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Design of Air Conditioning System

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Abstract: *In this thesis we have proposed an HVAC system, which we have carefully selected and designed for an IT company, based on the blueprint which was provided. Our approach was to calculate the Heat Load of the whole floor which was dedicated for the IT company. We tried to closely observe every aspect of the floor or the company which can have an impact on our heat load calculation. The floor level, windows, number of rooms, partitions, the specific work has to be done in that compartment, the level of radiation, electronics, gadgets, sunlight entering from the windows, the time and duration of the outside heat and many more important factors we took into consideration. Based on our calculation we had to provide the best efficient system which can fulfill the needs and can assure the better Indoor Air Quality (IAQ) and human comfort. The system which we selected for this particular IT company was VAV. Variable air volume (VAV) is a type of heating, ventilating, and air-conditioning (HVAC) system, this VAV systems vary the airflow at a constant temperature.*

Keywords - *Air conditioning, Air Quality, Efficiency, Heat Load, Variable Air Volume.*

I. INTRODUCTION

In this era where air comfort is very important in industrial and domestic building it is necessary to design a HVAC system which fulfill the all the requirements of customers and give them good air quality and fresh comfortable air. HVAC stands for Heating, Ventilation, and Air Conditioning. HVAC is a systems which used for moving air between indoor and outdoor areas and also used for heating and cooling both residential and commercial buildings. They're the systems that keep you warm and comfy within the winter and feeling cool and fresh within the summer. They are the systems that filter and clean indoor air to stay you healthy and maintain humidity levels at optimal comfort levels.

Each component in your home could also be separate, like a radiant system combined with window air conditioning units. However, it's more common for combined systems like heating and AC systems that use a one blower to circulate air via internal ducts in every room, or with a ductless system for various rooms or zones within the house. The aim of an HVAC system is quite just warming or cooling an area. Instead, it serves to boost indoor air quality and supply comfort for everybody inside a building. While there are several different types of HVAC systems, all of them begin with the identical essentials.

First, there's a source of fresh air intake from the outside or from within the house. This process is named as ventilation, and it happens in two alternative ways. Natural ventilation is present in most houses and refers to the way air typically moves in and out through windows, doors, vents, and other openings. This exchange of air is necessary to replenish oxygen, and get rid of odors, co2, unpleasant odors, and excessive moisture. We design VAV central air conditioning system for our project. VAV air conditioning system design as per the need of building and calculation of heat load. Central air conditioning plant component sequence and specification design to get maximum efficiency. In this project we introduce VAV central air conditioning system for better air quality and comfortable air temperature for employee of an IT building as well as for the processors use in IT building.

II. PROBLEM DEFINITION

2.1 Problem Statement

These are the some problems which we faced during the selecting designing of the system:

- VAV air-handler sizing
- ventilation control with VAV system
- VAV system zoning
- duct sizing
- duct design for VAV systems
- zone temperature sensors
- noise
- multiple zones serving a large zone
- number of VAV boxes 17

2.2 Objectives

- HVAC system selection and design for an IT company
- Design complete energy efficient HVAC system with all important sub system
- Assuring better IAQ measures undertaken to address human comfort and taken care of foul air to avoid suffocation
- Optimizing fresh air loads by maintaining appropriate ADP and BF which directly effects on energy efficiency of the system

III. METHODOLOGY

3.1 Variable Air Volume Systems -

In the central air conditioning there are two basic methods for supply air to the conditioned space

1 the constant air volume (CAV) systems and
2 the variable air volume (VAV) systems.

As per the name, constant volume systems provide a constant air volume to the conditioned space irrespective of the load with the air conditioner cycling on and off as the load varies. The fan may or might not still run during the off cycle.

VAV system, on the opposite hand, are designed to simultaneously meet a spread of cooling and heating loads during a relatively efficient manner. The system achieves this by varying the distribution of air counting on the cooling or heating a lot of each area. The air flow variation allows for adjusting the temperature during a single zone without changing the temperature of air within the whole system, minimizing any instances of overcooling or overheating.

3.2 VAV Air-Handler Sizing -

By using Diversity factor. The sizing of a VAV AHU is slightly different, as not all of the VAV zones will be at maximum heat load at the same time of the day. We had done heat load calculations for each VAV box zone at different times of the day. The scale of the VAV AHU is then based on worst case calculation of zone loads.

3.3 Ventilation Control With VAV System -

A minimum outdoor airflow must be introduced in most air handling systems to confirm good IAQ and to pressurize the building. The quantity of ventilation air is set in accordance with ASHRAE Standard 62-89, which requires a minimum of 20 CFM per person.

