HVAC System Explained

&

Kinds of it is available

Prepared by :

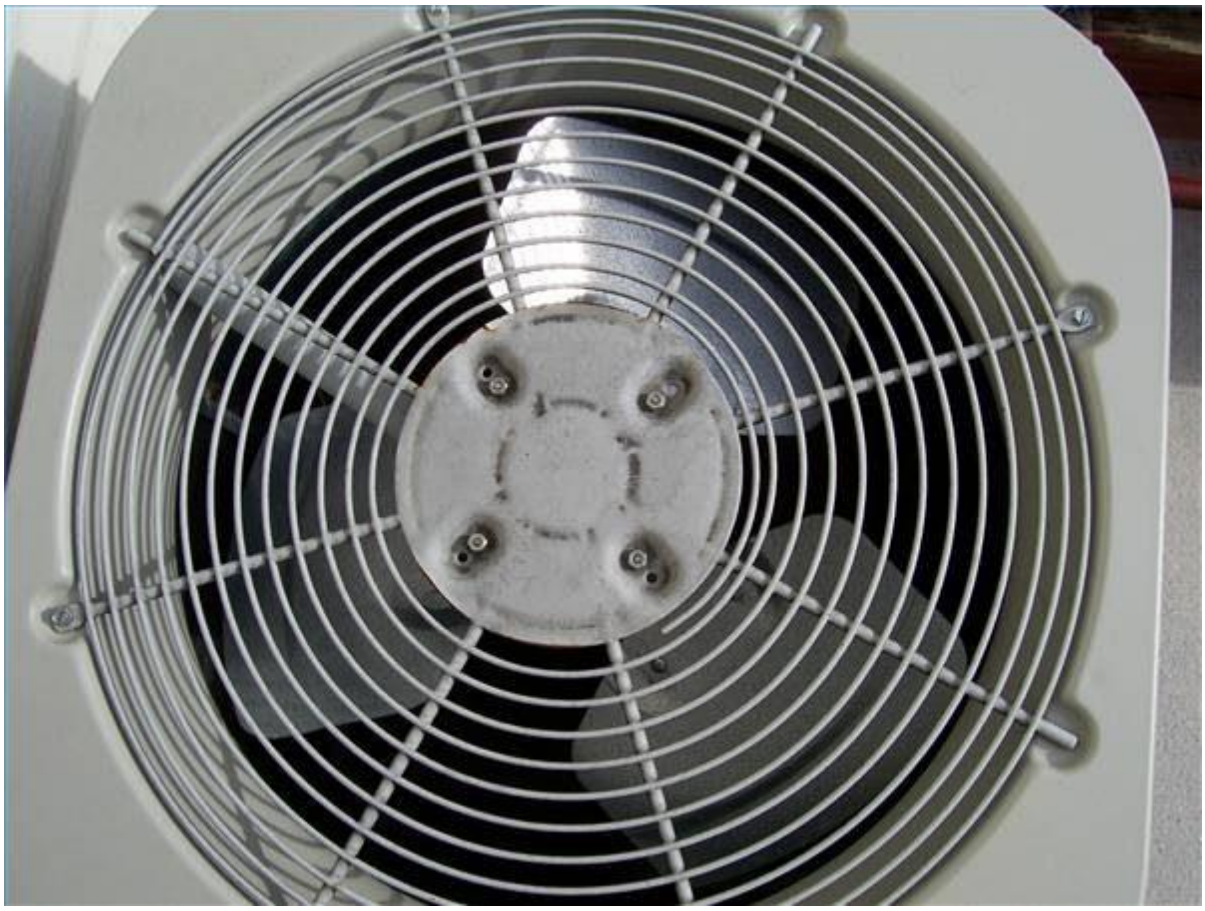
RIZGAR SAEED ALI

Mechanical Engineer

HVAC Definitions – Manufacturers

HVAC is the technology of indoor and vehicular environmental comfort. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as HVAC&R or HVACR, or ventilating is dropped as in HACR. HVAC is important in the design of medium to large industrial and office buildings such as skyscrapers and in marine environments such as aquariums, where safe and healthy building conditions are regulated with respect to temperature and humidity, using

fresh air from outdoors. Heating, ventilating, and air conditioning is based on inventions and discoveries made by Nikolay Lvov, Michael Faraday, Willis Carrier, Reuben Trane, James Joule, William Rankine, Sadi Carnot, and many others then named and called for industry by these discoveries persons. The invention of the components of HVAC systems went hand-in-hand with the industrial revolution, and new methods of modernization, higher efficiency, and system control are constantly introduced by companies and inventors worldwide. The three central functions of heating, ventilating, and air-conditioning are interrelated, especially with the need to provide thermal comfort and acceptable indoor air quality within reasonable installation, operation, and maintenance costs



