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Design and Development of Portable air cooler

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Abstract - In convention Air cooler, the outside air comes in contact with the water on the cooling pads. This outside air gives latent heat of vaporization to the water. Due to this water evaporates and that vapor get mix with the air the humidity of air has been increased. This increase in the humidity reduces the Human comfort, the chances of bacteria, viruses have been increased sandal so this condition is not suitable human comfort and to asthmas patient. So, we modified an Air Cooler, which will not increase the percentage of humidity in the air. The aim of this project is to develop portable Air Cooler which will not increase the humidity of the air as in case of Conventional Air Cooler. Air Cooler is an appliance that keeping the atmosphere cold. The basic concept is to make the indirect contact of water and air which goes out of the cooler for giving comfort. This project is to design and develop a low-cost portable air cooler as compared to Air conditioning system which can be used in Cars trucks and vehicles without A/C, house and office.

Key Words: Indirect evaporative cooling, portable air cooler, fan

1. INTRODUCTION

An air cooler serves to cool down the hot air in a room or vehicle. Air cooler cools the atmospheric air in a room or vehicle by adding water to the air. The water is added in the form of minute droplets. The air cooler has a fan installed in it that pulls the warm air from outside through a water wetted filter medium. The water in the cooler is evaporated by the warm air drawn by the fan. The evaporated water releases in the room. The temperature of the room comes down because the warm air is drawn by the fan of the air cooler. Air Cooler is one that is used forgiving comfort to human being as like Air conditioning. But the difference between this two is that Air Cooler gives humid air at outlet and Air conditioning gives de humidified air at outlet. [9]

Middle-class peoples cannot afford to purchase Air-conditioning system which cost more than Air Cooler. So we design and develop an Air Cooler which reduce the humidity of air and gives output like an Air conditioning system. This product has minimum cost than Air-conditioning system which the middle-class people can purchase for comfort. In this we make the indirect contact of air and water which reduces humidity in the out let air.

An air cooler is not the same as an air conditioner. The air cooler does not use compressor and refrigerant gas. We can say that though the air cooler is not as effective as air Conditioner, it is not harmful for the environment and is cost effective. The air coolers cool the atmospheric air mostly by the process of evaporation of water.

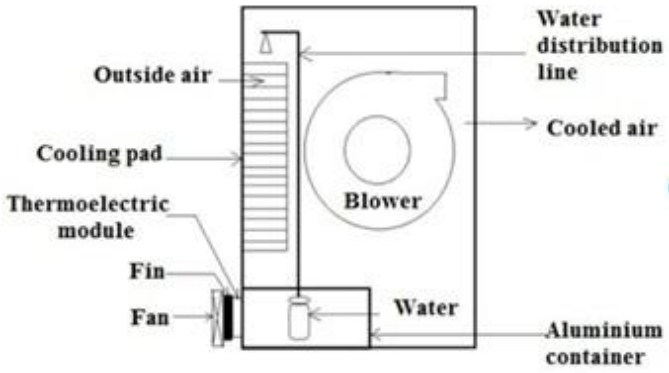

Fig.1.1 Evaporative air Cooler

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 ensure efficient heat transfer). In the case of the latter, it is done by using a fan blowing air into or onto the object one wants to cool. The addition of fins to a heat increases its total surface area, resulting in greater cooling effectiveness. [10]

2. THEORITICAL BACKGROUND

Newton's law of cooling:

Newton's law of cooling stats that the rate of heat lost by a body is directly propositional to the temperature deference between the body and its surrounding areas. given that such difference in temperature is small and the nature off the surface radiating heat remains constant .to put it in simpler terms ,we may say that the hotter and object is, the quicker it cools down.

$$Q = hA_s\Delta T$$

Where h is the convection heat transfer coefficient in W/m2· °C, A_s the surface area through which convection heat transfer takes place and ΔT is temperature deference.

Convection is classified as natural (or free) and forced convection, depending on how the fluid motion is initiated. In forced convection, the fluid is forced to flow over a surface or in a pipe by external means such as a pump or a fan. In natural convection, any fluid motion is caused by natural means such as the buoyancy effect, which manifests itself as the rise of warmer fluid and the fall of the cooler fluid.