3.4 VAV System Zoning -

As it is a commercial building office, typically the areas closest to the windows will be used as closed offices and each office should be an individual zone.

Using the common partitions as a single whole room or zone were same type of work has to be done or that occupancy going to be remain constant will help to maintain the overall temperature and helps in simpler zoning

3.5 Duct Sizing -

We are using the standard duct sizing method for our system. For variable air volume systems, the main supply duct should be designed for 1500 ft/min to 2000 ft/min and the branch leading into the VAV box should be designed for 1000 ft/min. If the ductwork at the inlet of the VAV box is just too large, the flow measuring station will only be employing a fraction of the range leading in inaccurate readings when there's not much load within the space.

3.6 Duct Design For VAV Systems -

Duct sizing is sometimes accomplished by one amongst the following methods.

a. Equal Friction
b. Static Regain - The essential principle of the static regain method is to size a duct run that the rise in static pressure at each take-off just offsets the loss due to friction within the succeeding section of duct. Static regain occurs when air slows down

3.7 Zone Temperature Sensors -

It is the foremost visible a part of the system. One among the benefits of VAV systems is that the ability to own a separate temperature sensor to regulate each zone.

3.8 Noise -

VAV box manufacturers provide two forms of sound data: discharge and radiated. Discharge noise is never a problem if the box has hard duct on the inlet, a lined outlet plenum and flex duct between the plenum and diffusers.

3.9 Multiple Serving a Large Zone -

In this case, one or more of the boxes will have a zero minimum (airflow setpoint), as long as at least one box has a non-zero minimum (airflow setpoint) that may meet the minimum ventilation requirements for the whole zone

3.10 Energy Efficiency -

VAV systems provide small zones within the building where the temperature for every is controlled by varying the number of conditioned air being supplied. A building with many VAV zones increases the chances of occupant comfort satisfaction.

IV. FIGURES AND TABLES

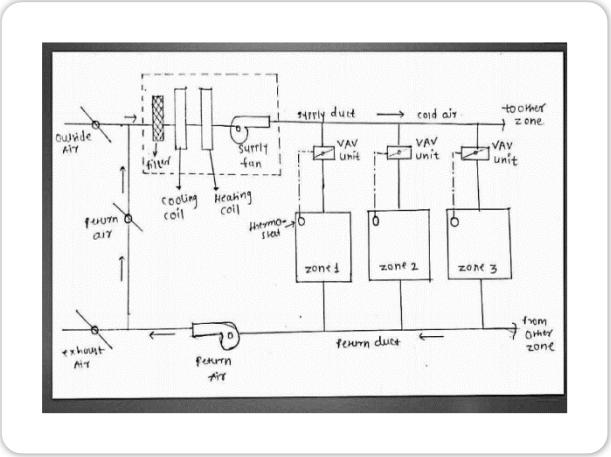

Fig.4.1: Block Diagram of VAV system

3.11How a VAV system works?

What distinguishes a variable air volume system from other sorts of air delivery systems is the use of a variable air volume box up the ductwork. The most basic VAV box consists of an enclosure with a bit air valve (damper) that regulates the air flow in response to the room's thermostat.

In a VAV system, an air handling unit (AHU) cools or heats air to accommodate the zone with the foremost extreme requirements, supplying the air through ducts to varied zones. At the individual zone or space, the quantity of air to be provided is regulated by air valves within a VAV box or terminal.

As the load decreases during a particular zone, the VAV air valve throttles the airflow matching the space requirements. Also when there's a sudden increase in load, the temperature sensor located within the zone will detect an rise in temperature and request the VAV box to open the air valve and increase the number of cool air flow. When a VAV box air valve closes, the static pressure in the adjacent runout and trunk duct will rise, resulting in increased airflow through the adjacent ductwork. This transformation in airflow will affect the space temperature within the new area supplied by that ductwork because a higher volume of air (usually cooled) is now flowing into the area.

The VAV system take outside air and returns air to the Air Handling Unit where both are mixed together. The mixed air is flow through a cooling coil, which decrease the temperature to a fixed supply air temperature. The temperature in the individual room is measured by thermostats, which directly control the dampers within the VAV units. The supply air fan is speed fluacuate by a variable speed drive, which controls the air volume by maintaining the duct static pressure constant. The pressure is measured by the sensor which is mounted approximately 2/3rd of the way down the main duct starting air handling unit. As per the zone dampers throttle back, the duct pressure increases, and the fan is controlled to decrease the duct pressure.

