DESIGN OF AIR CONDITIONING AND VENTILATION SYSTEM FOR A MULTI-STOREY OFFICE BUILDING

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Abstract

This project consists of how the proposed centralized air conditioning and mechanical ventilation system is designed and its criterion for a new building in Hyderabad. It consists of seven floors and two basements having an area of 39000sft per floor. The two basement (lower and upper) and major part of ground floor shall be meant for offices with a total area of 273000sft.

The main objective is to create a thermally controlled environment within the space of a building envelope such as office space, BMS room, society room, entrance lobby etc. and building mechanical ventilation namely basement ventilation, staircase pressurisation, lift well pressurisation, toilet exhaust etc. Design and planning of the above system shall meet the required below customer objectives, like econoical in cost,energy efficient,simple and flexible with respect to operation and maintenance.

The tentative air conditioning load for the system shall be 800TR apprix. Air cooled screw chillers with secondary variable pumping system are proposed to make the system energy efficient. The proposed air conditioning plant shall be located on the sw side on the building terrace.

keywords: *chillers, variable air volume, air handling unit.*

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1.INTRODUCTION

Air conditioning systems are generally divided into four basic types determined by the method through which the final with in the space cooling and heating are attained, the air surrounding the occupant is the end medium which is conditioned. In some systems most of the thermal effect is radiant.

The basic types are,

1. All – water systems,
2. All – air systems,
3. Air – water systems,
4. Heat pump.
5. Unitary refrigerant based systems.

Existing vs. new structures:-

There is a distinct difference between systems available for existing or new buildings. in exiting enclosures or structures heating and at times ventilation is already supplied.

The additional system is cooling only, the adapting and integrating the existing heating ventilation into a year around cycle.

The H07 building comprise of two basements,ground and 7th floors.

The two basements (lower and upper) and major part of the ground floor shall be meant for car park and utility areas. The balance part of Ground Floor contains Entrance lobby, Society room, BMS room, office space.

The upper floors (1st to 7th floor) shall be meant for offices. Each floor of office space is divided into areas known as left and right wings

1.1 Air Conditioning Load Estimate

The air conditioning load is estimated to provide the basis for selecting the conditioning equipment. It must take into account the heat coming into the space from outdoors on a design day, as well as heat being generated within the space. A design day is defined as:

1. A day on which the dry – and wet bulb temperatures are peaking simultaneously,
2. A day when there is little or no have in the air to reduce the solar heat gain thru glass.
3. All of the internal loads are normal
4. The air vapour pressure – a higher vapour pressure surrounding conditioned space causes water vapour to flow thru the building materials.
5. The wind blowing against a side of the building – wind causes the outdoor air that is higher in temperature and moisture content to infiltrate thru the cracks around the doors and windows.

6. Outdoor air usually required for ventilation purposes – outdoor air is usually necessary to flush out the space and keep the odour level down.

1.2 Internal Loads

The internal load or heat generated within the space, depends on the character of the application. Proper diversity and usage factor should be applied to all internal loads.

Generally,an internal heat gain consists of the following items:

1. People – the human body thru metabolism generates heat with in itself and releases it by radiation, convection, and evaporation from the surface, and by convection and evaporation in the respiratory tract.
2. Lights – illuminates convert electrical power into light and heat.
3. Electric motors – electric motors are significant load in industrial applications and should be thoroughly analyzed with respect to operating time and capacity before estimating the load.
4. Hot pipes and tanks – steam or hot water pipes running thru the air conditioned space , or hot water tanks in the space, add heat.
5. Miscellaneous sources – there may be other sources of heat and moisture gain with a space, such as escaping steam
6. (industrial cleaning devices, pressing machines, etc)

In addition to the heat gains from the indoor and outdoor sources , the air conditioning equipment and duct system gain or lose heat. The fans and pumps required to distribute the air or water thru the system and heat, heat is also added to supply and return air ducts running thru warmer or hot spaces.

2. SOLAR HEAT GAIN THROUGH GLASS

Solar heat gain through glass can be calculated as under: Solar heat gain through glass BTU / hr

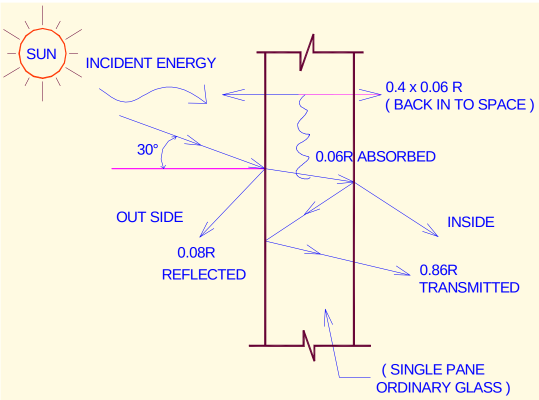


Figure 1.GLASS AREA in SFT x SUN GAIN x OVERALL FACTOR.