By temperature deference we mean that any phenomenon which leads to the follow of energy into a system or follow of energy from any system into the surrounding area .in the former case, the object heats of, whereas in the latter, the object cools down. Newton`s law of cooling leads to the often cited equation of exponential decline over time. This can be applied to several phenomenal of science and engineering which includes discharge of a capacitor and the decay in radioactivity. The law is helpful in the study of heating water as it can help us calculate what speed the heater in the pipes cools off.

The amount of heat absorbed by the air becomes equal to the amount of heat rejected by the water flowing in copper coil, and can be expressed as

$$\dot{Q} = \dot{m}c_p(T_{out} - T_{in})$$

Where Q is the rate of heat transfer to the air; c_p is the specific heat of air; T_{in} and T_{out} are the average temperatures of air at the inlet and exit of the enclosure, respectively; and $\dot{m}\cdot$ is the mass flow rate of air. [11]

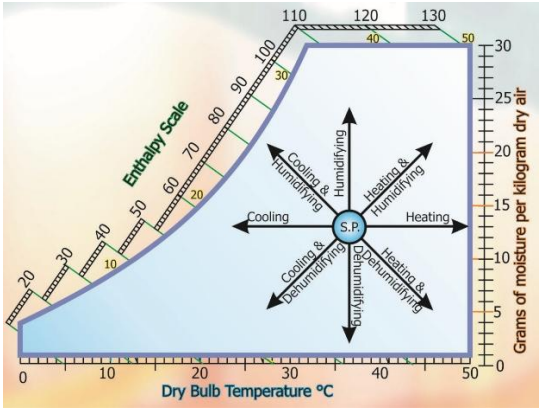

Fig.2.1 Psychrometric process

Types of psychrometric process

1. Simple heat transfer process
    a) Sensible cooling process
    b) Sensible heating process
2. Simple Humidification process at same DBT
3. Simple dehumidification process at same DBT
4. Heat transfer processes with change in humidity
    a) Cooling and dehumidification
    b) Heating and humidification
    c) Heating and dehumidification.
    d) Cooling and humidification [9]

3. LITERATURE REVIEW

B.L.Thakor et.al (2015) developed a new concept in which air cooling and air conditioning systems were combined together so cooled air could be obtained at low power consumption. Air cooler gives the cool and humid air. Humidity of air can be absorbed by amalgamation of evaporator at outlet of air cooler. This is chip and effective design conceptualization in comfort application. Evaporative air conditioner is for all pockets in equator and tropical region of earth. [5]

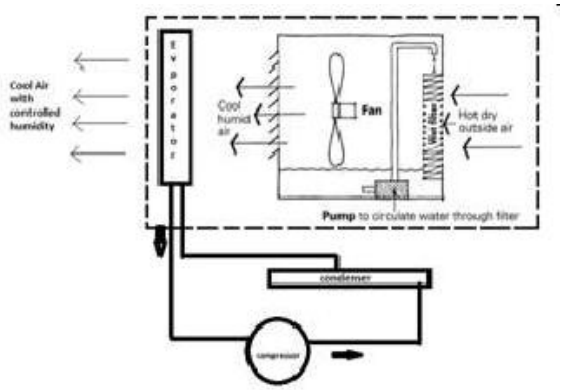

Fig.3.1 Evaporative air conditioner Experimental Set up

M. Abbas, M. Saleem Khan, Fareeha Zafar (2011) used the concept of fuzzy logic in air cooling systems. The design and implementation of an autonomous room air cooler using fuzzy rule-based control system. The rule base receives two crisp input values from temperature and humidity sensors, divides the universe of discourse into regions with each region containing two fuzzy variables, fires the rules, and gives the output singleton values corresponding to each output variable. [1]

Jakkula Rajesh et.al (2018) presents a novel design of the Portable air conditioner for a domestic purpose. Unlike conventional air conditioning systems which are fixed and effect complete space, portable AC's can be moved and spot cooling can be achieved. This eliminates the need for higher capacities and multiple AC's. Design is carried out considering the mass production of AC's. [3]

Himanshu George et.al (2021) is to make a Smart portable air conditioner that with the help of motion sensor would not only help to reduce electricity wastage but also that is affordable and reliably cool small confined for a limited amount of time and space. As well as it is eco-friendly as it does not release chlorofluorocarbons which normal air conditioners do which harms the atmosphere as it leads to ozone depletion and it should be easily affordable by poor people also. [2]