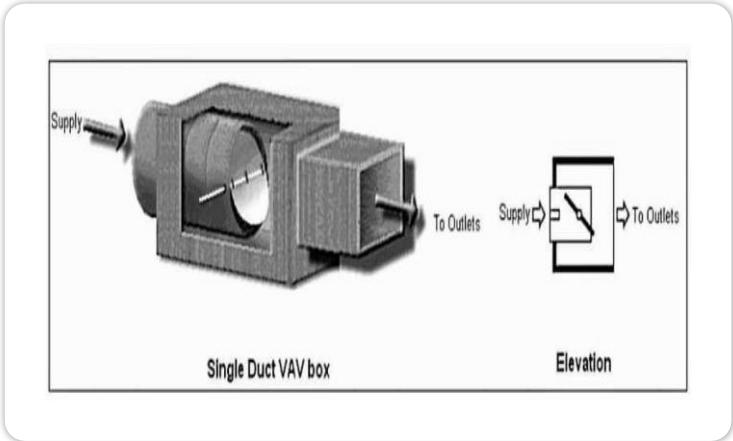

Fig.4.2: Single Duct VAV box

Fig 4.2 - A single duct VAV, also referred to as cooling only VAV is one among the foremost basic airport terminal units consisting of a damper, actuator, flow sensor and selected controls. It is simply an enclosure or box with single inlet and single outlet with an air valve in between.

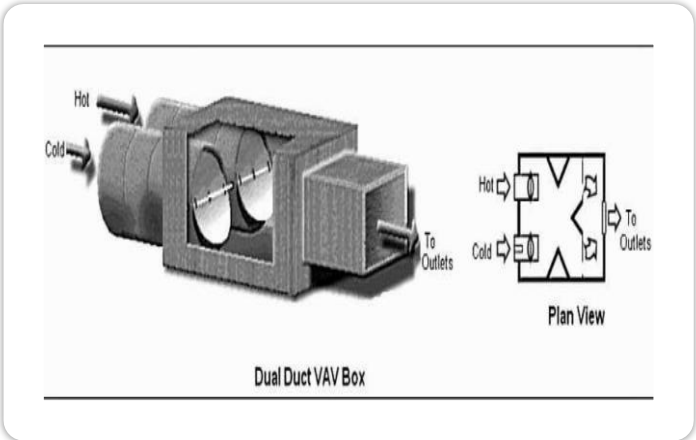

Fig.4.3: Dual Duct VAV Box

Fig 4.3 - A dual duct VAV have two primary air inlet connections, two primary air dampers, inlet velocity sensors, and a zone controller on the side of the box. The dual duct VAV terminal is full with both hot and cold air. When the space is require for full cooling, the cold deck damper opens to its maximum design CFM while the recent deck damper goes closed. The opposite happens when the space is require for full heating. What makes this box so unique is that when the space temperature is meet requirement the 2 dampers will mix its hot and cold air to supply the constant design flow without overheating or cooling the space.

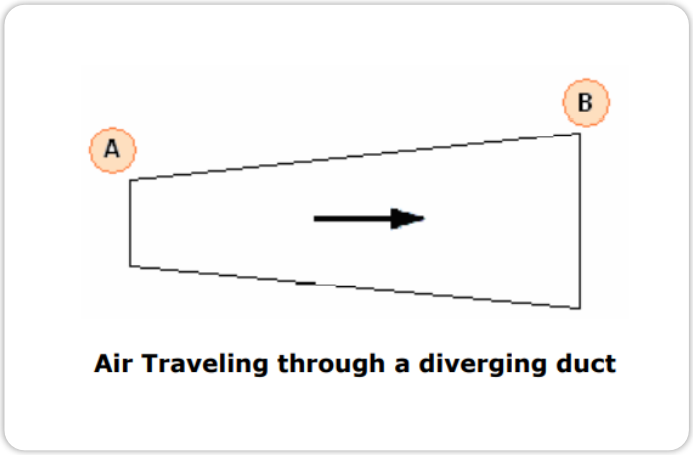

Fig.4.4: Duct Design

Fig 4.4 - duct design for VAV systems Correct duct design is that the most crucial item in the design of a decent VAV system. A decent duct system must be able to deliver air at approximately the identical pressure to all or any the VAV boxes served by the ductwork system and be able to withstand the pressures that may be encountered with not more than 5% leakage. Duct sizing is typically accomplished by one of the following methods.

