# HVAC Presentation

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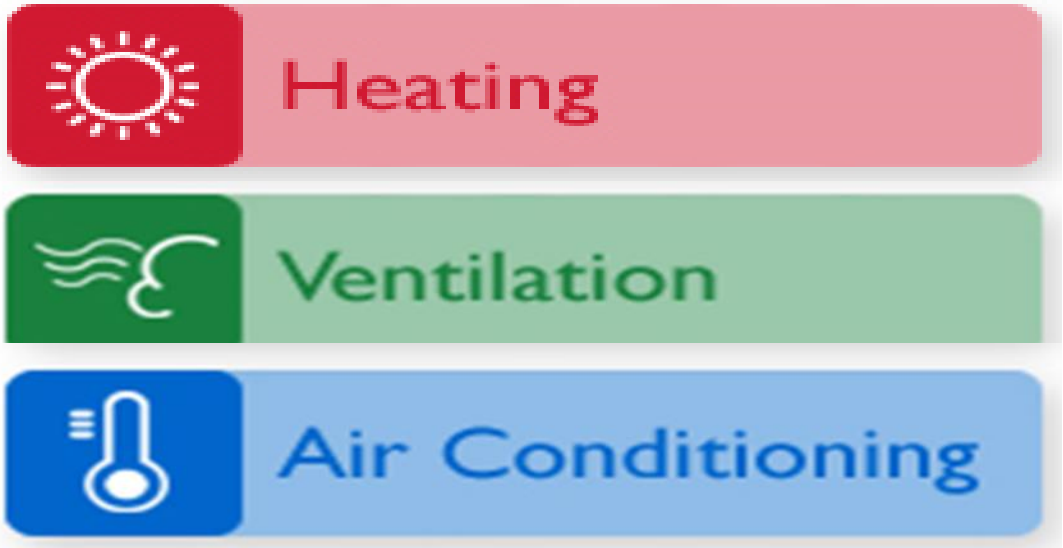
**Mechanical Power Engineer**

# What is HVAC ?



# 1. Heating

## The Purpose of Heating ?



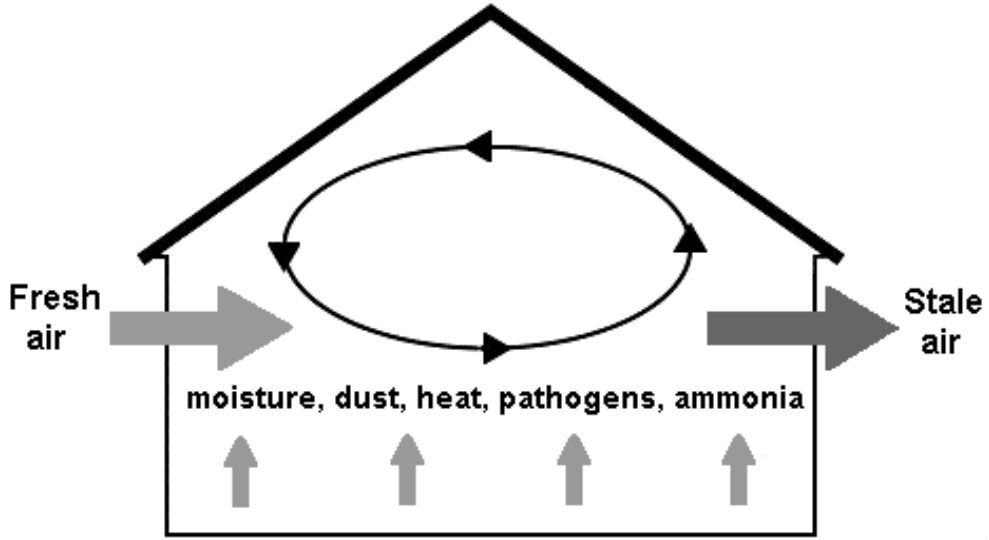

**Method of getting heat**

1. **Nature**
2. **Mechanical system**

# 2.Ventilation

## The PURPOSE OF VENTILATION ?

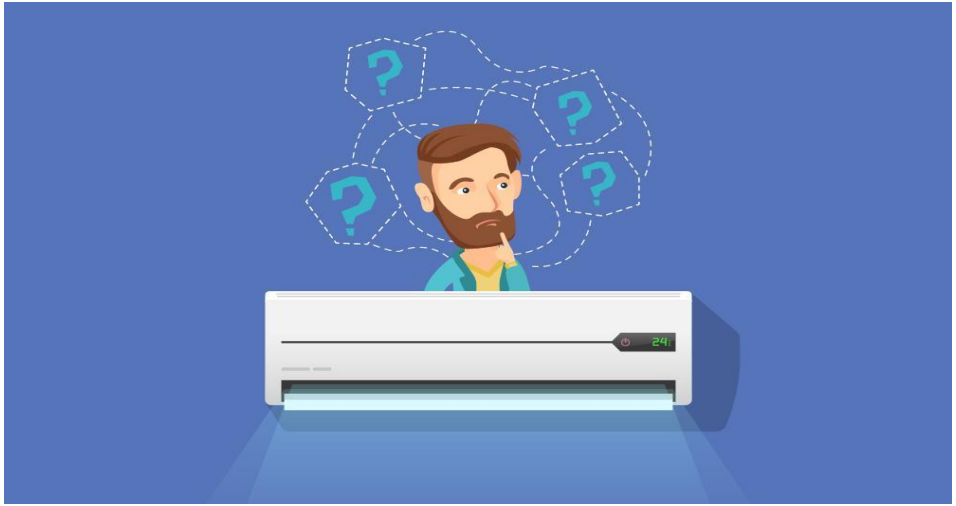




# 3.Air Conditioning

## Purpose of air conditioning?





# PURPOSE OF HVAC SYSTEMS



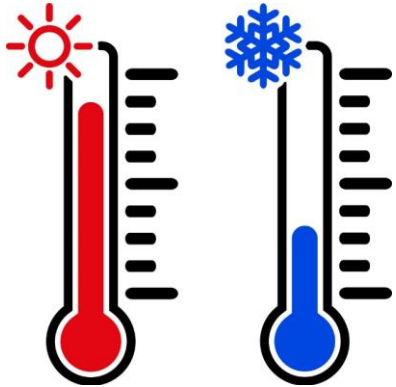
- **HUMAN COMFORT**

# Functions Of HVAC Systems

## 1. Control of air temperature



(ASHRAE) has established standards comfortable that when the air temperature is between 20-24°C



