REDESIGNING AND FABRICATION OF EXISTING AIR COOLER SYSTEM

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Abstract

We receive heated air with winds from the outdoors during the summer. Since humans cannot readily survive in most nations' extremely hot climates, we use air conditioning or cooling systems together with a variety of system-related equipment, including air conditioning systems, water blower systems, and air cooler systems. In all of these systems, air conditioning is used most frequently since it is affordable and widely available worldwide. The arrangement of the previous air cooler is different; the water flows from the engine upward in the new air cooler, which has a removable tub and cooler that can be simply separated from one another. Due to increased sweating and heat, the need for cooling air rises in accordance with human needs throughout the summer. Additionally, a basic air cooler cannot meet all human needs. As a result, we decided to use ducts to boost product efficiency and create spinning duct air coolers. It is more effective to use the duct cooler. Desert cooling is not as effective as duct cooling.
Duct coolers are just a form of impeller fan known as a blower fan. A duct cooler is an impeller-style device that uses rotating impellers to speed up and expand an airstream.

I. INTRODUCTION

Air cooling is frequently defined as the process of removing heat from an object by forcing air across its surface by convection. Air cooling requires that the air be colder than the object or surface from which heat is to be removed. An air cooler uses the state change cooling principle to cool the air by using water evaporation. Human sweating is a simple illustration of state change cooling. Sweat begins to evaporate, extracting the excess heat from the skin in the form of gas, which results in a cooling effect.

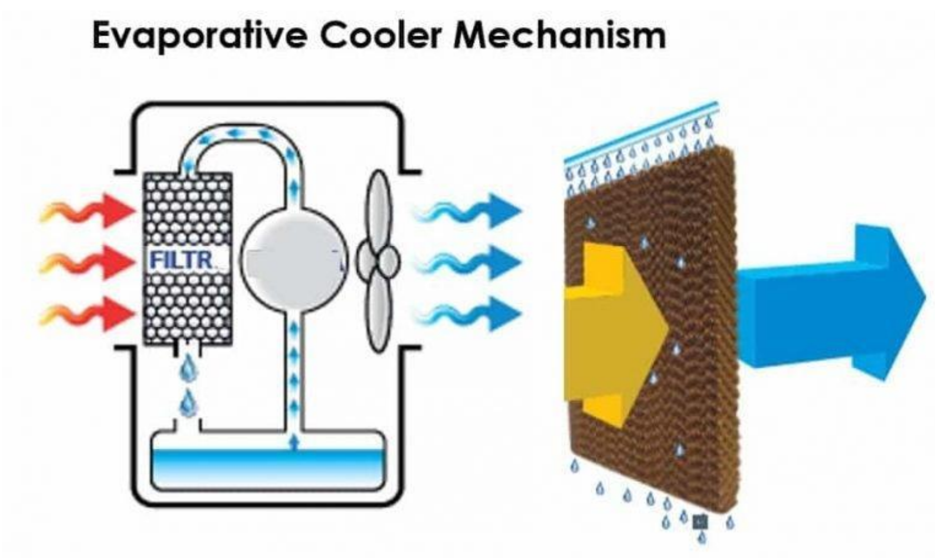


Fig. Air Cooler

The "Redesign and Fabrication of Existing Duct System" is the study's goal. Our primary convenience requirement is that we utilize the system of ducts to regulate the temperature of every inch of space. By sustaining constant, uniform temperatures throughout the learning environment and regulating the air, proper ducting will prevent hot and cold patches. To reach this goal, a proper duct and fan design is essential in the current environment. It becomes crucial to develop a solution for efficient cooling. The objective of this research is to look into and evaluate the circumstances that affect duct design and implementation. Less dust, allergens, and germs will be present in the air, making it cleaner.