1. Equal Friction
2. Static Regain

The equal friction method is that the more common one and because the name implies, it result in a system within which the duct static pressure reduces at a constant rate down the length of the duct. This method is ok for constant volume systems where manual duct dampers could also be used to throttle the airflow and acquire a balanced system. The throttling damper after all destroys the static pressure - it's important to know that a volume control damper is primarily a static pressure reducing device – the air flow can not be reduced unless the static pressure loss is increased. Volume flow rate through a diffuser is therefore directly associate with static pressure in the duct. To induce more air out of a diffuser, reduce the static pressure loss by opening the throttling damper.

Equal friction designed duct isn't complimentary to be use with complex VAV systems and it's essential to use the static regain method of duct sizing.

V. CONCLUSION

This system meets the needs of current fast track projects and at the same time ensures that the building gets the environmental system that will best fit its needs. Occupancy of zones can vary considerably with time. Considering an example, conference rooms can have highly varying occupancy over the course of a day and load is high. At times, they may be fully occupied (at the design occupancy), but at other times, there is low load due to low occupancy, may be a fraction of the design value, or the room may be entirely unoccupied. Constant minimum air flow set points for terminal boxes are still determined in the field largely using rules of thumb rather than computations for each terminal box and zone. This leads to excessive fan power consumption and potentially significant unnecessary reheating of air in terminal boxes before discharge into the zones. It can also result in excessive cooling of supply air by the air handler. Variable Air Volume technology is that the most viable technology in today's modern buildings both for energy efficiency and performance. The VAV boxes can be preconfigured with Building Automation System, which allows the facility manager to: ● Helped in maintaining desired temperature over vast area and zones ● Proper IAQ value is achieved ● Human comfort is achieved ● More energy efficient ● Display all the zone temperatures in an area on a graphic ● Adjust the individual set-points of zones from a central location ● Maintain historical records of zone temperature values. Occupancy of zones can vary considerably with time. considering a example, conference rooms can have highly varying occupancy over the course of a day. At times, they may be fully occupied (at the design occupancy), but at other times, occupancy may be only a fraction of the design value, or the room may be completely unoccupied (with no ventilation being required).

REFERENCES

Journal Papers:

[1] Prahlad Patel, Hamant Amhia, "Modeling and Simulation of HVAC System Fault", *International Journal of Science and Research (IJSR),, Volume 1 Issue 3, December 2012, 84 – 86*

[2] Vineet Kumar, Rajneesh Kumar Gautam, "Energy Auditing of a Commercial Building ? ?Optimization of HVAC System & Solar Assisted Heat Pump?", *International Journal of Science and Research (IJSR), Volume 5 Issue 7*, July 2016, 657 – 660

[3] Mohd Amir, Fithry, Yusoff, Mohd Zamri, "Numerical Investigation of a Single Phase Air Flow inside Porous Media of a Cross Flow Cooling Tower", *International Journal of Science and Research (IJSR), Volume 2 Issue 9*, September 2013, 345 - 350,

[4] Sharad Chaudhary, Santosh Kansal, "Performance Analysis of Backward curved Centrifugal fan in Heating Ventilation and Air-conditioning*", International Journal of Science and Research (IJSR), Volume 2 Issue 6*, June 2013, 170 – 172

[5] Ramadan Alushaj, Flamur Bidaj, "Active Chilled Beam (ACB) System, Solution with the Best Economic Life of High-Rise Buildings with High Thermal Mass and Low Cooling Capacity Load", *International Journal of Science and Research (IJSR), Volume 9 Issue* 11, November 2020, 1375 – 1380

[6] Singh O.P. 2011, "Parametric study of centrifugal fan performance*". International Journal of Advance Engineering & Technology 1,(2)*,pp 33-50.

[7]] Max M. Samfield, HVAC systems as a tool in controlling indoor air quality (IAQ), National Service Center for Environmental Publications (NSCEP) pp. 45-48, 1996.

[8] Sharad Chaudhary, Santosh Kansal Performance Analysis of Backward curved Centrifugal Fan in Heating Ventilation and Air-conditioning, pp. 170-172, 2013.

[9]] Yared Brhane Modelling and Designing HVDC Transmission Line Using Controlled rectifier and Voltage Source Inverter, pp. 387-391, 2020

Books:

[10] R.S. Khurmi, J.K. Gupta, *Refrigeration and Air Conditioning, Fifth Edition* (New Delhi, Eurasia publishing house, 2011).