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Design of HVAC Central Air Conditioning System

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Abstract: The field of Heating Ventilation and Air Conditioning design of a centralized air conditioning system for any building is more technologically challenging than ever. While design innovations and product improvements promise sleeker, more versatile, more powerful and more energy–efficient air conditioners, the challenge today lies in identifying the most appropriate product, or mix of products, for the application at hand.
With reference to the building plan of university and requirement of the case problem, air conditioning load is estimated for seasonal conditions. This paper is titled as "Design of HVAC Central Air Conditioning System".
This project is carried out on an Air Cooled Chiller cycle which is way-more efficient than other cycles in terms of effectiveness, maintenance and cost. It uses air to cool down the condenser coils not water as in the case of Water Cooled Chillers, as the running cost gets increased and water may not be sufficient.
The aim of this project is to design heating ventilation and air conditioning (HVAC) system for an approximate 60000sft area University building, simultaneously control in temperature, humidity, proper air distribution, controlled noise level, Thermal comfort, energy efficient and cost efficient. The project includes cooling load calculations, fresh air, ventilation, exhaust design, duct design, pipe design, layout of accessories such as indoor and outdoor units and energy efficiency obtained on the project wherever necessary. Load Calculation will be done using Hourly Analysis Program Software (HAP), while the duct sizing and pipe sizing will be done using McQuay duct and pipe sizer and drafting with AutoCad.
Keywords: Air conditioning, Air cooled chiller, University building, Supply/return ducts, chiller piping.

I. INTRODUCTION

A chiller is a vapour pressure mechanical refrigeration framework that associates with the procedure water framework through a gadget called an evaporator. The evaporator is a warmth exchanger in which warm caught by the procedure coolant stream is exchanged to the stream of refrigerant liquid. As the warmth exchange happens, the refrigerant dissipates, transforming from a low-weight fluid into vapour, while the temperature of the procedure coolant is lessened down the coveted LWT. Next, the refrigerant streams to a compressor, which performs two capacities. In the first place, it expels refrigerant vapour from the evaporator and guarantees that the weight in the evaporator refrigerant line (vapour weight) stays sufficiently low to retain process warm at the right rate. Second, it brings the weight up in active refrigerant vapour to guarantee that its temperature is sufficiently high to discharge its warmth when it achieves the condenser, where the refrigerant comes back to a fluid state.

The idle warmth surrendered as the refrigerant changes from vapour to fluid is diverted to the earth by a cooling medium (air or water). In this manner, there are two sorts of condensers: air-cooled and water-cooled.

Air-cooled condensers look like the "radiators" that cool vehicle motors. They utilize a mechanized blower to drive air over a lattice of refrigerant lines.

A. Air-cooled chillers

Air-cooled chillers have many advantages over water-cooled equipment. While it is true that water-cooled equipment can offer better performance, by the time the condenser pumps and water cooling tower fans are included, the performance difference is not as big as you might think. In fact, at part load conditions, there might not be any difference at all. The biggest advantage of using air cooled chillers is that they do not require cooling towers or condenser water pumps. While this has traditionally made air-cooled chillers very popular with small to medium projects, it is becoming more common to see large plants (2,000 tons and larger) that use air-cooled chillers.

Fig 1: Air cooled chiller

Another favourable position of air-cooled chillers is they don't require a mechanical space for the chiller. This authorizes significant space for inhabitant utilize. Like all items, air-cooled chillers have unique needs while applying them in a plan. The accompanying are a few of the key things that ought to be routed to accomplish a legitimate working chiller plant and a fulfilled client.

II. BACKGROUND

Business Centre structures are by and large multi-tenant; once in a while they may be controlled by a singular inhabitant, a lone affiliation. This point moves the best approach to manage an answer of the issues. The multi-tenant building requires all the all the more requesting applications. Despite the inhabitance most existing and some new structures have the going with essential zones to consider within and the periphery outside domains. Within regions are inside the point of convergence of a building not affected by outdoors segments, beside the best story under a housetop. Ranges around the edge of a working (outside zone) may extend from 12 to 20 feet inside from the outside divider. This zone is displayed to sun, twist, outside temperature and shading of the fundamental parts or neighbouring structures. There is a clear necessity for two differing ventilating systems to manage the two territories set apart by stores of different lead.