Dr Ayman Mohamed Afifi (2013) the research aims to contribute to solving the problem of high temperature in summer or minimize their effects and the design of cooler air can be carried during a walk in the open spaces outside the home. The Researcher was able to design Air cooler Manual to cope with rising heat in summer and especially outside the home. Users expressed interest in the device, because of the high temperature and the intensity of the need for such devices to be used in the street. [4]

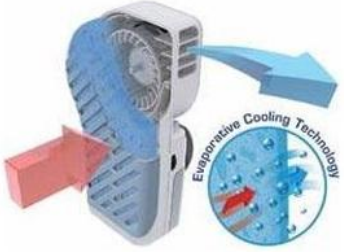

Fig.3.2 Handy Cooler with Small Fan

4. METHODOLOGY

This modified cooler works on the principle of indirect contact of air and water. When hot air comes in contact with copper cooling coil in which cold water is flowing. The cold water of copper cooling coil give cooling effect, due to this the temperature of air has been reduced. The temperature of air will get reduce without increasing the moisture content. [7]

Details of elements of Portable Air cooler:

1. Blower fan: Forced air is passed through cooling elements and circulated to the desired locations with the help of Blower Fan.

Fig.4.1 Handy Cooler with Small Fan

Table-1 Specification of fan

Sr no	Specification	Details
1	Nos of Blades	5
2	Materials of Blades	Acrylic
3	Dia. Of periphery	144mm

2. Water pump: The circulating pump is placed inside the water basin and draws cold water from it and passes it through the copper coil.

Fig.4.2 Water circulating pump

Table-2 Specification of pump

Sr no	Specification	Details
1	Voltage	220-230volt
2	Input supply	AC, Phase 1, 50hz
3	Power	18W
4	Max Head	5.5 ft
5	Out put	220 LPH
6	Weigth	200gm

3. Wooden body: - It is a frame or structure to fit or mount every accessory on it. The material is selected wooden as it provides sufficient strength as well as it is very cheap.

Fig.4.3 Wooden casing

Plywood material of L×W×H×t= 20cm×28cm×24cm× 1.3cm

4. Motor: Blower Motor is used to rotate the Fan mounted on it. The component in cooler design is the prime mover which runs the fan. Electric motor capable of providing desired rpm. The power required to run fan is provided by electric motor.

Fig.4.4 Motor

Table-3 Specification of Motor

Sr no	Specification	Details
1	RPM	1200
2	Frequency	50-60, AC
3	Voltage	220/240

5. Water storage tank: - the water storage tank is required to store cool water. Capcity of water storage tank 2.5 liter.

Fig.4.5 Water storage tank

6. Copper tube: use as a cooling oil because it's high thermal conductivity. It is used in many cooling and heating applications because it doesn't corrode and has a high melting point.

Fig 4.6 Copper tube

5. PERFORMANCE ANALYSIS OF MODIFIED AIR COOLER

Comparison air/ room temperature with normal and modified air cooler fan Initial condition.

Sr no.	Condition	Temperature	
1	Room Temperature	T_d= 33.5ºC	T_w= 23ºC
2	Temperature of Water	5.5ºC	

Table-4 Experiment Obervation

No.	Time min	Conventional fan		Modified air cooler		ΔT_d (°c)	ΔT_w (°c)
		T_{d1}	T_{w1}	T_{d2}	T_{w2}		
1	0	33.5	23	28.9	22.4	4.6	0.6
2	10	33.9	23	30.1	22.6	3.8	0.4
3	20	34	23.1	30.6	22.9	3.4	0.2
4	30	34	23.5	31	23	3	0.5
5	40	34	23.5	31.2	23.1	2.8	0.4
6	50	34.1	23.6	31.4	23.1	2.7	0.5
7	60	34.2	23.6	31.5	23.1	2.7	0.5

