:

It consist of various components i.e. Fan, DC motor, Cooling pad, Submersible DC pump, Frame, Water Tank, Step down transformer, Resisters and diode, WPS sheet (wood plastic composition), Temperature humidity sensor, Float gauge (water level indicator), SMPS, etc.
The whole assembly of wall mounted air cooler is mounted on frame which is also used to support the structure of cooler. Air cooler casing is made up of WPC sheet to cover the whole assembly. There are three sheets of cellulose pad mounted on three sides of cooler. Fan and DC motor is mounted in between cellulose pads and WPC sheet casing and the tank is provided at the bottom in which the submersible pump is provided. Another vertical pump is used to fill the water in air cooler water tank. Temperature and humidity sensor is used to measure the temperature difference and humidity inside the room and float gauge is used to control the water level in the water tank.

4.2 Working Principle of Wall Mounted Air Cooler:

Air coolers work on the principle of cooling by the evaporation of water which is present in them. These coolers are also called as evaporative air cooler and they require water, which is filled in this cooler. The cooling effect is produce due to the transition in phase from liquid state to vapor state. The cellulose pad cooling system draws outside air through wet vertical pads. The major components of this system are: pad media, water supply, pump, distribution pipe, etc. some of the moisture evaporates into the air stream, as air flows past the moist pad surface. Heat is withdrawn from the air during this process and the air leaves the pad at a lower temperature with higher moisture contain.

Fig. - 2: Fabricated Model of Wall Mounted Air Cooler

Table -1 : Specification of Wall Mounted Air Cooler

Parameters	Specification
Power	42 watt/hr
Cooling pad	Cellulose pad
Type	Wall mounted
Dimension	Length 2, Breath 1.5, Height 2.5
Air flow rate	0.4672 m^3/sec.
Temperature drop if initial condition is 35 ºC	10-13 ºC
Net Weight	12 kg
Water Storage Capacity	35 – 40 liter
Operated input current	DC current
Prevention	Rust-proof, shock proof
Maintenance	Low
Durability	High

4.4.3 Working of Wall Mounted Air Cooler:

Air cooler used the natural power of evaporation to cool our indoor space. They pull in hot dry air which is passing through a moistened pad the pad absorbs. The heat and the moisture in the pad evaporate.
Firstly the water is filled in the water tank with the help of vertical pump where the float gauge guide the water level and blow the buzzer when the water is filled up to certain limit and hence cut of the connection of vertical pump and as the cooler is started submersible pump gets activated the water is pump up with the help of submersible pump and pass through the PVC pipe fitted on the cooling pad with pores simultaneously as per the requirement due to which the water droplets are drawn on the walls of cellulous and it gets wet. When the cellulous pad get wet the surrounding hot air from ventilation and hot, humid air from the room passes through cooling pad and gets cool inside after passing from cooling pad and hence that inside cold air is the pass in the room forcefully with the help of fan.

5. ADVANTAGES DISADVANTAGES AND APPLICATIONS OF WALL MOUNTED AIR COOLER

5.1 Advantages

- Apart from being affordable, the air coolers use water for cooling and do not use any refrigerant such as CFC, HCFC etc. Hence they are eco-friendly.
- The initial cost of buying a cooler is much less than that of an air conditioner.
- No problem arising from thermal & chemical pollution of cooling fluids.
- There are also of several types based on their ability of cooling and also easy to install.
- It can work on solar, DC 12 volt battery and AC power supply.
- It is relatively cheap and requires less energy than other forms of cooling.
- Water level indicator with alarm.
- Easy to assemble and dissemble.

5.2 Disadvantage

- The performance of the cooler total depends on external atmospheric condition.
- Unable to provide cooling below wet bulb temperature of outside air.
- Unable to remove latent heat.

5.3 Applications

- It useful for domestic purpose.
- It is also use in small area for cooling effect.
- It is use in office cabins.

6. COST ANALYSIS

The cost of different component of wall mounted air cooler is as follows:

Sr. No.	Name of Part	Quantity	Price
1	Fan	1	30
2	DC motor	1	1700
3	Cooling pad	3	240
4	Pump	2	700
5	Frame	1	400
6	Water tank	1	400
7	WPC sheets	2	700
8	Water level indicator	1	100
9	SMPS	1	1100
TOTAL			5370

Total Cost = Fabrication + Cost of Component
= 250 + 5370
= 5620

7. RESULTS AND DISCUSSION:

Experimental analysis of conventional evaporative cooler and smart evaporative cooler shows following result:

Table - 2: Result (Comparison of Cooling Rate)

Parameters	Conventional Evaporative Cooler	Wall Mounted Air Cooler
Max temperature drop (ºC)	6.7 ºC	10 ºC
Max saturation efficiency (%)	68 %	77.61%
Max cooling capacity (KW)	4.8 KW	5.68 KW

Table – 3: Comparison between Air Cooler and Wall Mounted Air Cooler

Parameters	Domestic Cooler (Wood Wool Pad)	Wall Mounted Air Cooler (Cellulous Pad)
Power rating	250-300 watt/hr.	41watt/hr.
Electric consumption	0.2-0.3 unit/hr.	0.041 unit/hr.
Cooler weight	20 Kg	12 Kg
Cooler size	3 x 3 x 3.5 ft.	2.5 x 2 x 1.5 ft.
Water consume	150-200 lit	100-120 lit
Inside Room Temperature (t_{max} to t_{mean})	27 ºC	23 ºC
Power supply	AC	DC

Experimental analysis showed that maximum drop in temperature of outside air is obtained with modification in design of conventional evaporative cooler. Modified wall mounted air cooler has showed increase in its saturation efficiency cooling capacity which is able to meet internal cooling load of room.

8. CONCLUSION:

The calculated graphical analysis shows that the cooling efficiency of wall mounted air cooler is greater than conventional cooler. This experiment has carried out that cellulose pad has better efficiency and much water holding capacity as compare to conventional wood wool. After the completion of this project, the output we get better cooling capacity than conventional cooler. The cooling effect obtained by wall mounted air cooler is much more efficient than the conventional cooler. It is the better option than air conditioning at reasonable price.

The main expectation of a customer, while buying the cooler is that it should give effective cooling at minimum power consumption. While working on this project we tested the unit on various outside climatic conditions. The modifications included in the wall mounted air cooler use in cellulose pads in which the warm air outside is get converted into cold air of conventional cooler. It avoids direct contact between operators and working unit and whole body is made up of WPC sheet so it is avoids severe risk of shock.

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