Heating ⟷ Cooling

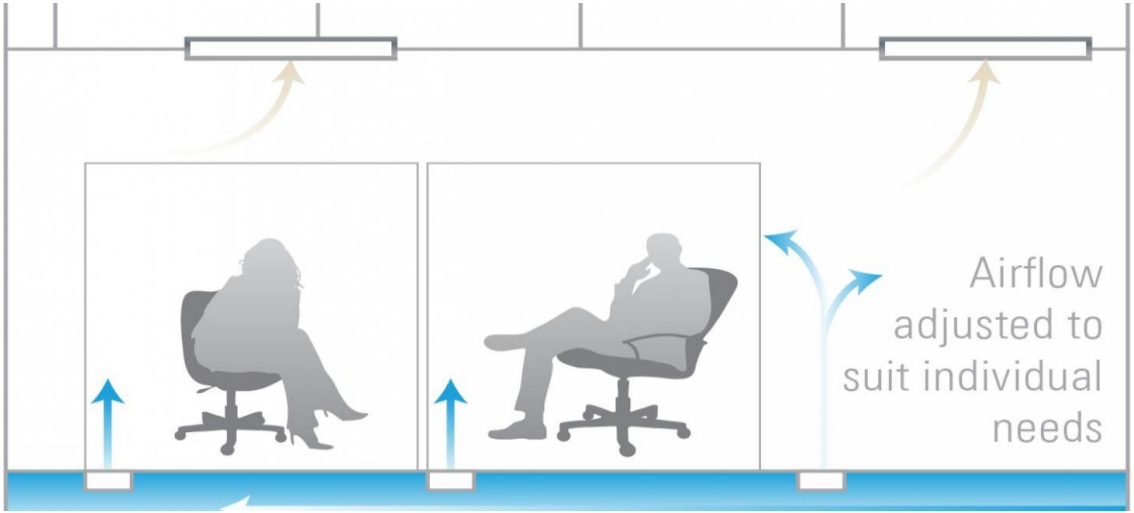
# 2. Control of air humidity



- Most people (90%) are comfortable when the air humidity is 50%.
- Also there are specific applications require specific humidity

# 3. Control of air cleanliness ( Filtration )
# 4. Control of air motion ( Air distribution )



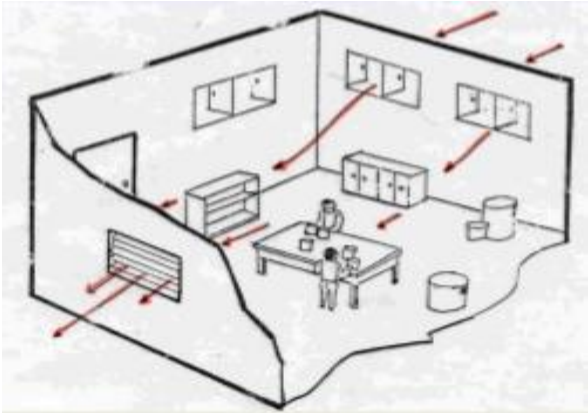


# Ventilation

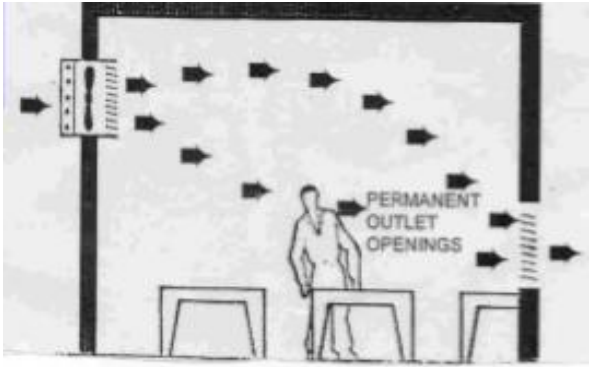
## Types of Mechanical ventilation systems