II. PROBLEM IDENTIFICATION

During analysis We receive heated air with winds from the outdoors during the summer. Since humans cannot readily survive in most nations' extremely hot climates, we use air conditioning or cooling systems together with a variety of system-related equipment, including air conditioning systems, water blower systems, and air cooler systems. In all of these systems, air conditioning is used most frequently since it is affordable and widely available worldwide. The arrangement of the prior air cooler is different; the water flows from the engine upward in the newer air cooler, and the tub and cooler are fixed; they may be simply separated from one another. Due to increased sweating and heat, the need for cooling air rises in accordance with human needs throughout the summer. Additionally, a basic air cooler cannot meet all human needs.
Therefore, we decided to use ducts to boost product efficiency and create duct rotating air coolers.

III. OBJECTIVES

1. To supply air conditioning while using less energy Create a Reliable system
2. Efficient use of the accessible space
3. Cut down on losses due to friction
4. Adequate circulation around the learning environment
5. To decrease the distortion
6. Reduce the machine's size and weight.
7. Minimization of cost

IV. LITERATURE SURVEY

[1] Effects of wall admittance changes on duct transmission and radiation of sound by D.L. Lansing and W.E. Zorumski's

Indicate how modifications to the acoustic properties of duct walls effect sound transmission through ducts. The study examines the effects of a single change in the duct wall's acoustic admittance in a rectangular duct with airflow that is infinitely long. The authors look at the acoustic behavior and sound transmission capabilities of these ducts.

[2] Corrugated-Duct Heat Transfer, Pressure Drop, and Flow Visualization by J. E. O'Brien and E. M. Sparrow's
A corrugated duct's pressure drop, flow visualization, and forced convection heat-transfer coefficients were measured in tests, you should say. The authors look into the efficiency of heat transmission and flow pressure drop characteristics in a duct with corrugated walls. They also provide illustrations of the flow patterns in the duct.

[3] Fully Developed Pressure Drop in Triangular Shaped Ducts by L. W. Carlson and T. F. Irvine's
It focuses on calculating the pressure drop in the hydrodynamic section of a triangle duct. Understanding how pressure drop behaves in fully developed flow conditions is the aim of the study. By examining the pressure drop, the authors provide insights into the flow characteristics and energy losses in triangular-shaped ducts.

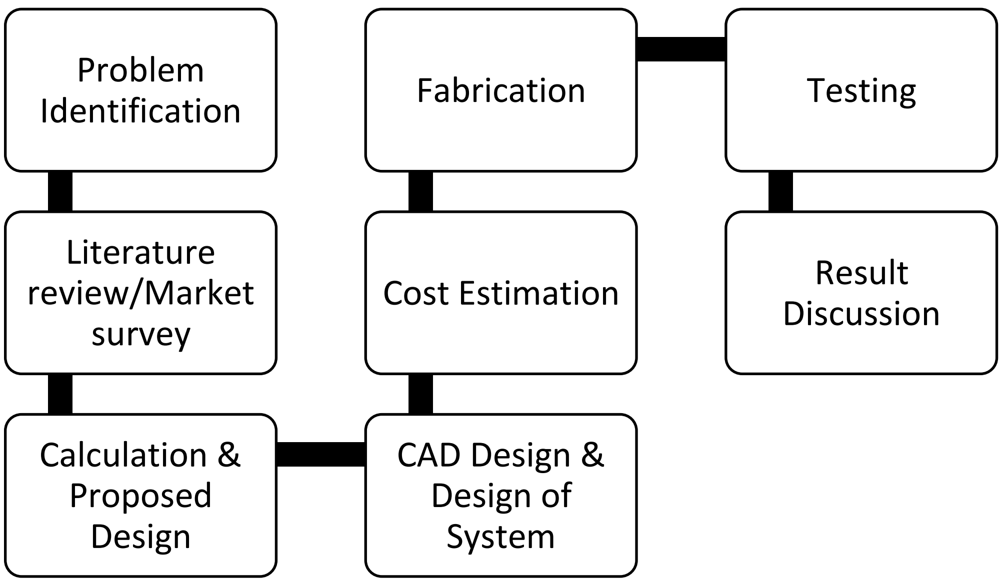
[4] Duct Designing in AC system & its Impact on system Performance by G.S. Sharma and Brijesh Sharma
Mention that a circular duct system has a smaller pressure drop than a rectangular one for a typical system made up of straight ducts, bends, and diffusers. So it is clear that for duct optimization, circular cross sections are preferred over rectangular duct systems for the aforementioned application; significant operating cost savings can be gained.

