Journal of Thermal and Fluid Science
Volume 2, Issue 2, August 2021, pp 88 - 92
https://doi.org/10.26706/jtfs.2.3.20210706

Design, Fabrication and Performance Analysis of Cross Flow Regenerative Evaporative Cooler

R. M. Dahekar[1]
rahul.dahekar@rediffmail.com

Bhavik D. Talware[2]
Corresponding Author
bhaviktalware31@gmail.com

Harshal S. Gourikar[2]
harshalgourikar1999@gmail.com

Kunal D. Lalzare[2]
lalzarekunal@gmail.com

Nitin H. Doye[2]
nitindoye470@gmail.com

[1]Assistant Professor and [2]Students
Department of Mechanical Engineering,
Govindrao Wanjari Collage of Engineering and Technology, Nagpur, India

***Abstract* - As per the technical evolution and latest trends taken into consideration here effectively created an advanced cooling system can be useful for industry, home, schools and colleges, hospital, factories, auditoriums, shopping malls. This system uses DC motor with following specifications. This project uses cooling tube along with condenser and inlet and out let air arrangement for cooling. This system is power optimistic and shock resistant. This system uses sprinkle arrangement of water so as to generate advance cooling. This complete system having multiple arrangements these are Air inlet and outlet arrangement, Condenser arrangement, cooling pads, cooling dome, Water dome. This complete system uses battery of 12v DC and 8 amp so complete system able to work on battery so no chances of shock and requirement of power is less. This system having some advantages i.e., Shock Resistant, Easy to use, simple arrangement, water Sprinkle arrangement, High speed cooling FAN, Minimum Use of Water, Long Life.**

Keywords – Indirect evaporative cooling (IEC), Direct evaporative cooling (DEC), Regenerative evaporative cooling, cooling effectiveness, Performance test Evaporative water flow rate.

I. Introduction

This system uses 2 motor arrangement with cross flow system and with sprinkle water arrangement. As per technical evolution and latest trends taken into consideration this system carries 2 different motor arrangement which is use to collect air from out outside in the cooling system and cool air pass outside via another motor [1]. Complete system works on 12v DC which using this system we can minimize the shock problem [2]. The water pump used in this project is also DC so no chances of shock during water filling. This system not only produce cooling but also reduces the power consumption and reduces chances of shock.

The evaporative cooling (EC) innovation depends on warmth and mass exchange among air and cooling water [3]. Direct evaporative cooling (DEC) depends on mechanical and warm contact among air and water, while roundabout evaporative cooling (IEC) depends on warmth and mass exchange between two surges of air, isolated by a warmth move surface with a dry side where just air is cooling and a wet side where both air and water are cooling. Both DEC and IEC are described by extremely high energy proficiency yet additionally by huge water utilization rates [4].

On account of IEC innovation, on the dry side of the warmth move surface (dry surface), is streaming the essential (or item) air that is chilling off. On the wet side of the warmth move surface (wet surface), is streaming the optional (or working) air in combination with water [5]. The objective of this examination is to introduce from both subjective and quantitative perspective, the accessible

Research Paper – Peer Reviewed
Published online – 01 August 2021

Cite this article – R. M. Dahekar, Bhavik D. Talware, Harshal S. Gourikar, Kunal D. Lalzare, Nitin H. Doye, "Design, Fabrication and Performance Analysis of Cross Flow Regenerative Evaporative Cooler", *Journal of Thermal and Fluid Science*, RAME Publishers, vol. 2, issue 2, pp. 88-92, 2021.
https://doi.org/10.26706/jtfs.2.3.20210706

logical data concerning various angles identified with the IEC: development standards, stream plans and working cycles [6].

Regenerative or Recuperate Evaporative Cooler (REC), as the IECs with closed-loop configuration, has the ability of providing supply air at a temperature below the wet-bulb towards the dewpoint temperature of inlet air theoretically [7].

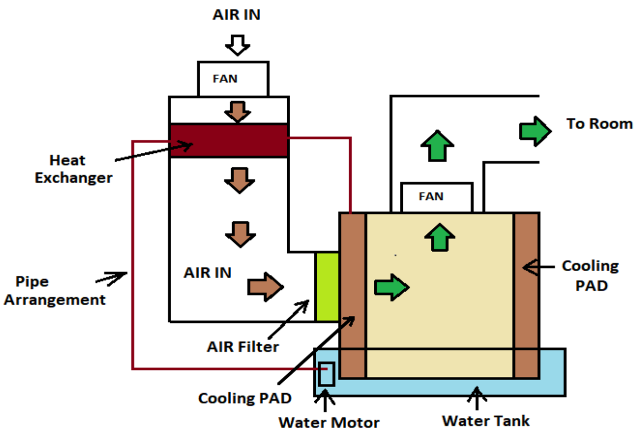

Fig 1. Block diagram

II. Stepwise Creation of Assembly

A. Diagrammatical representation of fabrication process:

a) Fabricated 13 inch × 13 inch × 30 inch duct for heat exchanger arrangement using 24-gauge mild steel sheet.