1. Nature Ventilation
2. Mechanical Ventilation



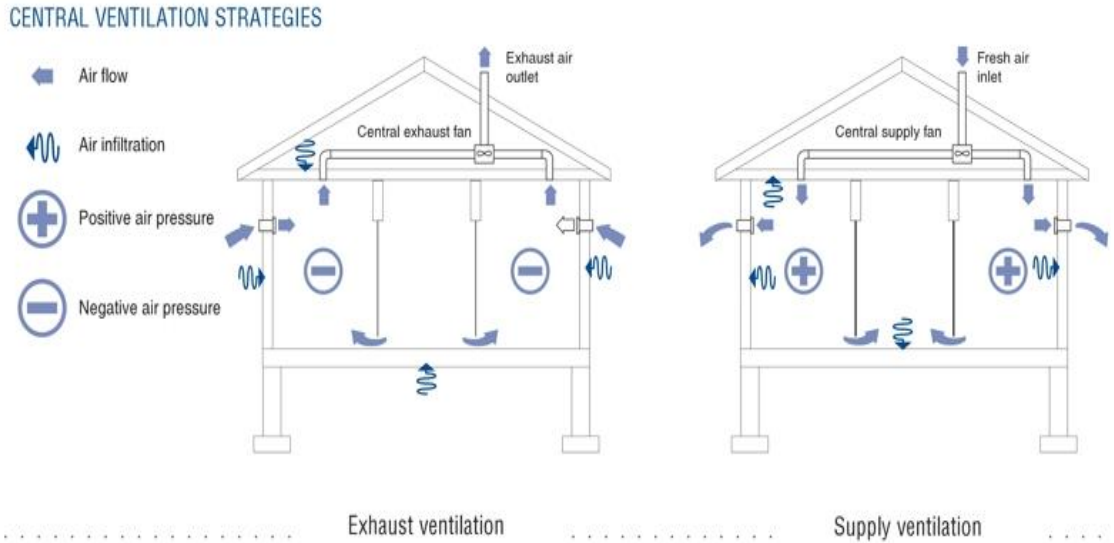
Natural Ventilation




Mechanical Ventilation

# (State of pressure for different applications)



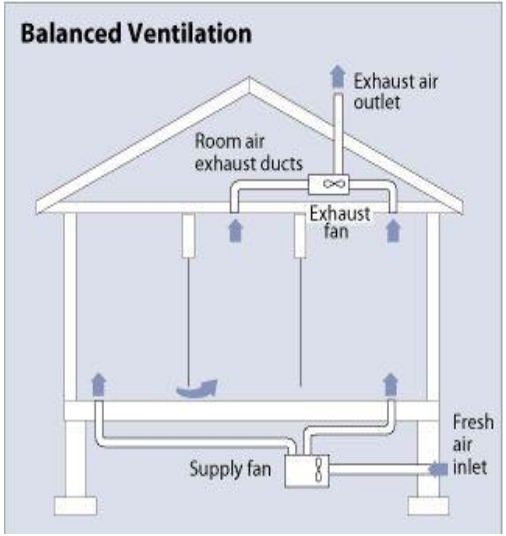



Exhaust ventilation

$EA > FA$

Supply ventilation

$EA < FA$



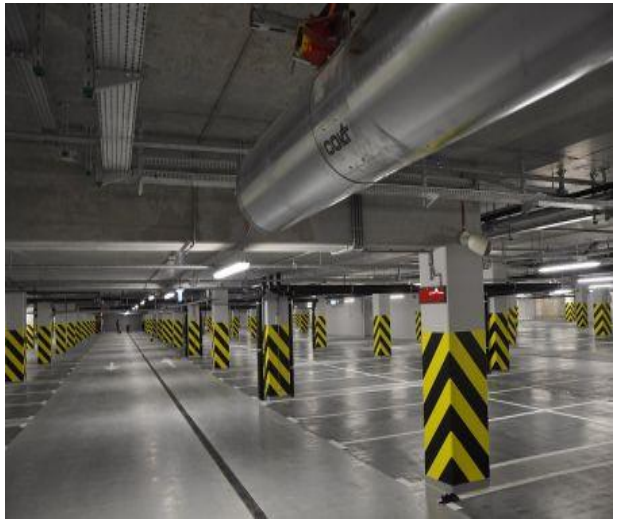

$EA = FA$

*EA: exhaust air*
*FA: fresh air*

# Applications of Ventilation System



- Kitchens
- Toilets
- Car Park at Basements
- Factories
- Chemical Industries
- Pharma Industries ,etc.



# Functional Requirements for Effective Building Ventilation



1. ACH should be optimum
2. Supplied air must be fresh and free of dust and Bactria (filtration)
3. If possible ,its better for outlet be near roof level and inlet opening near floor level
4. Should the humidity maintained on the correct level
5. Take into account the outside temperature effect on the inside temperature

# Steps of selection of ventilation system



1. Understand the existing processes in place
2. Get ACH for the place
3. Get the required CFM
4. Making design for ducts routing
5. Get the static pressure
6. Select the suitable fan

# How to calculate CFM for ventilation ?

$$\text{Required } CFM = \frac{Volume\ of\ Room(ft^3)\ x\ ACH}{60}$$

# ACH Tables



## Air Changes Per Hour (ACH) Table

This table provides suggested air changes per hour (ACH) under normal conditions based on our extensive experience.

| | | | |
|---|---|---|---|
| Assembly rooms | 4 - 8 | Hairdressing salons | 10 - 15 |
| Bakeries | 20 - 30 | Hospitals - sterilizing | 15 - 25 |
| Banks/Building Societies | 4 - 8 | Hospitals - wards | 6 - 8 |
| Bathrooms | 6 - 10 | Kitchens - domestic | 15 - 20 |
| Bedrooms | 2 - 4 | Kitchens # - commercial | 30minimum |
| Billiard Rooms * | 6 - 8 | Laboratories | 6 - 15 |
| Boiler Rooms | 15 - 30 | Launderettes/Laundromats | 10 - 15 |
| Cafes and coffee bars | 10 - 12 | Laundries | 10 - 30 |
| Canteens | 8 - 12 | Lavatories | 6 - 15 |
| Cellars | 3 - 10 | Lecture theatres | 5 - 8 |
| Changing Rooms Main area | 6 - 10 | Libraries | 3 - 5 |
| Changing Rooms Shower area | 15 - 20 | Living rooms | 3 - 6 |
| Churches | 1 - 3 | Mushroom houses | 6 - 10 |
| Cinemas & theatres * | 10 - 15 | Offices | 6 - 10 |
| Club rooms | 12 minimum | Paint shops (not cellulose) | 10 - 20 |
| Compressor rooms | 10 - 20 | Photo & X-ray darkrooms | 10 - 15 |
| Conference rooms | 8 - 12 | Public house bars | 12 minimum |
| Dairies | 8 - 10 | Recording control rooms | 15 - 25 |
| Dance halls | 12 minimum | Recording studios | 10 - 12 |
| Dental surgeries | 12 - 15 | Restaurants | 8 - 12 |
| Dye works | 20 - 30 | Schoolrooms | 5 - 7 |
| Electroplating shops | 10 - 12 | Shops and supermarkets | 8 - 15 |
| Engine rooms | 15 - 30 | Shower baths | 15 - 20 |
| Entrance halls & corridors | 3 - 5 | Stores & warehouses | 3 - 6 |
| Factories and workshops | 8 - 10 | Squash courts | 4 minimum |
| Foundries | 15 - 30 | Swimming baths | 10 - 15 |
| Garages | 6 - 8 | Toilets | 6 - 10 |
| Glasshouses | 25 - 60 | Utility rooms | 15 - 20 |
| Gymnasiums | 6 minimum | Welding shops | 15 - 30 |

* *Increase by 50% where heavy smoking occurs or if the room is underground.*

\# *Some commercial kitchens may require higher ventilation rates, based on cooking equipment in use.*

# ASHRAE Tables



APPENDIX

Table 7.1 Design Parameters—Hospital Spaces *(Continued)*

| Function of Space | Pressure Relationship to Adjacent Areas (n) | Minimum Outdoor ach | Minimum Total ach | All Room Air Exhausted Directly to Outdoors (j) | Air Recirculated by Means of Room Units (a) | Design Relative Humidity (k), % | Design Temperature (l), °F/°C |
|---|---|---|---|---|---|---|---|
| Continued care nursery | N/R | 2 | 6 | N/R | No | 30–60 | 72–78/22–26 |
| Labor/delivery/recovery (LDR) (s) | NR | 2 | 6 | NR | NR | Max 60 | 70–75/21–24 |
| Labor/delivery/recovery/postpartum (LDRP) (s) | NR | 2 | 6 | NR | NR | Max 60 | 70–75/21–24 |
| Newborn nursery suite | NR | 2 | 6 | NR | No | 30–60 | 72–78/22–26 |
| Nourishment area or room | NR | NR | 2 | NR | NR | NR | NR |
| Patient corridor | NR | NR | 2 | NR | NR | NR | NR |
| Patient room | NR | 2 | 4 (y) | NR | NR | Max 60 | 70–75/21–24 |
| PE anteroom (t) | (e) | NR | 10 | NR | No | NR | NR |
| Protective environment room (t) | Positive | 2 | 12 | NR | No | Max 60 | 70–75/21–24 |
| Toilet room | Negative | NR | 10 | Yes | No | NR | NR |