An inside zone has a for the most part unfaltering stack of light and people. Hence a singular all-air structure is the most proper.

The external zones have respectably moving weight qualities, from various uncommon mix of daylight based increment through glass, most extraordinary warmth transmission outside, lights and people to no load in the midst of minor atmosphere and to an antagonistic most prominent transmission stack in winter.

Regardless of the way that business centre structures are had in a general sense for 8-10 hour time ranges and some business centre involved into the night, the circulating air through and cooling gear should as a general rule worked for no under 16 hours. In the midst of peak design conditions the cooling structure should labor for 24 hours. This adds to a more mild assurance of rigging.

III. OBJECTIVES

The primary goal of this venture is to supply characterized strains to every one of the spaces along these lines keeping up the indoor air quality, room temperature, speed of wind current and relative mugginess.

PC based warming, ventilating and aerating and cooling (HVAC) stack computation programs have been accessible for a long time and are ordinarily utilized by most experts on all undertakings. What is being asked of the advisor that is ordinarily not done, is to order a rundown of hardware expected for each space and accepted in habitance. The product is for the most part utilized for business applications. Sources of info are particular to lighting,gear, individuals and the building envelope. In this manner, the gear input must whole up the general population and hardware warm loads. To enable all gatherings to recognize what is incorporated into the gear input, the notes segment for each zone will separate what number of individuals were utilized for the computation and what hardware and warmth stack was accepted for the figuring. Furthermore, the notes should depict other room necessities, for example, sort and number of BSCs expected in the room, amount of fumes required for the BSC or the room, and relative room pressurization (positive or negative).

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IV. METHODOLY

For computing the warmth stack there is a standard programming HAP(hourly Analysis program) which will give us the whole depiction to discover cooling condition capacity, likewise, duct sizer for ascertaining the area of duct and pipe sizer is for pipe estimate for water to move through it.

ASHRAE and ISHRAE standards are likewise accessible to take the qualities and articulations to discover the coil measure which we will use in the ceiling panels.

A. *HAP*

Hourly Analysis Program (HAP) is a PC based programming which encourages architects to outline a HVAC system for different structures. All the ASHRAE and ISHRAE standard have been used in calculating the load of Building and is found to be 290TR, for which two working chillers and one standby is installed.

B. Duct Sizer

Constant velocity method or static regain equal friction are used to calculate the maximum duct size by using a powerful design tool design as duct sizing program. The sizes of duct are calculated as round, square, rectangular or oval shaped.

To work on the duct sizer we need the following things:

1) CFM
2) Friction Loss rate
3) Velocity

C. Pipe Sizer

As all we should understand that how the water flow to reach the radiant ceiling panels that equipment is the pipe, which can carry and allows any kind of fluid to flow through it. The pipe size calculation will be done based on the water flow in us gpm, and the head loss must not be more than 2.5 ft/100ft. Manually we can select the pipe size based on the water flow, head loss and the water velocity using schedule 40 chart.

D. Beta Performance Data

Air flow terminals in the HVAC system are other things which are very important as they are the only things through which the conditioned air is flown into the space. These terminals are designed based on the air flow rate, velocity and type required by using Beta Performane Data.