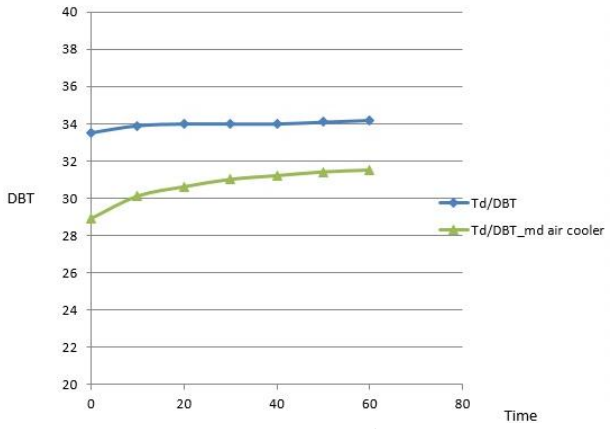

Fig.5.1 DBT V/S TIME

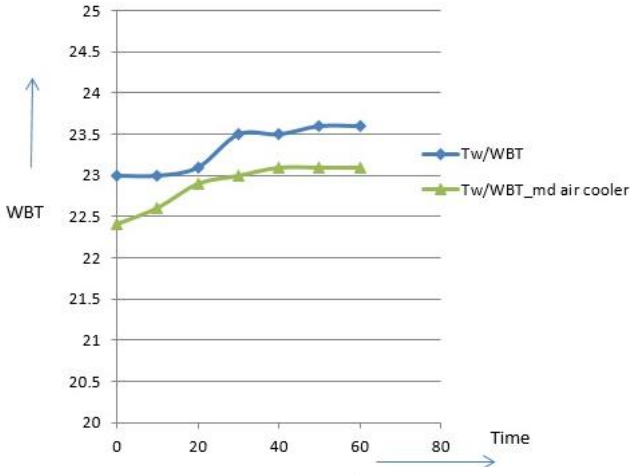

Fig.5.2 WBT V/S TIME

6. CONCLUSIONS

The main reason for the increase in humidity in the air inside the room when using a regular air cooler is that the cold air coming in direct contact with the cold water from the air cooler causes its temperature to drop. So that the humidity in the air increases.

This difficulty is overcome and delivered moisture free air, water will be passed through the copper pipe, which will reduce the temperature of the copper pipe and as air passes through the copper pipe the air will blow from one side to the other and the air temperature will also decrease. Here, the air is cooled by cold water without physical contact. This will make moisture free air available. Also, air is cooled indirectly by cold water.

From the above experiment and information we can say that when air comes out of cooler it is free from moisture and temperature drops by around 2-5ºC.

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REFERENCES

1. M. Abbas, M. Saleem Khan, Fareeha Zafar, “Autonomous Room Air Cooler Using Fuzzy Logic Control System” International Journal of Scientific & Engineering Research Volume 2, ISSN 2229-5518, Issue 5, May-2011
2. Himanshu George1, Er Vivek Agnihotri2, Er Mayank Kumar3, “DESIGN, SIMULATION AND FABRICATION OF SMART PORTABLE AIR CONDITIONER” IARJSET ISSN (Online) 2393-8021, Vol. 8, Issue 7, July 2021
3. Jakkula Rajesh, Suresh Akella, K. Sainath, “Portable Air Conditioner Design for Fabrication” International Journal of Research in Engineering, Science and Management, ISSN (Online): 2581-5782 Volume-1, Issue-10, October-2018
4. Dr Ayman Mohamed Afifi, “Handy Air Cooler Design to Face Rising Temperature Outside the Home” International Journal of Scientific and Research Publications, ISSN 2250-3153, Volume 3, Issue 12, December 2013
5. B.L.Thakor, “Economical Evaporative Air Conditioner for Equatorial and Tropical Regions”, International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC), ISSN: 2321-8169, Volume 3 Issue 1 , January 2015
6. Saichandu, Mr. K. Sainath ,T. Kishen Kumar Reddy, Suresh Akella, “Design And Fabrication Portable AC With Cooling Chamber” ijsart - volume 5 issue 2 –february 2019, ISSN [online]: 2395-1052
7. N.Beemkumar, D.Yuvarajan, J.Jayaprabakar, Dr.R. Velraj, “Experimental Investigation on Air Cooler with Thermal Storage” IEEE 2010, 978-1-4244-9082-0/10
8. Prabuddha Kr Verma1, Abhishek Sarkar, Adarsh Singh, Shadan Kamal, Mrs Garima singh, “Design and fabrication of portable air cooler” IRJET ISSN: 2395-0056, Volume: 09 Issue: 05 May 2022
9. Refrigeration and Air-conditioning system, by Khurmi and Gupta, Fifth Edition.
10. Shan K. Wang, Second Edition, McGraw-Hill, “Handbook of air conditioning and refrigeration” 27.1-27.26
11. Yunus cengel “Heat transfer” McGraw-Hill Education second edition, p.g 352-390.

BIOGRAPHIES

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