HVAC System Explained

ONE -Heating

Heating in HVAC can be any number of heating systems from gas furnaces, electric furnaces, oil furnaces, oil and gas boilers, radiant heating systems, and heat pumps. The "H" stands for heating and comprises of all of the aforementioned ways of providing heat using different methods and different types of heating systems.

Heat may be direct or forced air in nature. Direct systems take the heat directly to an area, using hydronic (steam or hot water) or electric radiant

floor systems, baseboards or radiators. Forced air systems heat air in a furnace using gas or electricity and then force it throughout the building using one or more fans. Forced air heating relies on a "return" of cold air to the furnace and many forced air systems have two sets of ducts and outlets---one circulating hot air and one with vents on or near the floor to return the sinking cooler air. Heat may also be generated by a "heat pump" (also called an exchanger), a more efficient generator that uses compression and condensation to draw heat out of air in cool weather. Heat pumps can use air or ground (geothermal) heat but lose efficiency when the temperature outside is a great deal cooler or warmer than the indoor air, making them an efficient supplement for HVAC systems in some areas.

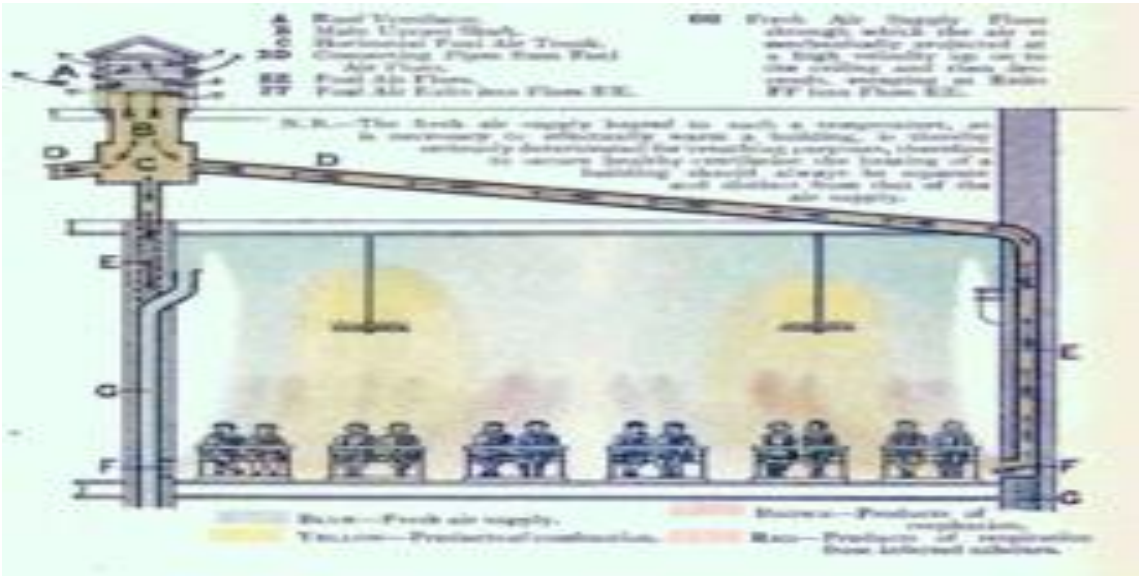
TWO -HVAC Definitions – Ventilation

Ventilation in HVAC or the "V" describes ventilation. This can be ventilating a home using ductwork or ventilating a kitchen using ductwork and fans with a hood. It can also refer to combustion air or the air needed to have combustion for various heating systems.. and safe ventilation rates are defined in various mechanical codes to provide safe and healthy air changes to the inside of buildings and structures.