The solar heat gain through ordinary glass depends on its location on the earth surface. Time of the day, time of the year, and facing direction of the window. The direct radiation component results in a heat gain to the conditioned space only when the window is in the direct rays of the sun, where as the diffuse radiation component results in a heat gain, even when the window is not facing the sun.

Ordinary glass absorbs a small portion of the solar heat (5% to 6%)and reflects or transmits the rest.

Heat gain to space = 0.86 r + (0.40x0.06 r) = 0.88 r

- absorptivity + reflectivity + transmissibility = i
- the amount of reflection & transmission depends on angle & incidence

3.TRANSMISSION GAIN THROUGH GLASS

Transmission gain through glass can be Calculated as under:

Transmission gain through glass BTU/HR = AREA in SFT x 1.13 x (OUTSIDE – INSIDE TEMP. DIFFERENCE^{O}F)

4. HEAT GAIN FROM PEOPLE

Heat is generated within the human bodyby oxidation, commonly called metabolic rate. The metabolic rate varies with the individual and with his activity level. The normal body process are performed most efficiently at a deep tissuetemperature may vary only thru a narrow range. However the human body is capable of maintaining this temperature range.

The term air-conditioning is usually used in a restricted sense to imply cooling,but in its broad sense it means to condition the air to the desired level by heating, cooling, humidifying, dehumidifying, cleaning, and deodorizing. The purposeof the air-conditioning system of a building is to provide complete thermalcomfort for its occupants. Therefore, we need to understand the thermal aspectsof the human body in order to design an effective air-conditioning system.The building blocks of living organisms are cells, which resemble miniaturefactories performing various functions necessary for the survival of organisms.The human body contains about 100 trillion cells with an average diameterof 0.01 mm.

BASIS OF DESIGN FOR AIR CONDITIONING SYSTEM FOR GANGA HITECH CITY 2- SOCIETY, HYDERABAD

Sl	Level	Location	Area (sft)	Inside Conditions	Occupancy	Fresh Air (cfm)	Dehumidified air qty (cfm)	Cooling load (TR)	Total Load (TR)	Capacity of AHU's Proposed
1	GF	BMS	465	22Deg C, 55%	4	101	2104	4	4	2200 cfm / 5 TR
2	GF	Lift lobby	885	24Deg C, 50%	7	194	2657	7.00	7	3750 cfm / 10 TR
3	GF	Entrance Lobby	835	24Deg C, 50%	8	183	2532	7.00	7	3750 cfm / 10 TR
4	GF	Society Room	1987	24Deg C, 50%	15	435	4651	12.00	12	3000cfm / 7.5 TR
1	1	Grid BF - 2, 12	14500	24Deg C, 50%	190	3178	27656	68.00	68	30000cfm / 65 TR
2	1	Grid FJ-2, 12 + Grid JP-7,12	15000	24Deg C, 50%	200	3281	21374	57.00	57	26000 cfm/ 55 TR
3	2-6	Grid BF - 2, 12	14500	24Deg C, 50%	210	3178	24117	63.00	315	30000 cfm/ 65 TR
4	2-6	Grid FJ-2, 12 + Grid JP-7,12	15000	24Deg C, 50%	220	3300	18362	52.00	260	26000 cfm/ 55 TR
5	7	Grid BF - 2, 12	14500	24Deg C, 50%	190	3178	24097	62.00	62	30000 cfm/ 65 TR
6	7	Grid FJ-2, 12 + Grid JP-7,12	15000	24Deg C, 50%	200	3281	18223	52.00	52	26000 cfm/ 55 TR
	Total Peak Summer Cooling Load (TR)								844	
	With diversity factor of 0.8								675	
	Proposed Chillers : 220TR Nominal capacity chillers - 4 Nos. (3w*+1s)									
	* Note : 4th Chiller also shall be working during peak summer to meet the building load. Hence, system is designed considering 4 chillers and 4 pumps working.									

5. EQUIPMENT SELECTION

After assessment of Air conditioning load, equipment must be selected with enough capacity to offset this load. The air supplied to the space must be of the proper conditions to satisfy both the sensible and latent loads estimated.