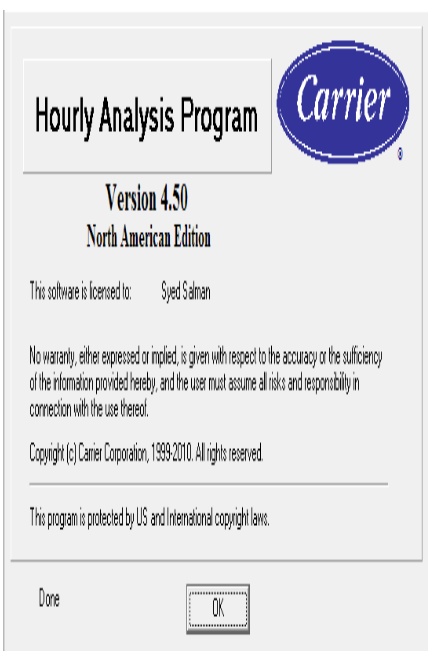

Fig 2: HAP

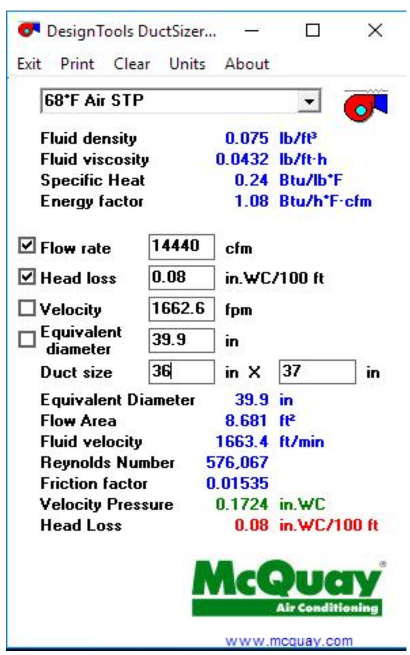

Fig 3: McQuay Duct sizer

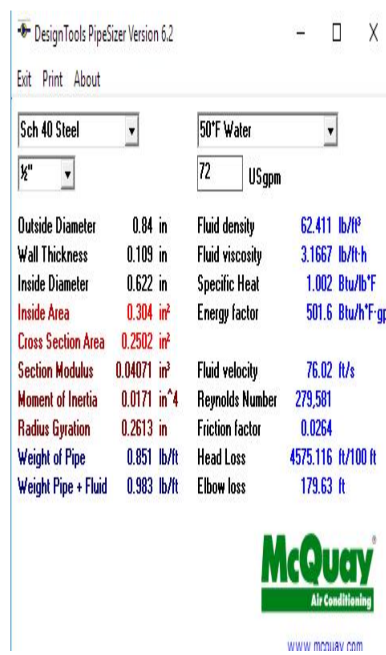

Fig 4: McQuay Pipe sizer

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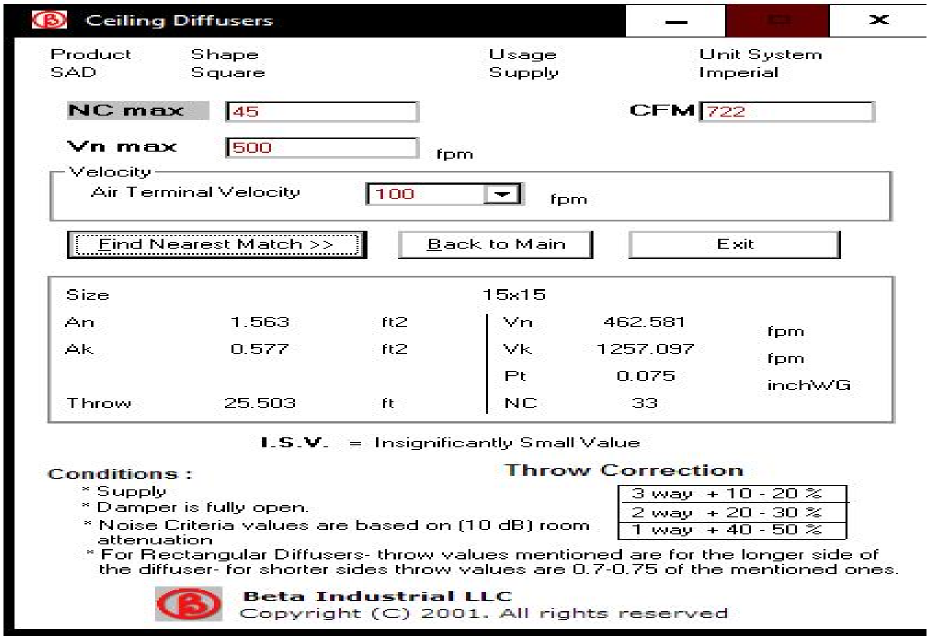


Fig 4: Beta Performanca Data

E. Pump Head Calculation

GPM = 2.4xTR {GPM- Gallons Per Minute}

= 2.4x150

=348 GPM

From charts of water piping, For 348 GPM of water we get the pipe of 5”≈125mm.

$$\text{PUMP HP} = \frac{\text{GPM x TDH x Specific gravity of fluid}}{\text{3960 x motor efficiency}}$$