SO Ventilation is the process of changing or replacing air in any space to control temperature or remove any combination of moisture, odors,

smoke, heat, dust, airborne bacteria, or carbon dioxide, and to replenish oxygen. Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into *mechanical/forced* and *natural* types.[14]

.Natural ventilation



Ventilation on the downdraught system, by impulsion, or the 'plenum' principle, applied to schoolrooms (1899)

Natural ventilation is the ventilation of a building with outside air without using fans or other mechanical systems. It can be via operable windows, louvers, or trickle vents when spaces are small and the architecture permits. Natural ventilation schemes can use very little energy, but care must be taken to ensure comfort.

Mechanical or forced ventilation

“Mechanical" or "forced" ventilation is provided by an air handler and used to control indoor air quality. Excess humidity, odors, and contaminants can often be controlled via dilution or replacement with outside air. However, in humid climates much energy is required to remove excess moisture from ventilation air.

Kitchens and bathrooms typically have mechanical exhausts to control odors and sometimes humidity. Direct drive fans are available for many applications, and can reduce maintenance needs.

Ceiling fans and table/floor fans circulate air within a room for the purpose of reducing the perceived temperature by increasing evaporation of perspiration on the skin of the occupants

Also In warm or humid climates, maintaining thermal comfort solely via natural ventilation may not be possible. Air conditioning systems

are used, either as backups or supplements. Air-side economizers also use outside air to condition spaces, but do so using fans, ducts, dampers, and control systems to introduce and distribute cool outdoor air when appropriate.

An important component of natural ventilation is air change rate or air changes per hour: the hourly rate of ventilation divided by the volume of the space. For example, six air changes per hour means an amount of new air, equal to the volume of the space, is added every ten minutes. For human comfort, a minimum of four air changes per hour is typical, though warehouses might have only two. Too high of an air change rate may be uncomfortable, akin to a wind tunnel which have thousands of changes per hour. The highest air change rates are for crowded spaces, bars, night clubs, commercial kitchens at around 30 to 50 air changes per hour.[15]

Room pressure can be either positive or negative with respect to outside the room.

Positive pressure occurs when there is more air being supplied than exhausted, and is common to reduce the infiltration of outside contaminants.

Consider specifying energy recovery ventilation equipment.

Indoor air can be 2 to 5 times more polluted than outdoor air; therefore, most HVAC system designers understand that increased amounts of outdoor air supply is generally better for IAQ. Yet there are concerns over the implications that this added amount of outdoor air supply has on the first cost and operating cost of the HVAC system, as well as moisture control for the school (too wet or too dry). As a

result, school designers often try to reduce the amount of outdoor air equal to — or even below — 15 cubic feet per minute (cfm) of outside air per person or 270 cubic meter per hours , the minimum for school classrooms, as established (ASHRAE

In the United States, HVAC engineers generally are members of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE),

THREE – AC.

The “AC” refers to Air Conditioning and the various methods of Air Conditioning use the

refrigeration process for cooling air or water for conditioning and cooling the space. Air conditioners and chillers usually accomplish the job of air conditioning or the “AC” in HVAC.

How does my AC or (HVAC) system work?

The heating, ventilation and air conditioning (HVAC) system of any building is like the respiratory system of a human being. It controls the movement, quality and temperature of air to ventilate, warm and cool the organism. Energy is consumed by the parts of the system that heat and cool the air and movement of air with fans requires energy. Air or water is heated or cooled using direct contact with heat or refrigerants and pushed through pathways (ducts or tubes), The use of water as the heat transfer medium is known as hydronics.

