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Design Of HVAC, Central Air Conditioning System for A Corporate Office Building

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Abstract- To study and evaluate the technical design requirement of an HVAC, Central Air Conditioning System for a Corporate-office building to achieve indoor Human Comfort conditions as per ASHRAE Standards. HVAC (Heating, Ventilation, and Air Conditioning) is the technology of indoor automotive environment comfort. To study and the reports generated through this project have been produce for the design and further installation for all systems in order to achieve the desired Human Comfort and Environment.

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INTRODUCTION

Heating, ventilation and air conditioning (HVAC) system control the temperature, humidity and quality of air in building to a set of chosen condition. To achieve this, system need to transfer heat and moister into and out of the air as well as control the level of air pollutants, either by directly removing them or by diluting them to acceptabe level.

Heating system increase the temperature in space to compensate for heat losses between the internal space and outside. Ventilation system supply to the space and extract polluted air from it. Cooling is needed to bring the temperature down in spaces in where heat gains have arise from people, equipment or the sun and are causing discomfort. Heating, ventilation and air conditioning system very widely in term of size and the functions they perform. Some system are large and central to the building services - these were probably designed when the building was originally commissioned and use ventilation to deliver heating and cooling. Other system may provide heating through boiler and radiators, with some limited ventilation to provide fresh air or cooling to certain parts of the building such as meeting rooms. In some cases, individual comfort cooling units have been added to a building to overcome a specific overheating problem that had not been thought of at the time of the original design.

So if Heating, Ventilation and Air Conditioning cab be separate system, why consider them holistically? The answer lies in the intersection of these services with other and with the building. By considering HVAC systems as individual elements rather then as an interacting system, it would be easy to overlook a major area of energy wastage - that one component might impact on another. For example, it would be waste full to increase heating inside a building while the cooling system is fighting to reduce the temperature. It is therefore useful to look at how the element of an HVAC system interact which each other and fine tune each part to save energy and money.

The true definition of an 'Air Conditioning System' is one which has the ability to control temperature, Humidity and air quality within precise limits, yet the term often applied to systems to simply cool the space. These cool air system are more correctly referred to as 'Comfort Cooling'.

HEATING, VENTILATION, AIR CONDITIONING (HVAC)

When thinking about energy efficiency, one of the most important decisions to be made regarding a new Home is the type of heating and cooling system to install. Equally critical to consider is the selection of Heating of a system depends as much on proper installation as it does on the performance rating of the equipment. Improper design and improper installation of the HVAC system have negative impacts on personal Comfort and on energy bills. Improper design and installation of a HVAC system can dramatically Degrade the quality of air in a home. Poorly designed and poorly installed ducts can create dangerous Conditions that may reduce comfort, degrade indoor air quality, or even threaten the health of the homeowners.

TYPES OF HEATING SYSTEMS

Keys to obtaining design efficiency of a system in the field include:

• Sizing the system for the specific heating and cooling load of the home being built;

• Proper selection and proper installation of controls;

• Correctly charging the unit with the proper amount of refrigerant;

• Sizing and designing the layout of the ductwork or piping for maximizing energy efficiency; and

• Insulating and sealing all ductwork.

Two types of heating systems are most common in a new home: forced-air or radiant, with forced-air being used in the majority of the homes. The heat source is either a furnace, which burns a gas, or an electric heat pump. Furnaces are generally installed with central air conditioners. Heat pumps provide both heating and cooling. Some heating systems have an integrated water heating system.

RADIANT HEATING SYSTEMS

Radiant heating systems typically combine a central boiler, water heater or heat pump water heater with piping, to transport steam or hot water into the living area. Heating is delivered to the rooms in the home via radiators or radiant floor systems, such as radiant slabs or under floor piping. Advantages of radiant heating systems include:

• Quieter operation than heating systems that use forced-air blowers.

• Increased personal comfort at lower air temperatures. The higher radiant temperatures of the radiators or floors allow people to feel warmer at lower air temperatures. Some homeowners, with radiant heating systems, report being comfortable at room air temperatures of 60°F.

• Better zoning of heat delivered to each room.

• Increased comfort from the heat. Many homeowners, with radiant heating systems, find that the heating is more comfortable. Disadvantages of radiant heating systems include:

• Higher installation costs. Radiant systems typically cost 40% to 60% more to install than comparable forced-air heating systems.

• No provision for cooling the home. The cost of a radiant heating system, combined with central cooling, would be difficult to justify economically. Some designers of two-story homes have specified radiant heating systems on the bottom floor and forced-air heating and cooling on the second floor.

• No filtering of the air. Since the air is not cycled between the system and the house, there is no filtering of the air. Difficulty in locating parts. A choice of dealers may be limited.