[5] Optimization of Heat Transfer through Rectangular Duct by Ravi Teja and Mandar Vahadne
Declares that the velocity distribution in a rectangular duct with 180 sharp corners demonstrates that the largest heat transfer rate is found at the stagnation point, where the velocity is zero and the corners have sharp edges.

[6] Duct Inspection and Cleaning Robot by Aditya Pratap Singh and Jitin Malhotraj
Declares that numerous contaminants, dust, germs, and fungus that cause human injury and degrade the capacity of the air conditioning are found in the ducts. We therefore achieve some noteworthy outcomes after employing this robot with cleaning brushes that thoroughly clean the ducts and keep the tubes free from fungi, bacteria, and dust. In this experiment, we calculated the dust concentrations in gm/m2. We obtained the maximum improvement of 98.22% while utilizing it with various types of ducting.

[7] Pressure Drop In And Noise Radiation From Rectangular And Round Ducts by O.A.B. Hassan And Z. Yue
Declare that the pressure loss through a rectangular duct is much more than that through a round duct of volume equivalent. The pressure loss in rectangular systems increases as the aspect ratio rises. It is also difficult to precisely estimate the turbulent friction factor in rectangular ducts. The measurement data in the literature clearly show that the prediction error of the friction factor always increases with aspect ratio.

V. METHODOLOGY



A. Specifications of the classroom:

1. Sitting Capacity =80 people
2. No Of Fans =4
3. No Of Light =6(3 LED & 3 CFL)
4. Projector =1
5. No Of Windows =6
6. No Of Doors = 2
7. Area Of Roof = Area of Floor=75.80 Sq.m

B. Heat emitting sources in the classroom

1. Peoples sitting in classroom
2. Numbers of Lights, fans other electrical appliances in the classroom
3. Windows exposed to sun
4. Walls in direct contact with sun
5. Walls not in direct contact with sun
6. Roof
7. Floor

C. Duct

A duct, also called a conduit, is a tubular passageway used to move fluids, gases, or air from one place to elsewhere. A duct is an enclosed passageway used in the context of cooling systems to deliver cooled air from a central air conditioner or air cooler to various rooms or regions of a structure.

1. Types of ducts: -
    a. Circular duct
    b. Rectangular duct
    c. Square duct

2. Different methods of duct design
    a. Velocity reduction method
    b. Equal friction method
    c. Static Regain Method

VI. DUCT DESIGN BY EQUAL FRICTION METHOD

(DESIGN TOOLS DUCT SIZER VERSION 6.4 MCQUAY)

M° = Q/(CP X ΔT)

where,

M° = mass flow rate kg/s
Q = (kW) heat load
Cp = Specific heat capacity (kJ/kgK)
ΔT = temperature difference
Cp = 1.026 (kJ/kgK) (standard value from ISHRAE)
ΔT = should be less than 10 °C
= 14.07 kW Total Heat Transfer
M° = 2.07 kg/s

M° = kW/(kJ/kgK.8K)
Density of Air = 1.2 kg/m3
Specific volume = Density-1
= 1.2-1 = 0.833 m3/kg
Formula: -

v° = m° X v

v° = volume flow rate (m3/s)
m° = mass flow rate (kg/s)
V = specific volume (m3/kg)
V = 2.07 X 0.833
V = 1.73 m3/s (1 cubic meter/second = 2118.8 cfm)