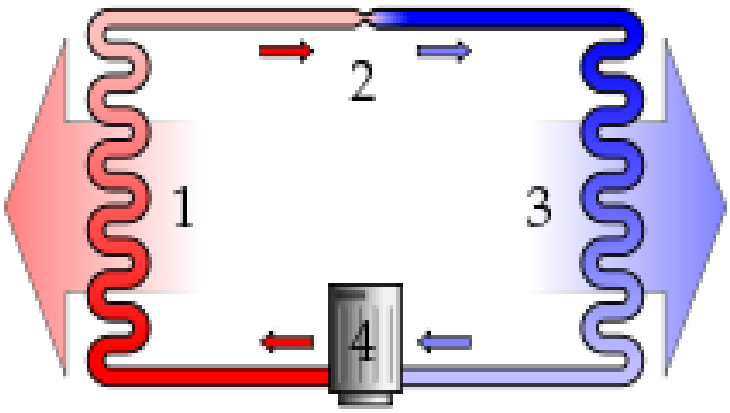
Escaping through outlets or vents until it travels throughout the structure. The air or water then returns to its origin to be heated or cooled again

An air conditioner cools and dehumidifies the air as is passes over a cold coil surface. The indoor coil is an air-to-liquid heat exchanger with rows of tubes that pass the liquid through the coil. Finned surfaces connected to these tubes increase the overall surface area of the cold surface thereby increasing the heat transfer characteristics between the air passing over the coil and liquid passing through the coil. The type of liquid used depends on the system selected. Direct-expansion (DX) equipment uses refrigerant as the liquid medium. Chilled-water (CW) can also be used as a liquid medium. When the required temperature of a chilled

As this liquid passes through the indoor cooling coil on the inside of the heat exchanger, two things happen to the air that passes over the coil’s surface on the outside of the heat exchanger. The air’s temperature is lowered

(sensible cooling) and moisture in the air is removed (latent cooling) if the indoor air dew point is higher than the temperature of the coil's surface. The total cooling (capacity) of an AC system is the sum of the sensible and latent cooling.. Manufacturers of AC equipment typically provide a "performance map" of specific equipment to show how total, sensible, and latent capacity change with changing indoor and outdoor temperatures and humidity. Power consumption and energy efficiency are also provided in these charts.

Refrigeration cycle



A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor

The refrigeration cycle uses four essential elements to cool.

- The system refrigerant starts its cycle in a gaseous state. The **compressor** pumps the refrigerant gas up to a high pressure and temperature.
- From there it enters a heat exchanger (sometimes called a **condensing coil** or condenser) where it loses energy (heat) to the outside, cools, and condenses into its liquid phase.
- An **expansion valve** (also called metering device) regulates the refrigerant liquid to flow at the proper rate.
- The liquid refrigerant is returned to another heat exchanger where it is allowed to evaporate, hence the heat exchanger is often called an **evaporating coil** or evaporator. As the liquid refrigerant evaporates it absorbs

energy (heat) from the inside air, returns to the compressor, and repeats the cycle. In the process, heat is absorbed from indoors and transferred outdoors, resulting in cooling of the building.

In variable climates, the system may include a reversing valve that switches from heating in winter to cooling in summer. By reversing the flow of refrigerant, the heat pump refrigeration cycle is changed from cooling to heating or vice versa. This allows a facility to be heated and cooled by a single piece of equipment by the same means, and with the same hardware.

..What Type of AC systems is available?

1- Cooling Only Split-System

A split system is a combination of an indoor air handling unit and an outdoor condensing unit. The indoor air handling unit contains a supply air fan and an air-to-refrigerant heat exchanger

(or cooling coil), and the expansion device. The outdoor condensing unit consists of a compressor and a condenser coil. Split-systems are typically found in residential or small commercial buildings. These systems have the highest energy efficiency rating (EER) of all the available AC systems. Manufacturers are required to take the EER rating a step further and provide a seasonal energy efficiency rating (SEER) for use by consumers. SEER ratings vary widely and range from 10 to 20.

2- Cooling Only Packaged rooftop unit (RTU) - System

A packaged system is a single unit combining all the components described in the split system. Since the unit is a package, it must be placed outside the building and indoor air is “ducted” from the building to the packaged system and back through an air distribution system. These units typically have SEER rating from 10 to 18. If heating is required, an alternate method of heating the interior of the building must be used, usually in the form of electric or gas heating.