5.1. The Major Equipment Involved In An Central Air Conditioning System :

- Chillers
- Primary pumps
- Secondary pumps
- Air handling units

a) Air-Cooled Chillers

The Chillers are Energy Efficient and Robust in construction. They are developed with state of art technology components. The chillers are fitted with R-134a optimized BitzerCSH3 series Semi-hermetic Screw Compressors, High efficiency DX Coolers and Aircooled Condensers. The latest generation High Efficient Copper tubes are incorporated in the Coolers. Electronic Expansion Valves and the new generation MCS Magnum Controller lead to precise control of refrigerant flow and chilled water temperature. Specially developed low noise Bird Wing design fans are used for optimum air flow.

Acoustic enclosure for compressor can be offered as an optional feature to reduce noise level. Special coatings on aluminium condenser fins can also be offered for better corrosion resistance required in coastal / industrial environments

6. Air-Cooled Versus Water-Cooled Chillers

Operating Cost:

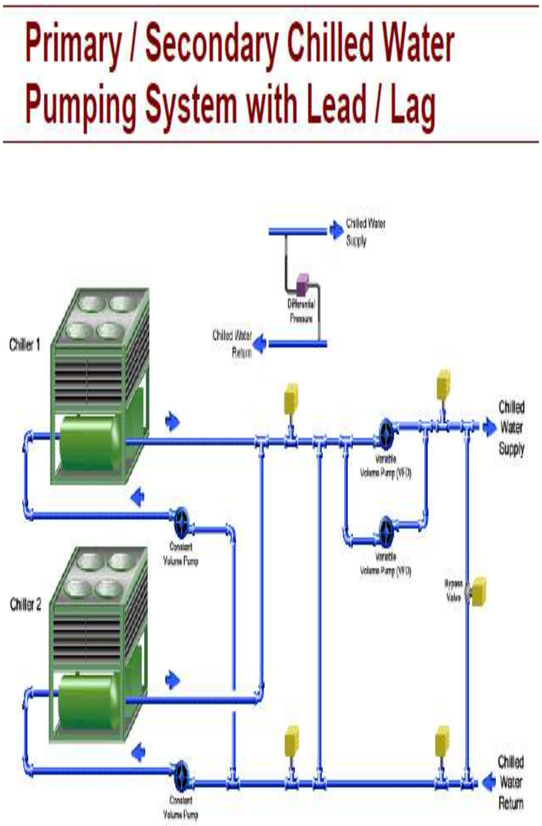
When compared to water-cooled chillers, air-cooled systems that function without any condenser water pumps or water cooling towers require lower initial installation and maintenance costs. However, lower condensing temperature of water-cooled chillers can offset this high installation cost.

b) Basic Chilled Water Pumping System

• Single Chiller, Single Constant Speed Pump
• 3-way valves for all Chilled Water Coils (or even more basic – no valves – full flow) maintains constant flow.
• Control strategy: Enable chilled water pump when outside air temperature is above
set point and at least 1 chilled water coil control valve is open to coil. Enable chillerafter flow is proven. Chiller operates to maintain leaving chilled water temperature atsetpoint. Coil valves modulate to maintain comfortable space conditions.[7]

7. Basic Primary / Secondary Chilled Water Pumping System

• Single Chiller, Single Constant Speed Primary Pump, bypass loop with no valve, Variable Speed Secondary Pump.
• The primary pump pumps water through the chiller. The secondary pump pulls water from the primary system and pumps it to the coils.
• Add a Water Differential Pressure Transmitter near the end of the piping run (in an accessible location).
• VFDs and pumps have minimum recommended operating speeds,typically about 20%. Use 3-way valves for 1 or more coils to ensurethat there is always this amount of water flowing in the secondary loop. My recommendation is to use 3-way valves at units that are expected to have full occupancy for the most hours and not atGymnasium or other units that serve areas where significant operating time is at less than full occupancy (partial / low load areas).
• Control strategy: Enable both primary and secondary chilled water pumps when outside air temperature is above setpoint and at least 1chilled water coil control valve is open to coil. Modulate (vary) thespeed of the secondary pump VFD to maintain a constant differentialpressure. Enable chiller after flow is proven. Chiller operates tomaintain leaving chilled water temperature at setpoint. Coil valvesmodulate to maintain comfortable space conditions.