**Minimum outdoor >>>> minimum fresh air**
**Minimum total >>> minimum supply air**

# Calculation of static pressures



## Uses of pressure loss charts

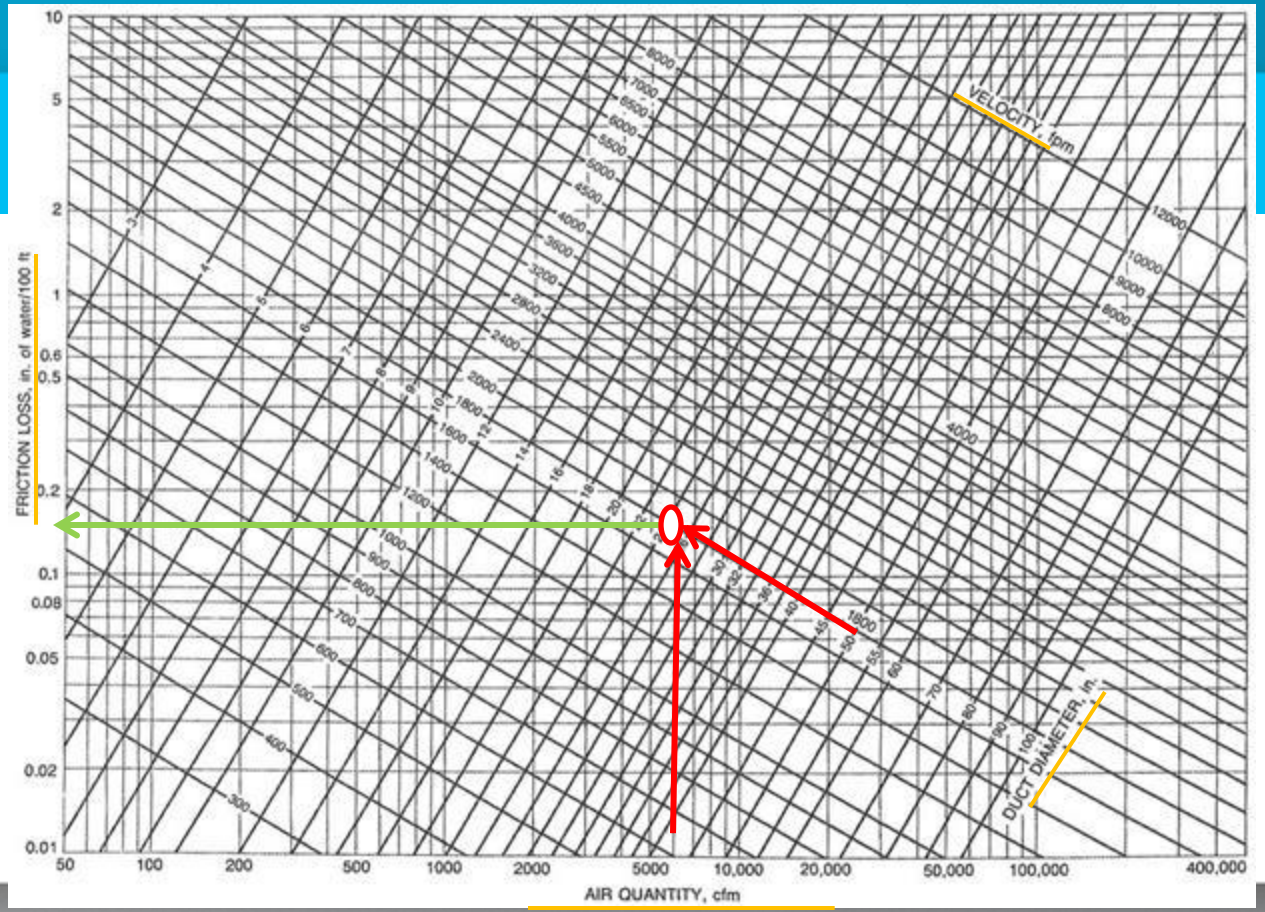
i. Equal friction method
ii. Equal velocity method

1. By recommended velocity from ASHRAE 2007
2. And calculated CFM
3. Get Pst and make it constant along the system
4. Get main Diameter
5. Then for different flowrates Q=V x A get duct sizing

**Recommended air velocities (f/m)**

| | Recommended velocity | | |
|---|---|---|---|
| | Residence | Schools, public areas | Industrial areas |
| Outside air inlet | 500 | 500 | 500 |
| Fan outlet | 700 | 800 | 1000 |
| Main ducts | 700-900 | 1000-1300 | 1200-1800 |
| Branch duct | 500-600 | 500-600 | 800-1000 |