3-Heat Pump

Heat pumps are commonly used for both heating and cooling a house. Heat pumps use electrical energy to transfer heat from one area to another. In winter, they draw heat out of the outside air and transfer it indoors

They are especially common where winters are mild because heat pumps lose efficiency when the outside air temperature is less than 40 degrees Fahrenheit

Most heat pumps can also be used to pump heat from inside to outside, thus acting as an air conditioner in summer

Heat pumps are similar to cooling only systems with one exception. A special valve in the refrigeration piping allow the refrigeration cycle to be operated in reverse. A cooling only system cools the indoor air and rejects heat to the outdoors. A heat pump can also cool the indoor air, but when the valve is reversed, the indoor air is heated. A supplementary electric resistance heater may also be used to assist the heat pump at lower outdoor temperatures. In colder climates, heat pumps require a defrost period. During defrost times the electric heater is the only means of heating the interior of the building. These units are manufactured as either split or packaged systems.

4-Window Air Conditioners

As the name implies, a window air conditioner is typically installed in a window or custom opening in a wall. The Window AC can only cool small areas and are not intended to provide cooling to multiple rooms or zones. These air conditioners are manufactured as cool only or can provide both cooling and heating. An optional damper in the unit can provide fresh outdoor air if necessary.

5-Packaged Terminal Heat Pump

Packaged terminal heat pumps (PTHP) are similar to a window-mounted air conditioner. These units are typically installed in a sleeve passing through the outdoor wall of an apartment, hotel, school classroom, etc. PTHPs are completely self contained and require only an electrical connection in addition to the opening in the building shell. They use the outdoor air as the heat source in winter and as a

heat sink in summer. They also can provide ventilation air. Flexibility and lower installed cost are the primary advantages of the PTHP. Disadvantages include in-room maintenance, higher operating cost, relatively short life, imprecise "on-off" temperature control, and they can be rather noisy.

6-Chilled Water System

In a chilled water system, liquid water is pumped throughout the building to “chilled water coils”. Since the liquid water needs to be at a cold temperature, a “cooling plant” is required. The plant is typically referred to as a chiller plant. Vapor compression equipment in the plant, similar to that described in “How does my AC work”, cool water to a cold temperature and pump the cold water to air-to-water heat exchangers where needed.

Reciprocating Chiller

1- Used to be common at relatively small capacities

2- More recently displaced by scroll and screw compressors

3- Control capacity with cylinder unloading

KIND OF CHILLER

A- Scroll Chiller

1- Small capacities < 50 tons

2- Most common in smaller air conditioners and packaged unitary equipment

3- Typically no capacity modulation

B-Screw Chiller

1-Medium capacities, 30-500 tons

2- Relatively low speed, direct drive

3- Capacity modulation using slide valve or variable speed drive

C- Centrifugal Chiller

1- Large capacities, 200- 2500 tons

2- Highest efficiencies

3- Often improved cycle efficiencies

4- Capacity control with inlet vanes or VSD

Chiller Performance

1-Larger chillers are more efficient

2-Capacity and efficiency increase when compressor lift (pressure differential) is reduced