b) Prepare 1 slot with 13 inch × 13 inches × 10 inches for air outlet.

c) Top of this duct, placed 1 motor along with locking to absorb air from atmosphere.

d) Place heat exchanger arrangement inside heat exchanger duct using copper pipes along with bindings and locking.

e) Fabricated duct for cooler i.e., 24 inch × 24 inch × 46 inch.

f) Prepared 4 rectangular slot on 4 horizontal side for cooling pads.

g) Prepared 1 rounded slot to place fan with motor.

h) Fabricated 1 duct for air outlet arrangement i.e., 15 inch × 15 inch × 20 inch made by 16-gauge mild steel sheet.

i) Prepared cooling pad with metal bar net and place cotton bristles slices.

j) Lock all cooling pads on cooler slots.

k) Done electrical connections to provide power to all motors.

l) Fabricated water distribution arrangement using plastic pipes.

m) Prepare tank to store water with dimensions 26 inch × 26 inch × 10 inch.

n) All ducts join using nut and bolt arrangement.

o) All ducts fabricated using bending machine.

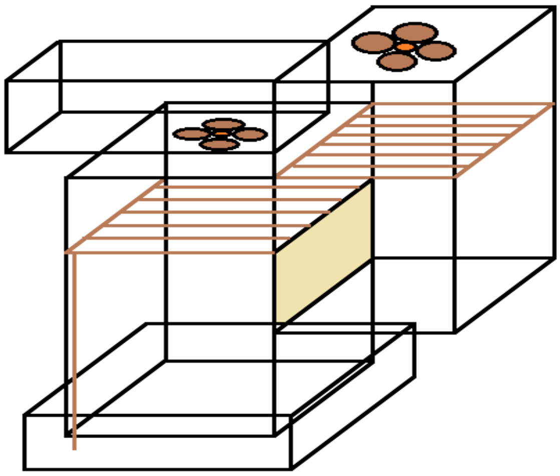

Fig 2. Skeleton Arrangement

TABLE 1
DUCT DIMENSION

Sr No	Arrangement	Dimensions
1	Duct	15 Inch × 15 Inch × 20 Inch
2	Round	13 Inch Diameter

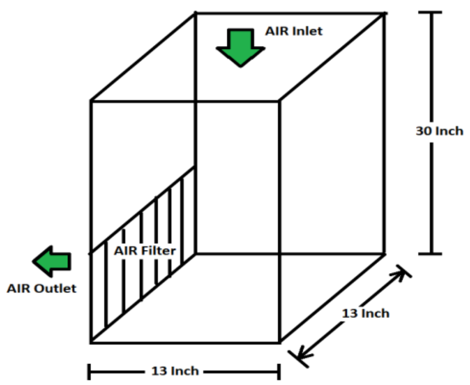

Fig 3. Duct Arrangement

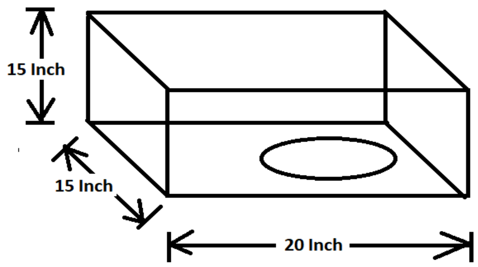

Fig 4. Air Outlet Arrangement Dimensions

B. Skelton for manufacturing uses following dimensions

TABLE 2

SKELETON DIMENSIONS

Sr No	Arrangement	Dimensions
1	Duct with inlet FAN arrangement	13 Inch × 13 Inch ×30 Inch
2	Cooling Dome Duct	24 Inch × 24 Inch × 46 Inch
3	Water Storage Tank	26 Inch × 26Inch × 10 Inch
4	Upper AIR Outlet duct	15 Inch ×15Inch × 20 Inch
5	Bar Used	1 Inch × 1 Inch square
6	Metal Sheet	1 mm sheet (4 feet by 8 feet qty 2)