So,
v = 1.73*2118
= 3665 cfm

Considering factor of safety of 2.73
v = 3665×2.73=10,005CFM

VII. LOSSES IN DUCTS

A. *FRICTION LOSSES*

$P_{fr1} = \frac{f1l1v_1^2}{2\times\frac{dr1}{4}}$

Where f_1 = C-efficient of friction
L_1 =Length of duct 1 of right branch
V_1 =Velocity of air in duct 1 of right branch
D_{r1} =Diameter of first duct

Now,

$p_f = \frac{0.3164}{R_e}$ (For turbulent flow)

$$R_e = \frac{\rho v d}{\mu}$$

$$R_e = \frac{1.13 \times 6 \times 0.67}{19.12 \times 10^{-6}}$$

= 237.58 × 10^3

$$P_f = \frac{0.3164}{237 \times 10^3}$$

= 1.33× 10^{-6}

$$P_{fr1} = \frac{1.33 \times 10^{-6} \times 1.524 \times 6^2}{2 \times \frac{0.68}{4}}$$

= 2.178 × 10^{-4}m of air

Similarly,

$$P_{fr2} = \frac{1.59 \times 10^{-6} \times 1.524 \times 6^2}{2 \times \frac{0.55}{4}}$$

= 3.178 × 10^{-4}m of air

$$P_{fr3} = \frac{2.287 \times 10^{-6} \times 1.524 \times 6^2}{2 \times \frac{0.39}{4}}$$

= 6.436× 10^{-4} m of air

For left branch

$$P_{fr4} = \frac{2.287 \times 10^{-6} \times 1.524 \times 6^2}{2 \times \frac{0.39}{4}}$$

$=6.436\times 10^{-4}$ m of air

Total friction loss

$P_f = P_{fr1} + P_{fr2} + P_{f3} + P_{fr4}$

$= 2.178 \times 10^{-4} + 3.178 \times 10^{-4} + 6.436 \times 10^{-4} + 6.436 \times 10^{-4}$

$= 18.228 \times 10^{-4}$ m of air

B. *CONTRACTION LOSSES*

$P_c = k_1 \times k_{r1} \times (\frac{v}{4.04})^2$ mm of air

=0.0267 mm of air

C. *BENDING LOSSES*

Assuming 10% loss occurs due to bends provided in our system

∴Loss of flow rate due to bend = 0.1 × 10322 m^3/ h = 1032.2 m^{-3}/ Hr.

Power loss due to friction and contraction is=$\rho \times g \times Q \times h_f$

Where $h_f = P_f + P_c$

$= 18.228 \times 10^{-4} + 0.0267 \times 10^{-3} = 1.85 \times 10^{-3}$ m

∴Power loss due friction and contraction= $1.13 \times 9.81 \times 2.87 \times 1.85 \times 10^{-3}$

=0.058 watt

Which is very small as compared to power input for 24 inch fan i.e., 500 watt as per specification.

Therefore, the major loss is due to bends.

D. *SIZE OF DUCT*

We have flow rate = 2.87 m^3/sec

For left branch

Flow rate = 0.25×2.87

= 0.7175 m^3/sec

Now we have

Flow rate = area × velocity

0.7175=area ×6

Area=0.119 m²

∴Diameter, D_L = 0.39 m

For right branch

Flow rate = 0.71 × 2.87

= 2.1525 m^3 /sec

Now for first duct of right branch

Flow rate=area×velocity

2.1525 =area ×6

Area =0.3587 m²

∴ D_{r1} = 0.67m

For second duct of right branch

Flow rate = area×velocity

1.435=area×6
Area =0.239 m²

D_{r2}= 0.55m

For third duct of right branch

Flow rate =area × velocity

Flow rate = 0.25 × 2.87

= 0.7175 m^3 /sec

0.7175=area ×6

Area = 0.119 m²

∴Diameter, D_{r3} =0.39 m

Rectangular equivalent for diameter

$$D = \frac{1.265(a\times b)^{0.6}}{(a+b)^{0.2}}$$

Where a and b are sides of rectangular cross section

Now for D_{r1}Rectangular cross section = 32 × 16

For D_{r2}Rectangular cross section = 26 × 16

For D_{r3}Rectangular cross section = 18 × 16

For D_L-Rectangular cross section = 18 × 14

E. Required Specifications of duct and cooler

1. Cooler: -
   a. Metal body cooler
   b. 3 Wood Wool pads
   c. 900 rpm motor
   d. 33'' fan made of fiber
   e. 2 water pumps
   f. Diverter
   g. Pipes