HEAT PUMP EQUIPMENT

Heat pumps are designed to move heat from one fluid to another. The fluid inside the home is air and the fluid outside is either air (air-source), or water (geothermal). In the summer, heat from the inside air is moved to the outside fluid. In the winter, heat is taken from the outside fluid and moved to the inside air.

AIR-SOURCE HEAT PUMPS

The most common type of heat pump is the air-source heat pump. Most heat pumps operate at least twice as efficiently as conventional electric resistance heating systems in Climate Zone 4. They have typical lifetimes of 15 years, compared to 20 years for most furnaces. A reversing valve allows the heat pump to work automatically in either heating or cooling mode. The heating process is:

1. The compressor (in the outside unit) pressurizes the refrigerant, which is piped inside.

2. The hot gas enters the inside condensing coil. Room air passes over the coil and is heated. The refrigerant cools and condenses.

3. The refrigerant, now a pressurized liquid, flows outside to a throttling valve where it expands to become a cool, low pressure liquid.

4. The outdoor evaporator coil, which serves as the condenser in the cooling process, uses outside air to boil the cold, liquid refrigerant into a gas. This step completes the cycle.

5. If the outdoor air is so cold that the heat pump cannot adequately heat the home, electric resistance strip heaters usually provide supplemental heating.

AIR CONDITIONING

In summer, air conditioners and heat pumps work the same way to provide cooling and dehumidification. They extract heat from inside the home and transfer it outside. Both systems typically use a vapor compression cycle. This cycle circulates a refrigerant, a material that increases in temperature significantly when compressed and cools rapidly when expanded. The exterior portion of a typical air conditioner is called the condensing unit and houses the compressor, the noisy part that uses most of the energy, and the condensing coil. An air-cooled condensing unit should be kept free from plants and debris that might block the flow of air through the coil or damage the thin fins of the coil. Ideally, the condensing unit should be located in the shade. However, do not block air flow to this unit with dense vegetation, fencing or overhead decking. The inside mechanical equipment, called the air-handling unit, houses the evaporator coil, the indoor blower, and the expansion, or throttling valve. The controls and ductwork for circulating cooled air to the house complete the system.

AIR CONDITIONERS

Air conditioners use the vapor compression cycle

1. The compressor (in the outside unit) pressurizes a gaseous refrigerant. The refrigerant heats up during this process.

2. Fans in the outdoor unit blow air across the heated, pressurized gas in the condensing coil; the refrigerant gas cools and condenses into a liquid.

3. The pressurized liquid is piped inside to the air-handling unit. It enters a throttling or expansion valve, where it expands and cools.

4. The cold liquid circulates through evaporator coils. Inside air is blown across the coils and cooled while the refrigerant warms and evaporates. The cooled air is blown through the ductwork. The refrigerant, now a gas, returns to the outdoor unit where the process repeats. If units are not providing sufficient dehumidification, the typical homeowner's response is to lower the thermostat setting. Since every degree the thermostat is lowered increases cooling bills 3% to 7%, systems that have nominally high efficiencies, but inadequate dehumidification, may suffer from higher than expected cooling bills. In fact, poorly functioning "high" efficiency systems may actually cost more to operate than a well-designed, moderate efficiency unit.

HVAC SYSTEMS

For proper operation, a HVAC system must be properly designed, sized and installed. A proper HVAC system will provide an improved indoor environment and minimize the cost of operation. In the planning process for an energy efficient home, everything should be done to reduce the heating and cooling load on the home before the HVAC system is designed.

SIZING

When considering a HVAC system for a residence, remember that energy efficient and passive solar homes have less demand for heating and cooling. Substantial savings may be obtained by installing smaller units that are properly sized to meet the load. Because energy bills in more efficient homes are lower, higher efficiency systems will not provide as much annual savings on energy bills and may not be as cost effective as in less efficient homes. Not only does oversized equipment cost more, but also it can waste energy. Oversized equipment may also decrease comfort. For example, an oversized air conditioner cools a house but may not provide adequate dehumidification. This cool, but clammy air creates an uncomfortable environment. Many contractors select air conditioning systems based on a rule, such as 600 square feet of cooled area per ton of air conditioning (a ton provides 12,000 Btu per hour of cooling). Instead, use a sizing procedure such as:

• Calculations in Manual J published by the Air Conditioning Contractors Association;

• Similar procedures developed by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

• Software procedures developed by electric or gas utilities, the U.S. Department of Energy or HVAC equipment manufacturers.The heating and cooling load calculations rely on the outside winter and summer design temperatures (see the appendix for a definition) and the size and type of construction for each component of the building envelope, as well as the heat given off by the lights, people, and equipment inside the house. If a zoned heating and cooling system is used, the loads in each zone should be calculated.