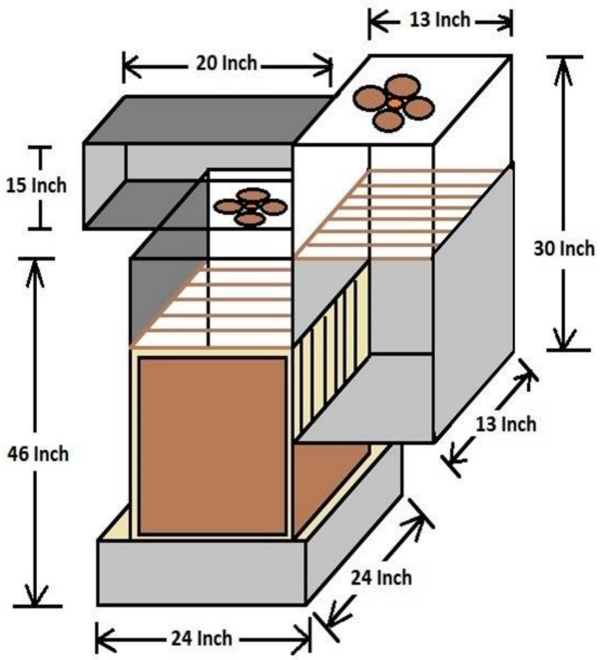

Fig 5. Dimension of cooler

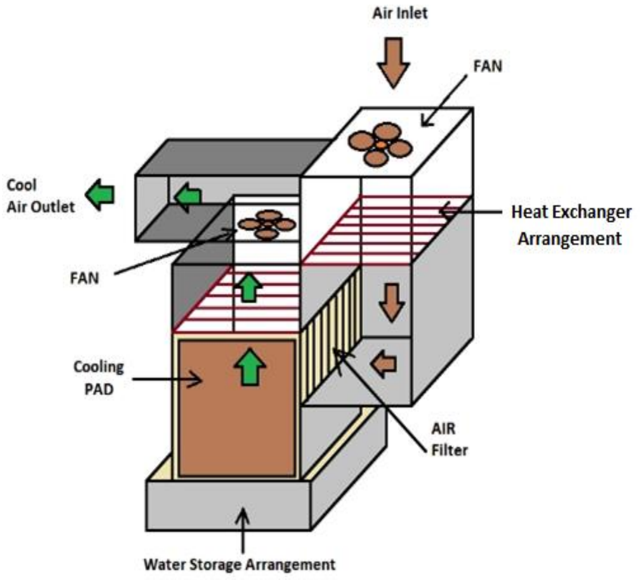

Fig 6. Experimental Setup

The arrangement used in this project are as follows

a) High Speed Motor for air outlet
b) Medium speed motor for air inlet
c) FAN for air inlet and outlet
d) Heat exchanger
e) Water Pump for heat exchanger & cooling pad
f) Cooling pads
g) 12 V, 8 Amp battery
h) Switch Board
i) Basement Body
j) Water dome

TABLE 3

OBSERVATION TABLE

Time in Min	Atmospheric temperature (T_a)	Temperature After Heat Exchanger (T_1)	Temperature inside cooling duct (T_2)	Temperature of Delivery air (T_3)
10	32.2	31.5	30.1	30.2
20	32.1	31.1	29.7	29.9
30	32.3	31	28.4	28.3
40	32.4	30.7	26.9	26.7
50	32.7	30.5	25.7	25.3
60	32.9	30.2	24.2	23.9

C. AVERAGE TEMPERATURE CALCULATIONS

$$T_{avg} = \frac{\text{Total Sum Of All Temeratures}}{\text{No Of Temeratures}}$$

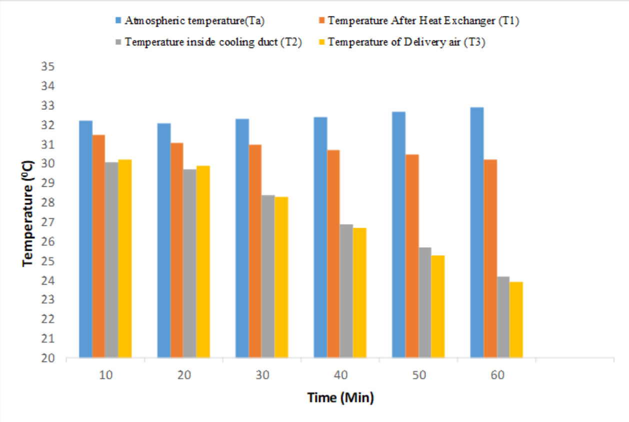

Fig 7. Temperature Readings with respect to time

- Atmospheric Air Temperature

$$Ta_{(avg)} = \frac{32.2 + 32.1 + 32.3 + 32.4 + 32.7 + 32.9}{6}$$

= 32.4 ºC

- Temperature After Heat Exchanger

$$T_{1(avg)} = \frac{31.5 + 31.1 + 31 + 30.7 + 30.5 + 30.2}{6}$$

= 30.8 ºC

- Temperature Inside Cooling Duct (T_2)

$$T_{2(avg)} = \frac{30.1 + 29.7 + 28.4 + 26.9 + 25.7 + 24.2}{6}$$

= 27.5 ºC

- Temperature of Delivery Air (T_3)