# Pressure loss chart



# Variables are required in selection of fans



- ✓ **CFM =** $\frac{volume\ X\ ACH}{60}$ **= V x A**

**A: Area** **H: Height** **ACH: Air change per hour**

- ✓ **Type of application**
- ✓ **Static pressure**

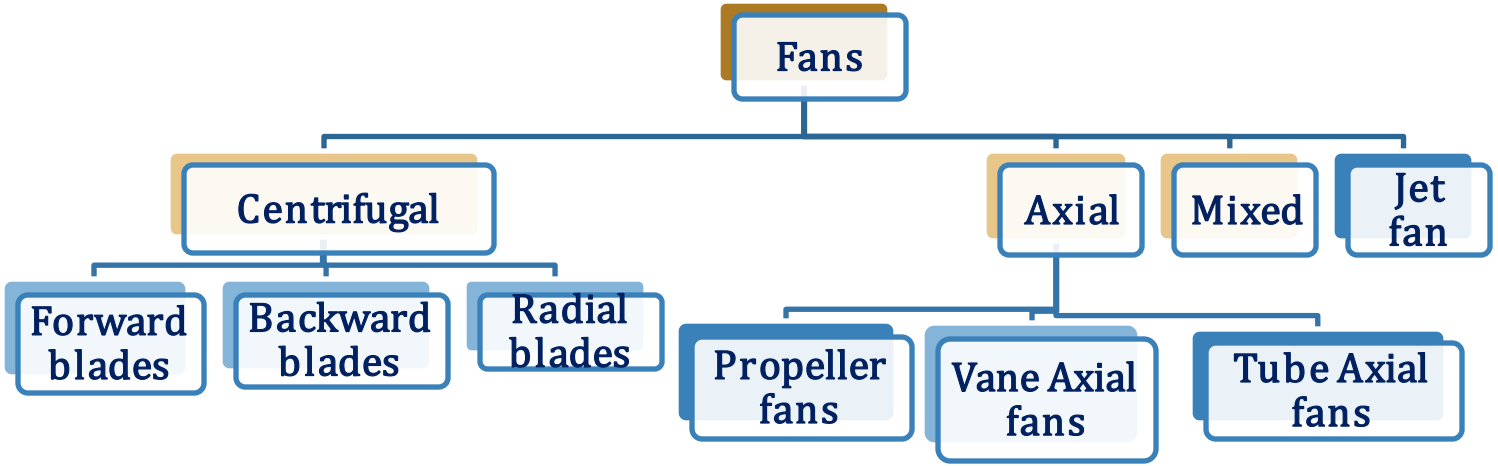
# Fans



- Any device that produces a current of air by the movement of the blades can be called a fan.
- Fans used either in FCU ,AHU ,Supply fan or Exhaust fan

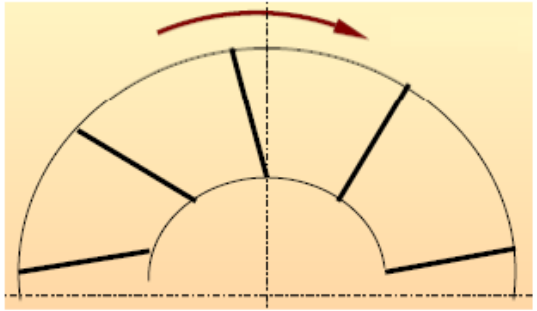
# Fans Types



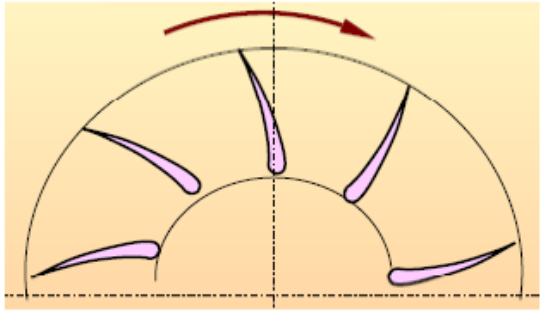

Fans
Centrifugal
Axial
Mixed
Jet fan
Forward blades
Backward blades
Radial blades
Propeller fans
Vane Axial fans
Tube Axial fans