VENTILATION AND INDOOR AIR QUALITY

All houses need ventilation to remove stale interior air and excessive moisture and to provide oxygen for the inhabitants. There has been considerable concern recently about how much ventilation is required to maintain the quality of air in homes. While it is difficult to gauge the severity of indoor air quality problems, building science experts and most indoor air quality specialists agree that the solution is not to build an inefficient, "leaky" home. Research studies show that standard houses are as likely to have indoor air quality problems as energy efficient ones. While opening and closing windows offers one way to control outside air for ventilation, this strategy is rarely useful on a regular, year-round basis. Most building researchers believe that no house is so leaky that the occupants can be relieved of concerns about indoor air quality. The researchers recommend mechanical ventilation systems for all houses. The amount of ventilation required depends on the number of occupants and their lifestyle, as well as the design of the home. The ANSI/ASHRAE standard, "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings" (ANSI/ASHRAE) recommends that houses have 7.5 natural cubic feet per minute of fresh air per bedroom + 1, plus additional air flow equal to (in cubic feet per minute) 1% of the house conditioned area, measured in square feet. In addition, the standard requires exhaust fans in the kitchen and bathrooms that can be operated when needed.

SUPPLYING OUTSIDE AIR FROM AIR LEAKS

The air vented from the home by exhaust fans must be replaced by outside air. This new air comes into the home either through air leakage or through a controlled inlet. Relying on air leaks requires no extra equipment; however, the occupant has little control over the air entry points. Many of the air leaks come from undesirable locations, such as crawl spaces or attics. If the home is airtight, the ventilation fans will not be able to pull in enough outside air to balance the air being exhausted. This generates a negative pressure in the home, which may cause increased wear on fan motors. In addition, the exhaust fans may threaten air quality by pulling exhaust gases from flues and chimneys back into the home.

SUPPLYING OUTSIDE AIR FROM INLET VENTS

Providing fresh outside air through inlet vents is another option. These vents can often be purchased from energy specialty outlets by mail order. They are usually located in exterior walls. The amount of air they allow into the home can be controlled manually or by humidity sensors. Locate inlet vents where they will not create uncomfortable drafts. These inlet vents are often installed in bedroom closets with louvered doors or high on exterior walls.

SUPPLYING OUTSIDE AIR VIA DUCTED MAKE-UP AIR

Outside air can also be drawn into and distributed through the home via the ducts for a forced-air heating and cooling system. This type of system usually has an automatically controlled outside air damper in the return duct system. The blower for the ventilation system is either the air handler for the heating and cooling system or a smaller unit that is strictly designed to provide ventilation air. A slight disadvantage of using the HVAC blower is that incoming ventilation air may have sufficient velocity to affect comfort during cold weather. The return ductwork for the heating and cooling system may be connected to a small outside air duct that has a damper which opens when the ventilation fan operates. The incoming air flow should not adversely affect comfort. Special controls are available to ensure that the air handler runs a certain percentage of every hour, thus providing fresh air on a regular basis.

DEHUMIDIFICATION-VENTILATION SYSTEMS

Kentucky homes are often more humid than desired. A combined dehumidification-ventilation system can bring in fresh (but humid outdoor air), remove moisture, and supply it to the home. These systems can also filter incoming air. These systems require an additional mechanical device. A dehumidifier must be installed on the air supply duct. This dehumidifier should be designed for the specific needs of the home. A well-designed conventional A/C system without outdoor ventilation air should not need supplemental dehumidification. It is the excess moisture in outdoor ventilation air that may require the special dehumidification equipment, especially when mild outdoor temperatures do not require the cooling

system to operate many hours per day to maintain the set point temperature

HEAT RECOVERY VENTILATORS

Air-to-air heat exchangers, or heat recovery ventilators (HRV), typically have separate duct systems that draw in outside air for ventilation and distribute fresh air throughout the house. Winter heat from stale room air is “exchanged” for the cooler incoming air. Some models, called enthalpy heat exchangers, can also recapture cooling energy in summer by exchanging moisture between exhaust and supply air. The value of any heat recovery ventilation system should not be determined solely on the cost of recovered energy. The controlled ventilation and improved quality of the indoor environment must be considered as well.

SAMPLE VENTILATION PLANS

Three options for providing a mechanical ventilation system for a home are shown in the following designs. While providing mechanical ventilation plans is routine for commercial buildings, their use in homes is just beginning. As a result, few standard designs exist and some time will be needed for them to be developed for different climates.

WHAT IF HIGH LEVELS ARE FOUND?

With the basics of a radon mitigation system already installed, it is relatively inexpensive and easy to make the system active. Adding an in-line fan, rated for continuous operation, is a relatively simple addition that will ensure the safe removal of radon from beneath the building.

REFERENCE

[1] DEWALT® HVAC/R PROFESSIONAL REFERENCE MASTER EDITION by American Contractors Educational services (Author)

[2] HVAC Design Sourcebook by Larsen Angel (Author)