A-Higher evaporator temperature

B-Lower condenser temperature

Absorption Chillers

1-No fluorocarbons

2-Energy source can be waste heat

3-Relatively low efficiency, COP = 0.6

4- Risk of crystallizing solution

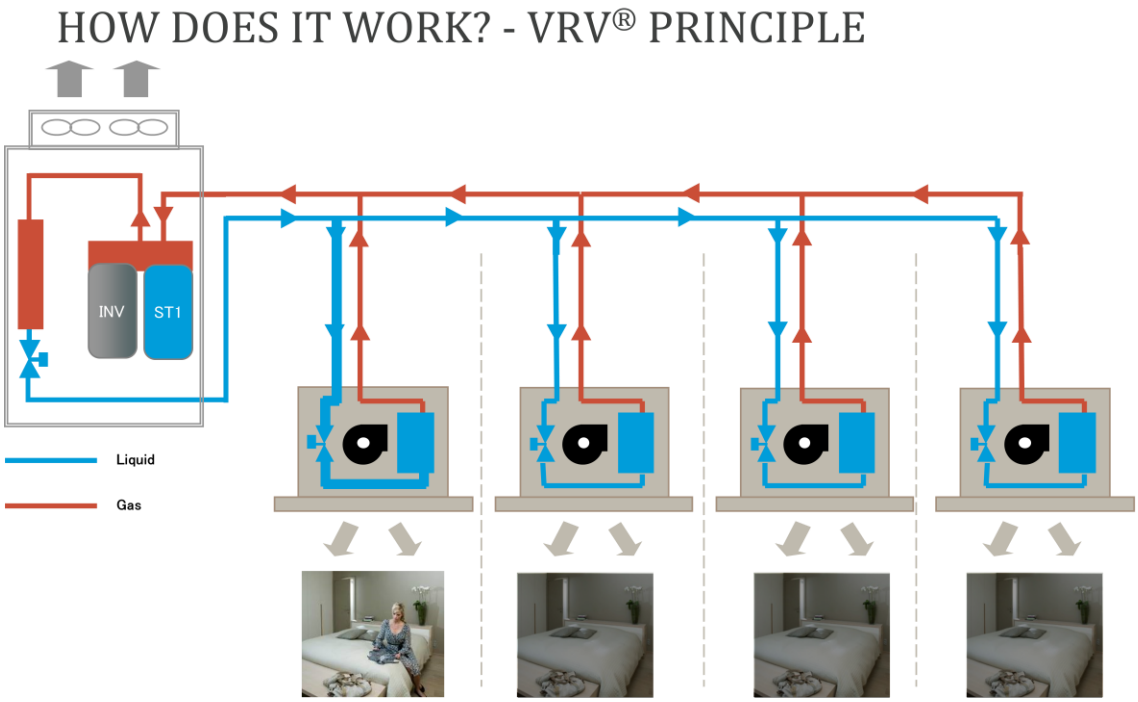
7- VRV System

VRV® = Variable Refrigerant Volume

Variable: The system responds depending on the required capacity.

Refrigerant: Direct expansion system.

Volume: The refrigerant volume is regulated by an electronic expansion valve in each indoor unit...



How is humidity controlled with an AC system?

Humidity is becoming more of a concern to building operators and owners. High indoor humidity leads to mold and mildew growth inside the building. The are several methods of controlling indoor humidity. The simplest (and most expensive) method is to connect a humidistat to an electric heater. When the

humidity inside the building rises above the humidistat set point, the heater is turned on Or the evaporator operates at a temperature below the dew point, moisture in the air condenses on the evaporator coil tubes. The additional heat causes the air conditioning system to run longer and remove more moisture.

A more efficient method of controlling humidity is to use the waste heat from the refrigeration cycle itself.

Four - HVAC-R Definitions – Refrigeration

The “R” in HVACR is applicable to this description of refrigeration.

HVACR is a thriving business not only for refrigeration systems but also for helping to keep people comfortable with warmth in the

winter and cooling in the summer. It is a hardworking and necessary industry in this day and age and if you need a good job inside this industry it wouldn’t hurt to look into HVAC educational opportunities for a long term HVAC career.

- 

How do refrigerants deplete the Ozone layer?

Refrigerant 22 (R-22 or MonoChloroDi FlouroMethane, CHClF2) is one of the most common refrigerants . This refrigerant is believed to be partially responsible for damaging the earth's ozone layer and it's use is being phased out over the next two decades. The ozone layer is a result of sunlight reacting with oxygen to produce a layer in the stratosphere more than 10 km above the earth's surface. As R-22 refrigerant escapes from an AC system through leaks or is released into the atmosphere by other means, the R-22 molecule containing the chlorine atom ("monochloro") rises in the atmosphere. Sunlight breaks down the R-22 molecule to yield a free chlorine radical (Cl-). The free chlorine radical combines with ozone (O3), decomposing it into normal oxygen (O2).

Therefore Refrigerants manufactured as replacements for R-22 are HFC-134a, R-410a,

R-410b to name a few. The new refrigerants do not contain the chlorine atom and are not harmful to the earth’s ozone layer.

Also The use of furnaces, space heaters, and boilers as means of indoor heating may result in incomplete combustion and the emission of carbon monoxide, nitrogen oxides, formaldehyde, volatile organic compounds,

Without proper ventilation, carbon monoxide can be lethal at concentrations of 1000 ppm (0.1%). However, at several hundred ppm, carbon monoxide exposure induces headaches, fatigue, nausea, and vomiting. Carbon monoxide binds with hemoglobin in the blood, forming carboxyhemoglobin, reducing the blood's ability to transport oxygen. The primary health concerns associated with carbon monoxide exposure are its cardiovascular and neurobehavioral effects.