$$T_{3(avg)} = \frac{30.2 + 29.9 + 28.3 + 26.7 + 25.3 + 23.9}{6}$$

= 27.3 ºC

- Temperature Drop (ΔT) = Ta(avg) –T3(avg)
  = 32.4 -27.3
  = 5.1 ºC

- Rate of Heat Transfer (Q) = $mC_p\Delta T$ = 5.12 Kj/s

III. Result

1. 4% to 5% effective temperature drop of air after passing over the heat exchanger.
2. 10% to 11% cooling effect after air passing through the cooling pad.
3. 1% to 2% temperature drop has been obtained while delivering air.
4. Overall temperature drop obtained

$$\text{Temperature drop} = \frac{Ta_{(avg)} - T3_{(avg)}}{Ta_{(avg)}} \times 100$$

$$= \frac{32.4 - 27.3}{32.4} \times 100$$

= 15.74%

IV. Future Scope

a) This project can modify according to wireless module which can be operate from long distance via wireless module. For these future modifications will require Bluetooth module and microcontroller for operation [8]. With the use of this module operator can send wireless data to cooling system i.e., ON, OFF, Pump ON-OFF, etc.

b) This system can operate on Solar system so as to reduce the power consumption. To make this system solar operated there is a requirement of Solar panel as per power consumption, Charge controller and battery [9].

c) We can use the refrigerant in HE instead of water so cooling capacity increases more effectively also the heating arrangement can be installed in setup to control the humidity of working air [10].

V. Conclusion

In this project our main objective is to increase the performance of REC by using cross flow arrangements and two stages of cooling.so as per our requirement we have to build a cost-effective model with increase efficiency. So, at first stage we design the cooling system which consist of Fan, DC motor, heat exchanger, cooling pad, air filter, battery, water motor and it is cost effective as compare with air conditioning. So, this project can be developed up to 15 to 20 thousand. While conventional cooler cost 17 thousand and air conditioning system cost approx. 20 thousand.

References

[1] Velasco Gómez E, Tejero González A, Rey Martínez FJ., "Experimental characterization of an indirect evaporative cooling prototype in two operating modes", *Applied Energy*, volume 97, 2012, pp. 340–6.

http://dx.doi.org/10.1016/j. apenergy.2011.12.065.

[2] Campaniço H, Hollmuller P, Soares PMM, "Assessing energy savings in cooling demand of buildings using passive cooling systems based on ventilation", *Applied Energy*, volume 134, 2014, pp. 426–38. http://dx.doi.org/10.1016/j.apenergy.2014.08.053.

[3] Maheshwari GP, Al-Ragom F, Suri RK., "Energy-saving potential of an indirect evaporative cooler", *Applied Energy*, volume 69, 2001, pp. 69–76. http://dx.doi.org/10.1016/ S0306-2619(00)00066-0

[4] Cerci Y., "A new ideal evaporative freezing cycle", *International Journal Heat Mass Transfer*, volume 46, 2003, pp. 2967–74. http://dx.doi.org/10.1016/S0017-9310(03)00072-3.

[5] Lee J, Lee DY., "Experimental study of a counter flow regenerative evaporative cooler with finned channels", *International Journal Heat Mass Transfer*, volume 65, 2013, pp. 173–9. http://dx.doi.org/10.1016/j.ijheatmasstransfer.2013.05.069.

[6] Woods J, Kozubal E., "A desiccant-enhanced evaporative air conditioner: numerical model and experiments", *Energy Convers Manage*, volume 65, 2013, pp. 208–20. http://dx.doi.org/10.1016/j.enconman.2012.08.007.

[7] Anisimov S, Pandelidis D, Jedlikowski A, Polushkin V., "Performance investigation of a M (Maisotsenko)-cycle cross-flow heat exchanger used for indirect evaporative cooling", *Energy*, volume 76, 2014, pp. 593–606. http://dx.doi.org/10.1016/j.energy.2014.08.055.

[8] Riangvilaikul B, Kumar S., "An experimental study of a novel dew point evaporative cooling system", *Energy Build*, volume 42, 2010, 637–44. http://dx.doi.org/ 10.1016/j.enbuild.2009.10.034.

[9] Hasan A., "Going below the wet-bulb temperature by indirect evaporative cooling: analysis using a modified -NTU method", *Applied Energy*, volume 89, 2012, pp. 237–45. http://dx.doi.org/10.1016/j.apenergy.2011.07.005.

[10] Liu Z, Allen W, Modera M., "Simplified thermal modeling of indirect evaporative heat exchangers", *HVAC&R Res*, volume 19, 2013, pp. 37–41. http://dx.doi.org/10.1080/10789669.2013.763653.