2. Duct: -
    a. GI sheet material
    b. Gauge: - 24
    c. Powder coated double deflection aluminum grills

VIII. WORKING

We decided to use ducts to boost product efficiency and create duct rotating air coolers. We frequently employ the following items in our projects: the outer body, fan blade, motor, air filter, water pump, diverter, duct, nut, and bolt. Ducts are channels or tubes via which air is either delivered or evacuated, almost like conduits. The phase change cooling technology used by duct air coolers ensures the supply of fresh, cool air while also removing stale air from a space or area. These Duct Coolers may also serve the dual goal of supplying modern air/ventilation within the region or space during the weather condition or the winters. Conduits or air ducts are likewise useful in ventilation. A duct cooler directs the cool air to each area or room it is intended to cool by blowing it via metal conduits with the proper amount of pressure. Due to the air being forced through ducts and disseminated by a single or a number of shops, the management and flow of chilled air from a duct air cooler are both exemplary uniforms. Evaporation is the basis for how the cooling system operates. Simple controls make the chiller easy to use. The cooler's close air force, the air's interaction with the water, and the subsequent rise in the air's water content will illustrate how the operation works. Every phase change cooler contains a cooling medium. We utilized wood wool in our cooler because it is readily available and inexpensive everywhere. Dry air and vapor already make up the surrounding air, but when we use a cooling system, we tend to breathe more of it. In order to force the air forward at a great distance with the help of the axial flow fan, this type of cooler pulls the air in a centrifugal manner through the centrifugal flow fan. The wood wool covering the cylindrical cage is forced to let air through. Wood wool collects water from the cooler's storage tank as the cylindrical cage rotates inside the cooler with the help of a low-speed motor. When air is forced through the cylindrical cage, the wet wool cools the air and provides the cooling effect.

Fig. Duct Rotating Air Cooler

A. ADVANTAGES

1. Since the air cooler only has a fan and a motor pump, any problems are simple to fix. The cost of the repairs is likewise extremely low.
2. Air coolers raise humidity levels, which is beneficial in dry conditions.
3. The air conditioner is less expensive than this.
4. The product is simple to assemble.
5. Be able to move around with ease.