8. VARIABLE VOLUME / VARIABLE SPEED

VARIABLE SPEED PRIMARY CHILLED WATER PUMP CONTROLWITH TWO WAY VALVE DIRECT RETURN SYSTEM

DESCRIPTION:

The volume of water supplied to the system is[4] varied in response to the cooling load by the two-way zone valves. The basis of variable speed pumping is to save pumping cost by optimizing the pump motor horsepower input. The pump produces only the flow and head required at any time. This is performed by regulation of the pump speed/adjustable frequency drive and modulation of a bypass valve through the use of the Technologic™ Controller. The controller regulates the pump speed and valve position in response to the system load conditions and in order to protect the pumps and chillers.

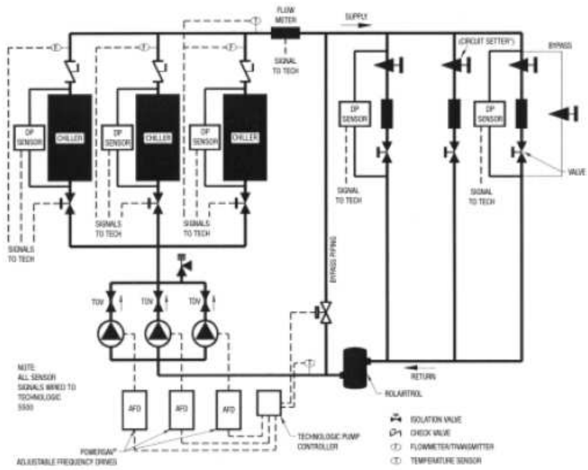


Fig . VARIABLE SPEED CHILLED WATER PUMP CONTROL VARIABLE SPEED PRIMARY SYSTEM WITH BYPASS AT THE CHILLERS

Reduce Energy Consumption.

Utilizing the variable volume system (two-way terminal control valves), the pumping energy can be reduced by more than two-thirds that of a constant speed pumpingsystem riding its pump curve.

The variable speed system responds to a differential pressure sensor/transmitter, which is sensing across a terminal and two-way valve. This allows for energysavings as the terminal responds to a lighter load and the two-way valves control at a lower flow position. This increased pressure drop signals the controller to operate the pump(s) at a lower speed to maintain its set point.

Applications that operate for a high percentage of time at part load will utilize the variable speed, energy savings potential of variable primary systems by loweringspeed, thus consuming less energy during lighter loads. Those that operate at full load but with lower that design return water temperature benefit in a similar manner by slowing down the pumps to an adequate rate, thus maintaining optimal return temperature, allowing the chiller(s) to operate more efficiently.

C) Air Handling Apparatus

Air handling apparatus can be of three types

a) Built up apparatus where the casing for the conditioning equipment is fabricated and installed at or near the job site

b) Fan coil equipment that is manufactured and shipped to the job site, either completely or partially assembled; and

c) Self-containedequipment which is shipped to the job site completely assembled.

LOCATION

The location of the air handling apparatus directly influences the economic and the sound level aspects of any system

9. ECONOMIC CONSIDERATION

The air handling apparatus should be centrally located to obtain a minimum-first cost system. In a few instances, however, it maybe be necessary to locate the apparatus,refrigeration machine,and cooling tower in one area, to achieve optimum system cost.

When the three components are grouped in one location, the cost of extra ductwork is offset by the reduced piping cost. In addition, when the complete system becomes large enough to require more than one refrigeration machine, grouping the mechanical equipment on more than one floor becomes practical. This design is often used in large buildings.

The upper floor equipment handles approximately the top 20 to 30 floors , and the lower floor equipment is used for the lower 20 to 30 floors.

General Arrangement of AHU 2 (30000 cfm)

10. RESULT:

1. Air balancing is done measuring the velocity of air using digital anemometer thus by arriving volume of the flow (flow=area x velocity), regulating volume control dampers in the ducts and controlling collar dampes provided in the air terminal.
2. Water balancing is done as per designed flow rate using double regulating balancing value by taking differential pressures across the valve to ensure water flow as per the design.
3. Temperature and relative humidity is measured is all the conditioned area and recorded that 23 Deg C temp and 55to 58 RH, using digital temperature & RH indicator.
4. Variable air volume thermostat is set for 23Deg c and observed that air volume is getting reduced as the VAV actuator will close the damper proportionately on achieving set temperature of 23c. Similarly VAV actuator opens the damper proportionately on increase of inside the cabin temperature.

11. SCOPE OF FUTURE WORK:

Building automation system consists of Start / stop manual auto switches along with potential free function for monitoring the manual peration status, can be provided for those equipment whose start stop is controlled by building automation system.

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