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Designing of Energy Efficient HVAC System

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ABSTRACT

The creation and execution of an effective duct and cooler system for educational settings are the main goals of this project. By enhancing indoor air quality and temperature control, the goal is to provide a pleasant and beneficial learning environment.

The project starts with a detailed examination of the existing laboratory circumstances, taking into account elements like space needs, occupancy, ventilation, and temperature. Appropriate design parameters are created based on this research to produce the best cooling and air dispersion. Determining the required air capacity and fan capacity is essential for achieving the desired cooling effect. Proper airflow distribution throughout the workplace is crucial to ensure that every area receives adequate cooling. Selecting fans with the appropriate capacity and efficiency will help maintain the desired comfort level while minimizing energy consumption.

1. INTRODUCTION

Under present scenario of global warming and climate change it becomes important to reduce the use of fossil fuel and the burning of other fuels. As majority of electricity today is made in thermal power plant and fuels are used for the combustion. In today's Indian energy scenario the price of electricity is high, for eg. In Maharashtra 1 unit of electricity is of 7 rupees, in this circumstances using an air conditioner is not an optimal option for energy conservation and reducing your electricity bill, the main purpose of air conditioner is to provide comfort to human by maintaining the right amount of humidity by humidifying or dehumidifying the space. In places like Nagpur where the humidity is less using a cooler duct is energy efficient and cost efficient. An air cooler duct (HVAC) uses evaporation of water and directing it to a space for cooling.

1.2 WORKING

A Cooler ducting uses evaporative cooling for cooling. Its cooling depends on the evaporative cooling, duct designing, Airflow regulation.

1. Evaporative Cooling Process: Evaporative coolers use the principle of evaporation to cool the air. Water is pumped from a reservoir onto a cooling pad. As warm air is drawn through the wet pads by a fan, the water evaporates, absorbing heat from the air and reducing its temperature. The cooled air is then pushed out into the ducting system.
2. Ducting Design:
   - Inlet: Cooler ducting usually begins with an inlet where cold air from the cooler is drawn into the system.
   - Distribution: The ducting system is designed to distribute the cooled air effectively.
   - Outlet: The cooled air is released into the lab space through outlets from a vent having an air deflector.
3. Airflow Regulation:
   - Variable speed fans: Evaporative coolers may feature variable speed fans to adjust airflow based on cooling requirements and outdoor conditions.

2.1 IMPROVEMENTS

The Improvements done in HVAC system compared to traditional HVAC involves considering factors such as energy efficiency, indoor air quality, and overall comfort. Here are several methods to enhance HVAC systems:

 Improved Insulation

- Insulation upgrades: using insulation (crosslink 10mm) for insulating the duct for less heat loss with the air is passing through the ducting.
- Air sealing: Seal gaps and cracks with proper packing material to prevent air leakage, reducing the workload on HVAC systems and improving comfort.

 Optimized System Design:

- Right-sizing equipment: Ensure HVAC systems are properly sized for the building's heating and cooling loads to maximize efficiency and performance.
- Ductwork optimization: Seal and insulate ducts to minimize air leaks and ensure efficient distribution of conditioned air throughout the building.
- Compact duct size: compact duct size to reduce the airflow loss and to reduce the price of material and construction.

2.2 Heat load calculations (for the space where cooling is required):-

I. Two types of wall area

1. Gross wall
2. Net wall area

Q = U x A x T

Where,

U= Overall heat Coefficient.

U= 1/ sumR

sumR = (Resistance of susbtance)

A= 34.6 x 16.2

= 560sq.ft

Δt = 106-76 = 30°F

1. Gross wall area

Q = U x A x T

A= 179 sq.ft

Δt = 30°F

ISHRAE STANDARD VALUES

SumR = $0.25 + \frac{1}{2} \times (0.12) + (8 \times 0.2) + \frac{1}{2} \times 0.12 + 0.25$

SumR = 2.2

U = $\frac{1}{SumR} = \frac{1}{2.2} = 0.45$ BTU/hr. F.Ft

∴ Q = UAΔt

Q= 0.45 x 138 x 30

Q= 1863 BTU/hr (1w = 3.14 BTU/hr)

Q= 593.31W

Q= 0.593kW

2. Roof area

Q= U x A x ΔT

U = $\frac{1}{SumR}$

U= $\frac{O}{A} \times \frac{1}{2} \times (C.P) + 8 inch\ brick + \frac{1}{2} \times (C.P) + I.A$

U= $0.25 \times \frac{1}{2} + 0.12 + 8 \times 0.08 + \frac{1}{2} \times 0.12 + 0.65$

SumR = 1.72

TAKING STANDARD ISHRAE VALUES

$U = \frac{1}{SumR} = \frac{1}{1.72} = 0.58$ BTU/hr F.ft

A = 30 x 14

A = 420sq.ft

ΔT = 106 – 76 = 30F

Q = U x A x T

Q = 0.58 x 420 x 30

Q = 7308 BTU/hr

Q = 2327.38 W

Q = 2.32 kW

Internal heat load

1. **People heat load**
2. **Lighting heat load**
3. **Electrical heat load**

1. **People heat load**

$$Q_s = \frac{\text{Sensible heat}}{people \ \times no.of\ people}$$

$$Q_l = \frac{\text{Latentheat}}{peoplw \ \times no.of\ people}$$

Ex. Lab room = 420 sq.ft = 3 people

Sensible heat (from the carts of ISHRAE)

For seated light office work = 245

Latent heat (from the carts of ISHRAE) = 155

Q_s = 245 x 3

Qs = 0.735 BTU/hr = 0.23 kW

Q_l = 0.465 BTU/hr = 0.14 kW

2. **Lightning heat load**

Q = watt/ sq.ft x 3.4

For office = 1.1 watt/sq.ft

Q = 1.1 x 420 sq.ft x 3.4

Q = 1570.8 BTU/ hr

Q = 0.50 kW

3.Electrical heat load

Q = total equipment load (watts) x 3.4

Q = 440 x 3.4

Q = 1,496 BTU/hr

Q = 438.70 w

Q = 0.45kw

TOATL HEAT =4.5KW

SINCE 3.5 KW = 1 TON OF AIR CONDITIONING

THEREFORE 4.5 KW = 1.3 TON ≈ **1.5 TON OF AIR CONDITIONIG**

A 1.5 ton air conditioner (AC) typically uses 1.2–1.5 kilowatt (KW) of electricity per hour, depending on the temperature. If the AC is used for 7 hours a day, it might consume around 360–480 units of electricity in a month

According to Maharashtra (India) price of electricity per units = 7 rupees per unit consumed

Assuming 480 units consumed per month = 7 x 480 = **3,360 rupees per month**

Therefore going for a cooler ducting is an optimal solution to reduce the power consumption

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