# Fan/Blower Blades Types

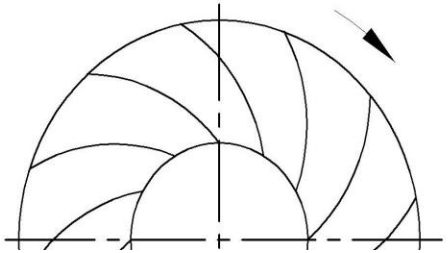




Constant thickness blades



Aerofoil blades

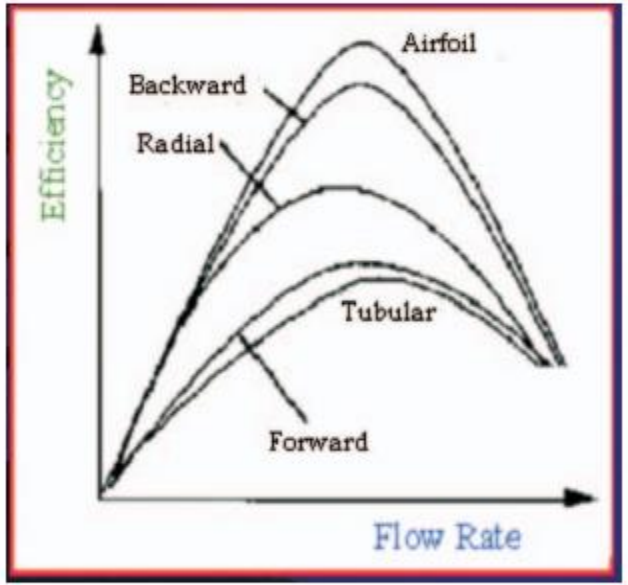


Curved blades

# Fan efficiencies

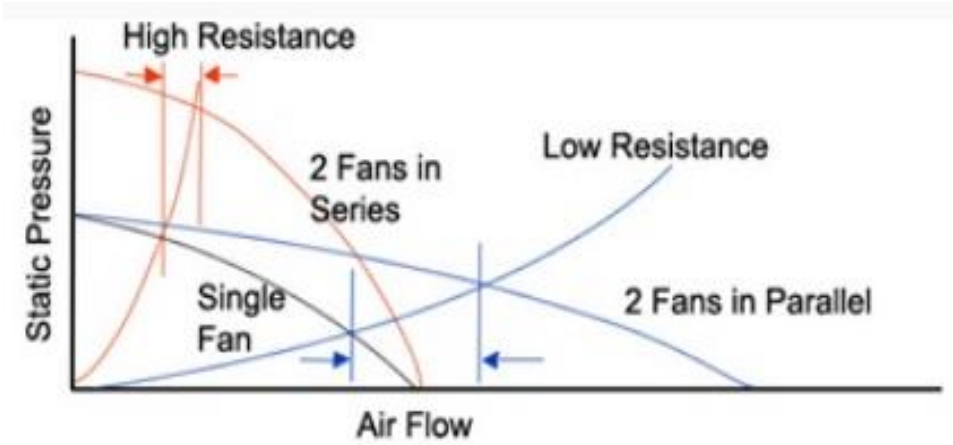


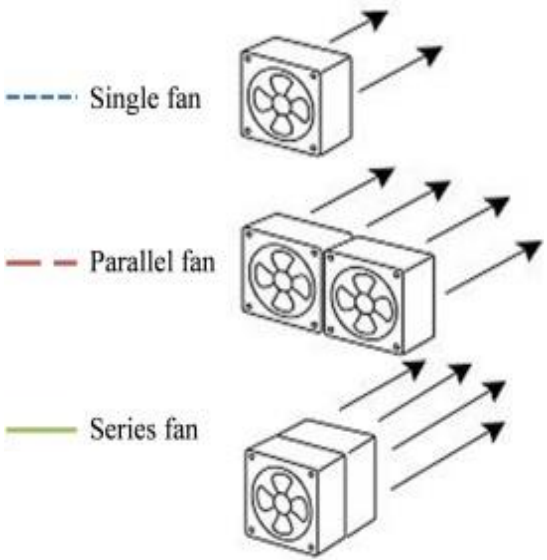
| Type of fan | Peak Efficiency Range |
|---|---|
| **Centrifugal Fans** | |
| Airfoil, backward curved/inclined | 79–83 |
| Modified radial | 72–79 |
| Radial | 69–75 |
| Pressure blower | 58–68 |
| Forward curved | 60–65 |
| **Axial fan** | |
| Vane axial | 78–85 |
| Tube axial | 67–72 |
| Propeller | 45–50 |



# Series and Parallel Operations for fans





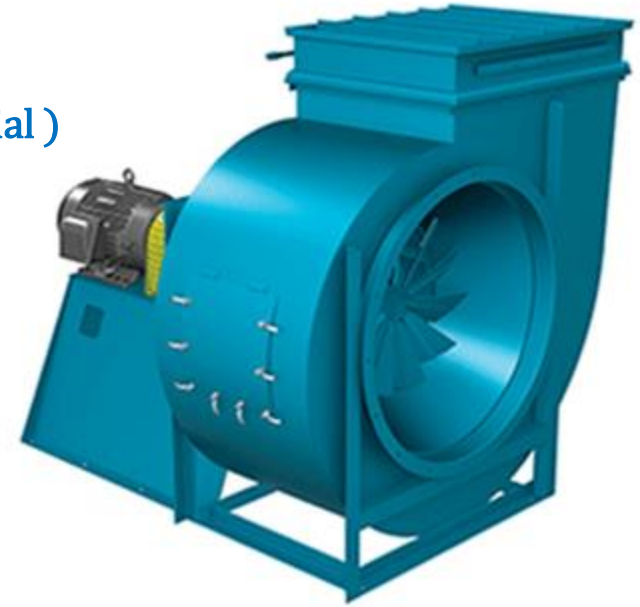



# Centrifugal fan



- It could be catalogued by:

1. Drive type (Belt drive OR Direct drive)
2. Blade type either it (forward or backward or Radial )



# Drive type (Belt drive OR Direct drive)



Direct

Belt

# Blade type either it (forward or backward or Radial )



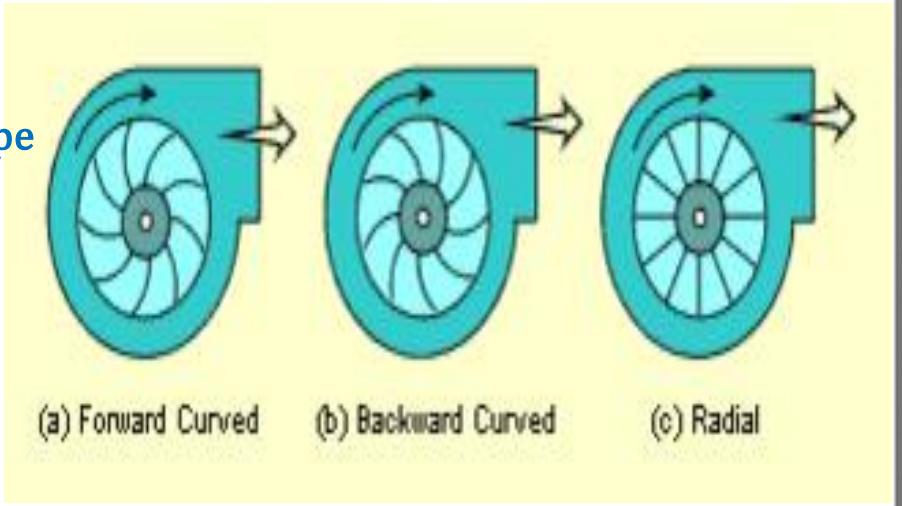
a) Forward blades

- Common with FCU
- Constant or curved blade shape
- Medium efficiency

b) Backward blades

- Common with AHU
- Constant ,curved or airfoil blade shape
- Higher efficiency
- Efficient than forward because change in static pressure don't overload the' motor ''non-overloading'
- Low noise

c) Radial blades (straight blades)



# Axial fan

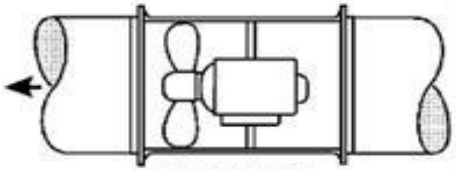
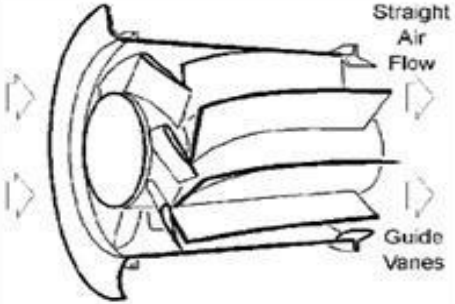
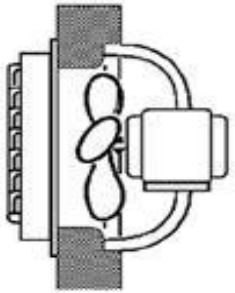


a) Propeller fans
- Less efficient, low airflow
- Not ducts
- Used in split and window types AC
- Low static pressure