Total Dynamic Head (TDH) = Hs + Hv + Hf + Ha

Hs = Static head=0 (Since the piping is for closed cycle)

Hv = Velocity head

$= \frac{v^2}{2g}$ where v is the velocity of fluid in fps and g is the gravitational constant in fps

$= \frac{10^2}{2*32.2}$

For riser v=10fps

shaft v=8fps

floor v= 6fps

=1.5’

Hf = friction head

$$\text{Friction head} = \text{F loss x } \frac{\text{Pipe length in inches}}{100}$$

After calculating the friction head for all the valves and fittings and combining them we get 10.5’

Ha = 0 (For closed cycle piping)

TDH = 0+1.5+10.5+0

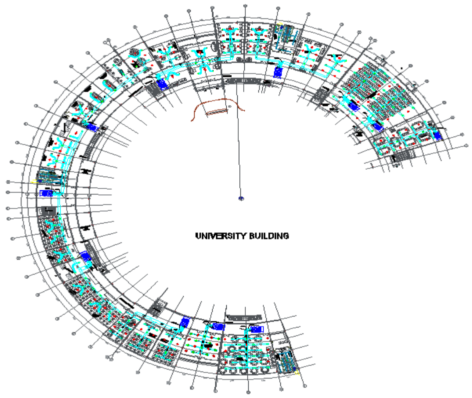
= 11.5’

$$\text{PUMP HP} = \frac{348 \text{ x } 11.5 \text{ x } 1}{3960 \text{ x } 0.85}$$

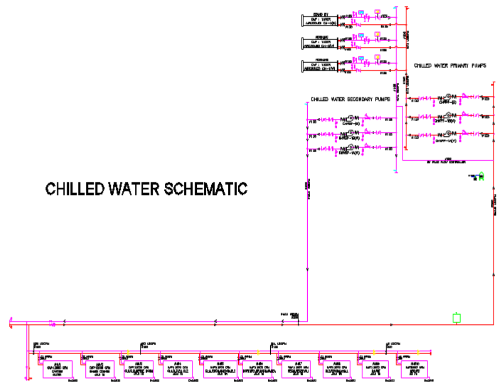
= 1.189 ≈ 1.2 HP

NOTE: 2 pumps working each of 1.2 HP with one pump as standby of same HP.

Final Building Layout:



Final chiller schematic



V. CONCLUSION

With reference to the building design of University and prerequisite of the case issue, ventilating load is evaluated for regular conditions. The undertaking is done as "Design of HVAC Central Air Conditioning System".

This project is carried out on an Air Cooled Chiller cycle which is way-more efficient than other cycles in terms of effectiveness, maintenance and cost. It uses air to cool down the condenser coils not water as in the case of Water Cooled Chillers, as the running cost gets increased and water may not be sufficient.

According to the aim of this project, Design of HVAC Central Air Conditioning System for a University Building is done for 60000sft area building which includes all the Cooling load calculations, Ventilation calculations and fresh air supply wherever necessary. All the duct layouts with respective AHU can be seen in the AutoCAD file. Load Calculation has been done using Hourly Analysis Program Software (HAP), while the duct sizing and pipe sizing using McQuay duct and pipe sizer.

Air Cooled chillers are compared with the water cooled chillers for the same tonnage and refrigerants used and found that the Air Cooled chillers are more efficient than water cooled chillers as there may be not availability of sufficient water or it can be costly. It can also be seen that Air Cooled chillers reduces the annual operating cost of system upto 58% when compared with water cooled chillers as shown in the tables below.

Hence, It is highly recommended to employ the Air Cooled chiller over the Water Cooled chillers for system capacity up to 500TR,It gets costly when the system capacity increases from 500TR. Thereafter Water Cooled chillers become more efficient depending upon the Annual operating cost and working conditions.

REFERENCES

As the project is based on the HVAC(Heating Ventilating and Air Conditioning). Therefor we have referred to the books and related articles from the internet.