Details Of Attachment Using In HVAC

Air Handling Units (AHU)

1- Delivers air to zones

2-Heats and cools air

3- Often integrates ventilation

Air Handling Systems (cont.)

1- Dual duct (DD) systems

Mix hot and cold air at each zone

Use constant or variable supply airflow

2-Multizone (MZ) system

Mix hot and cold air for each zone at the air handler

Fan Coil

1-One or two coils (use seasonal valves if one coil for both hot and cold water)

2- Thermostat controls water flow

3-Ventilation must be met with con’U]

I] I7T6/78UVKMN ditioned or unconditioned

Fan Coil System: 4 Pipes

Fan Coil System: 2 Pipes

Duct

 Optimization of initial cost with operating costs

1- Larger ducts have lower velocity, pressure drop, and fan energy

2- Small ducts reduce ducting costs and save building space Double duct size reduces fan power by factor of 32! Typically use sizing heuristics

Flexible ducts

Flexible ducting to suit every condition—both insulated and acoustic.

Motorised dampers

Range of motorised dampers manufactured to exacting international standards.

Take offs

Branch take offs that can be easily customised to meet every size, turn and direction.

Diffusers

Wide range of quality diffusers to meet all your air conditioning requirements.

Diffuser Selection

1- Mix air without causing draft, quietly, with low pressure drop

2- Velocities less than 50 fpm (0.25 m/s) in occupied zone

3-Diffuser manufacturers report throw: distance till velocity is reduced to specified level

4- Beware of change in throw at reduced airflow

Commercial Types of HVAC Systems

-  1 
- According Two types of **zone** HVAC system apply :

1.Single Zone

- Single zone HVAC systems serve only one area of a building. All of the rooms in this area must have similar cooling and heating vents that are regulated by a common thermostat.

2-Multipe Zone

- Multiple zone HVAC systems provide more than one area of a building with cooling and heat. Each zone can have a different temperature regulated with separate thermostats.

- Sponsored Links

Also According Three types of Volume HVAC system apply

1-Constant Volume

- Constant volume HVAC systems are designed to provide each zone with a constant volume of airflow. Temperatures are changed by switching the HVAC unit on or off.

2-Variable Volume

- Variable volume HVAC systems allow users to vary the amount of cooled or heated air delivered to each zone. This type of HVAC system tends to overcool or overheat areas.

3-Radiant Systems

- Radiant HVAC systems typically run cold or hot water through metal pipes to cool or heat the air before it is released into the room. These systems are old-fashioned and mostly used in older homes and buildings.

Maintenance

All modern Air Conditioning systems, even small window package units, are equipped with internal air filters. These are generally of a lightweight gauzy material, and must be replaced or washed as conditions warrant. For example, a building in a high dust environment, or a home with furry pets, will need to have the filters changed more often than buildings without these dirt loads. Failure to replace these filters as needed will contribute to a lower heat exchange rate, resulting in wasted energy, shortened equipment life, and higher energy bills; low air flow can result in "iced-up" or "iced-over" evaporator coils, which can completely stop air flow. Additionally, very dirty or plugged filters can cause overheating during a heating cycle, and can result in damage to the system or even fire.

Because an air conditioner moves heat between the indoor coil and the outdoor coil, both must be kept clean. This means that, in addition to

replacing the air filter at the evaporator coil, it is also necessary to regularly clean the condenser coil. Failure to keep the condenser clean will eventually result in harm to the compressor, because the condenser coil is responsible for discharging both the indoor heat (as picked up by the evaporator) and the heat generated by the electric motor driving the compressor.

Well-engineered ventilation patterns aid circulation, introduce fresh air and controls the buildup of carbon dioxide (a byproduct of human respiration), carbon monoxide (from combustion sources) and miscellaneous toxic gases from building materials and household activities. Well-designed HVAC systems, passive filters, insulation and gravity make the system more effective and efficient