b) Vane Axial fans
- Higher efficient
- Medium static pressure

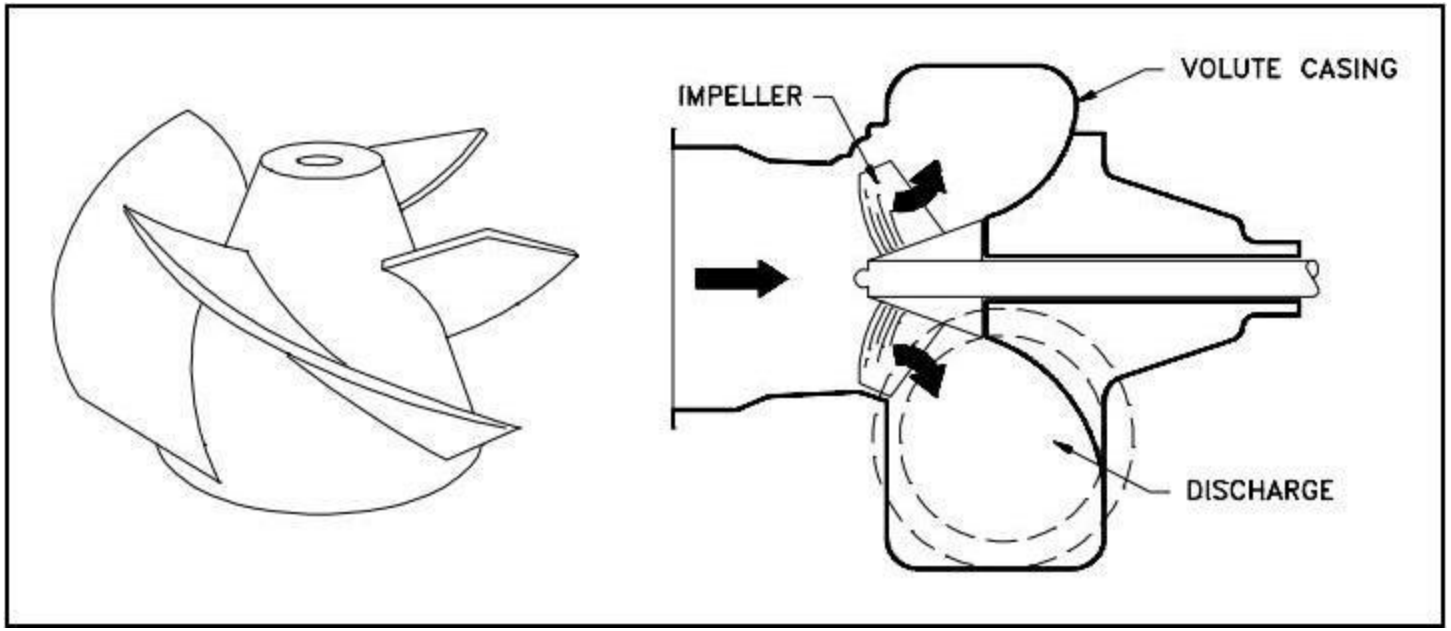
c) Tube Axial fans
- Higher speed than propeller so high airflow

➢ Constant or aerofoil blade shape

| Tube Axial | Vane Axial | Propeller |
| --- | --- | --- |
|  |  |  |
|  TUBEAXIAL FAN |   VANEAXIAL FAN | PROPELLER FAN Belt Drive or Direct Connection  |

# Mixed fan

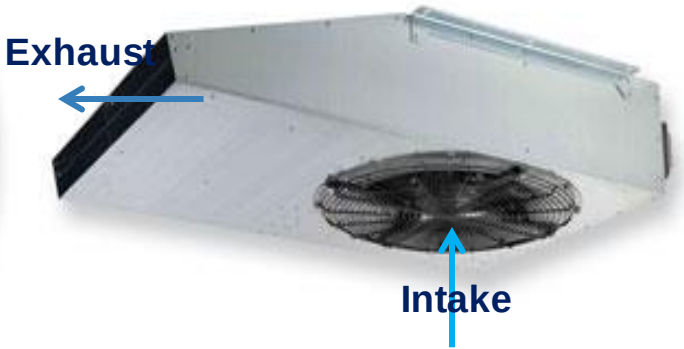




# Jet fan
# Types of jet fans:



Axial Jet Fan

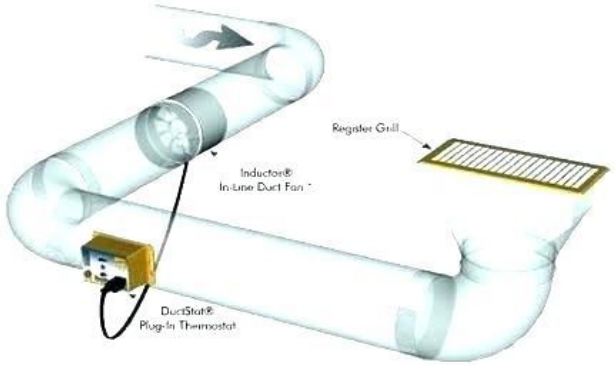



Centrifugal Induction Jet Fan

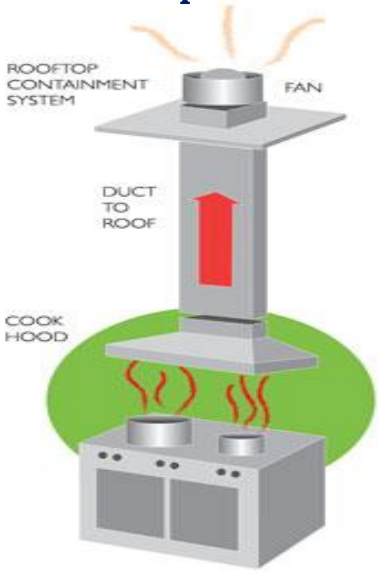
# Fans Installation



1. Inline ducted




2. Rooftop




3.Wall mounted

# Fans being exist for more safety on the system

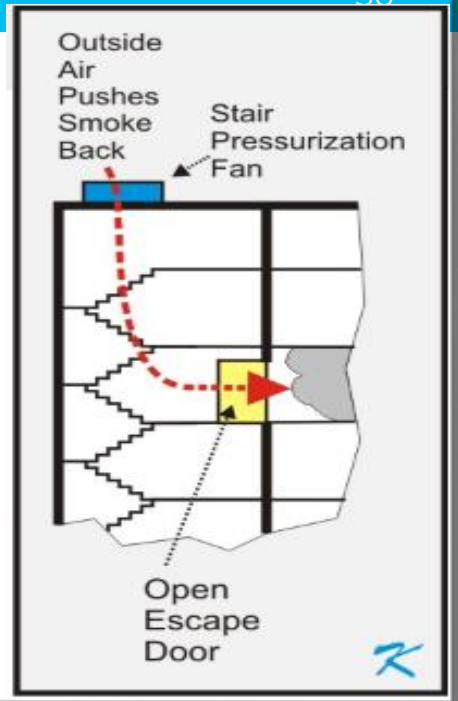
## Pressurized fan



**Its Important of exciting of those system**

**1. Stair Pressurization Fan (SPF)**

- When there's a fire, clean outside air is forced by a Stair Pressurization Fan into a stairwell.
- The pressurization is used to push back on smoke, keeping the smoke out of the escape route.
- The pressurized air helps people escape the fire and firefighters battle the fire.