The following are the books

[1] ASHRAE. 2000. ASHRAE Handbook -2000 HVAC Systems & Equipment, chapter 44.Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] ASHRAE Handbook (2007) - ‘Heating Ventilating and Air-Conditioning- Applications

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[4] Modern Refrigeration and Air conditioning-By: Andrew D.Althouse

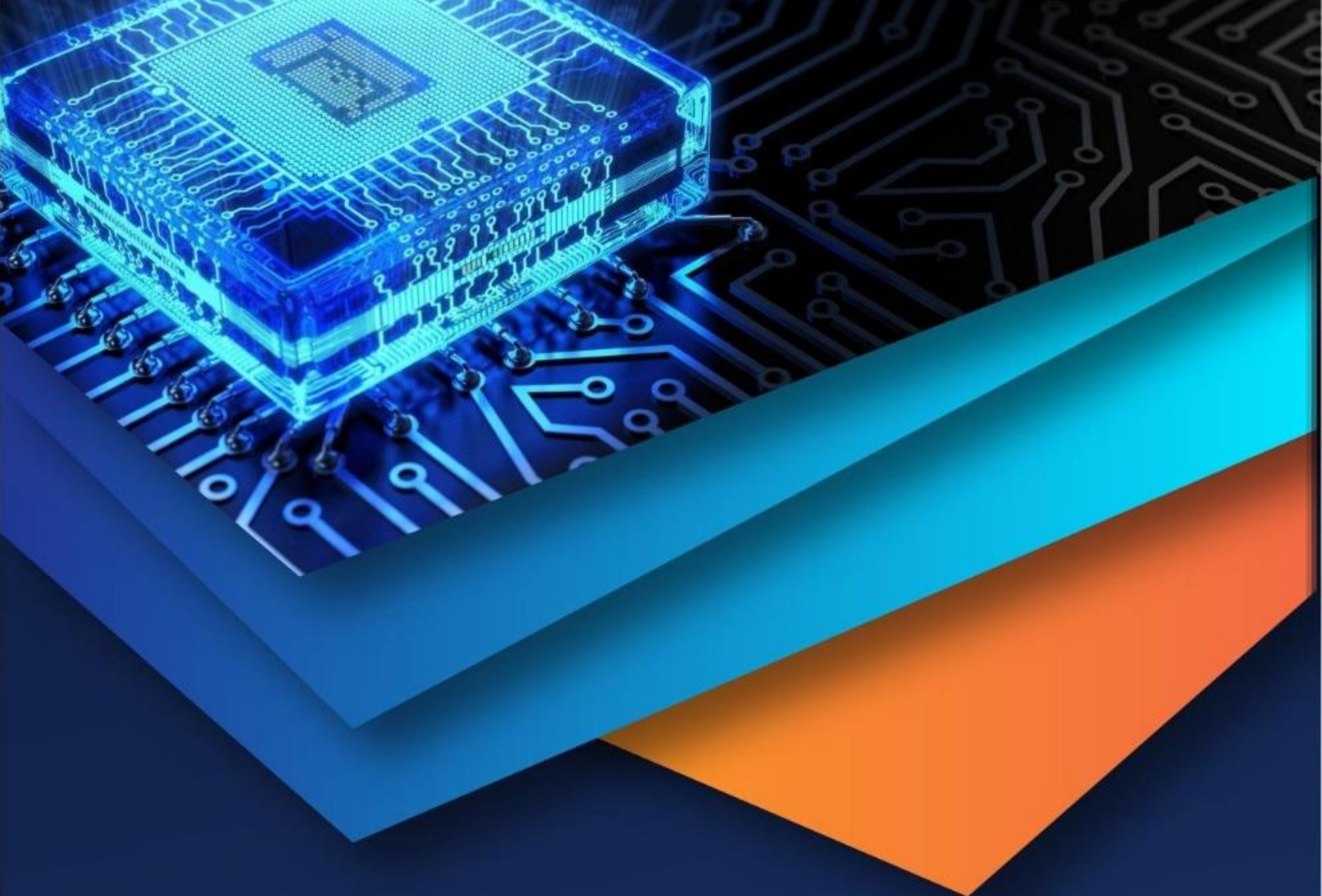
[5] Refrigeration and Air Conditioning-By: Ahmadul Ameen

Related Web Links:

a) https://www.ashrae.org/resources--publications/bookstore/handbook-online

b) https://en.wikipedia.org/wiki/Hvac

c) https://www.scribd.com/doc47631764/Air-Conditioning-Principles--and-Systems-An-Energy-Approach-4th-Edition.



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