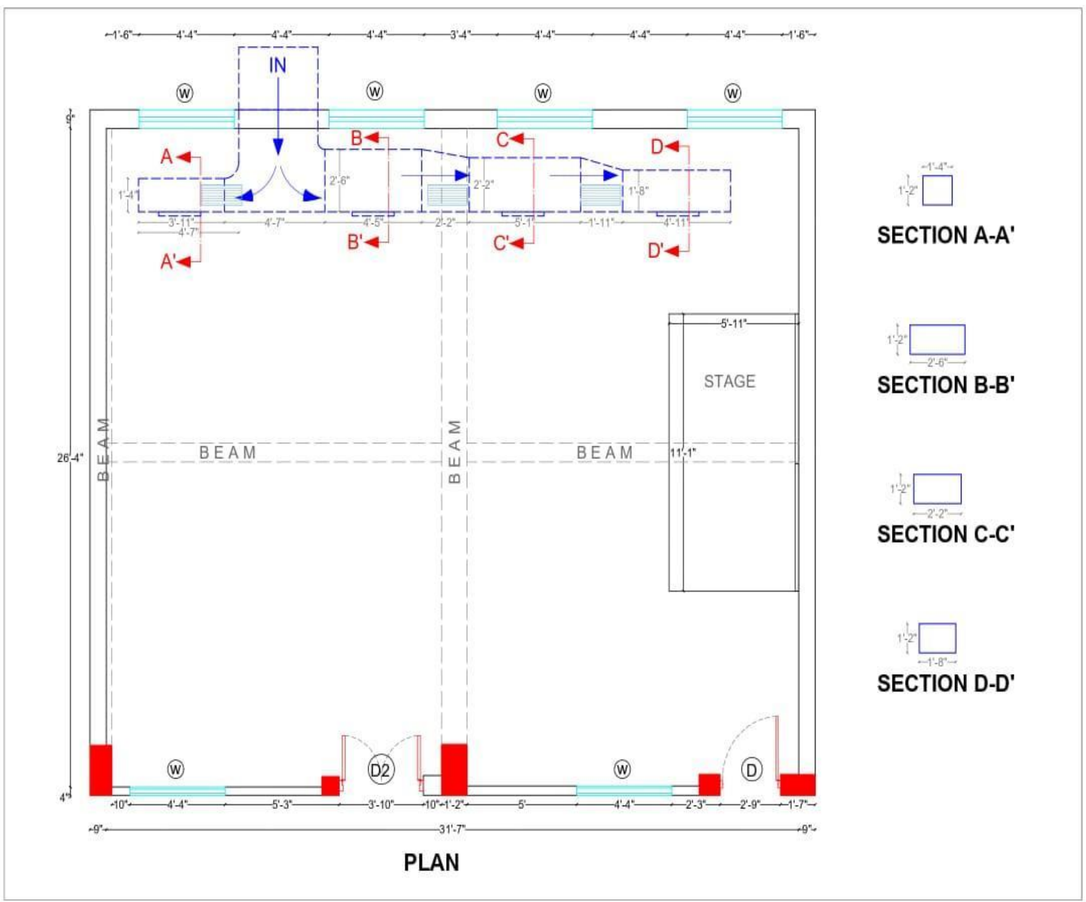
B. DISADVANTAGES

1. Air coolers make things wetter. Due to the increased degree of humidity during the summer, it will become uncomfortable.
2. The air cooler becoming a mosquito breeding ground is another disadvantage. Diseases spread as a result of it.
3. People who have asthma attacks should be extra attentive about the cleanliness of the air coolers.

C. Figures

As said, to insert images in *Word,* position the cursor at the insertion point and either use Insert | Picture | From File or copy the image to the Windows clipboard and then Edit | Paste Special | Picture (with "Float over text" unchecked).

IX. PROPOSED DESIGN



X. CONCLUSION

In conclusion, rebuilding and manufacturing existing duct systems can significantly improve thermal comfort, indoor air quality, and energy efficiency. To improve duct design, reduce fabrication mistakes, and boost duct performance, CFD models, sophisticated manufacturing techniques, and intelligent materials can be used. These developments in the design and manufacture of duct systems are essential for producing environmentally friendly and energy efficient buildings that also reduce operating costs and increase tenant quality of life. Redesigning and fabricating existing duct systems is an important area of research and development in the HVAC industry. Because to developments in materials, building processes, and design concepts, modern duct systems that can be adjusted for a multitude of applications are more effective, long-lasting, and versatile. More innovation in this area is possible as the demand for energy-efficient buildings grows, with the potential for even larger energy and operating cost reductions. The quality of the design and fabrication is satisfactory. To the fullest extent possible. This project combines an efficient operation with a competitive value. The chances of rust are decreased and the cooler's lifespan is extended as fewer components are returning in tune with the water. When compared to a normal air cooler, water consumption is low. The wood wool is versatile due to its uncomplicated design. a lot more hygienic than the standard air cooler since there isn't any water discharge because there isn't any water dripping outside the cooler. The cooler even cleanses the air that is about to leave the outlet by using the air filters on the side vents, giving us cleaner air in addition to cool air. greater ability to cool air than a standard air cooler

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