# Smoke fan



# Car Park Ventilation System

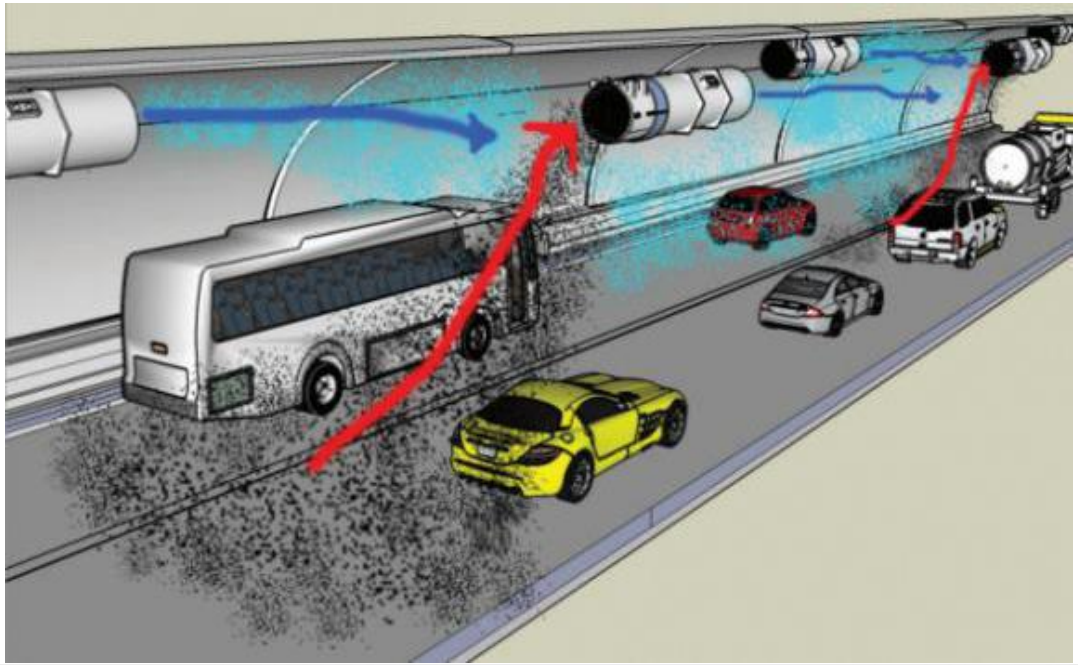


1. **System components**

1. Jet fan
2. Ducted system (Supply/Exhaust)
3. Louvers

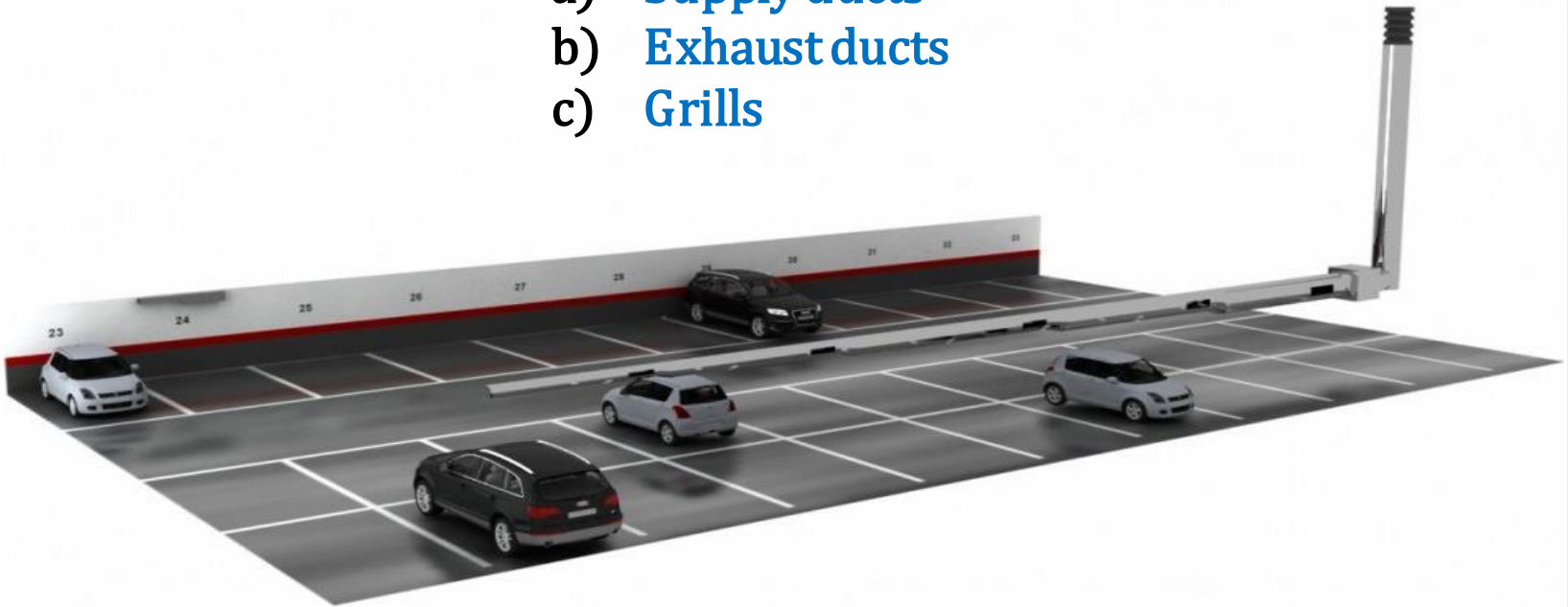
# 1. Jet fan





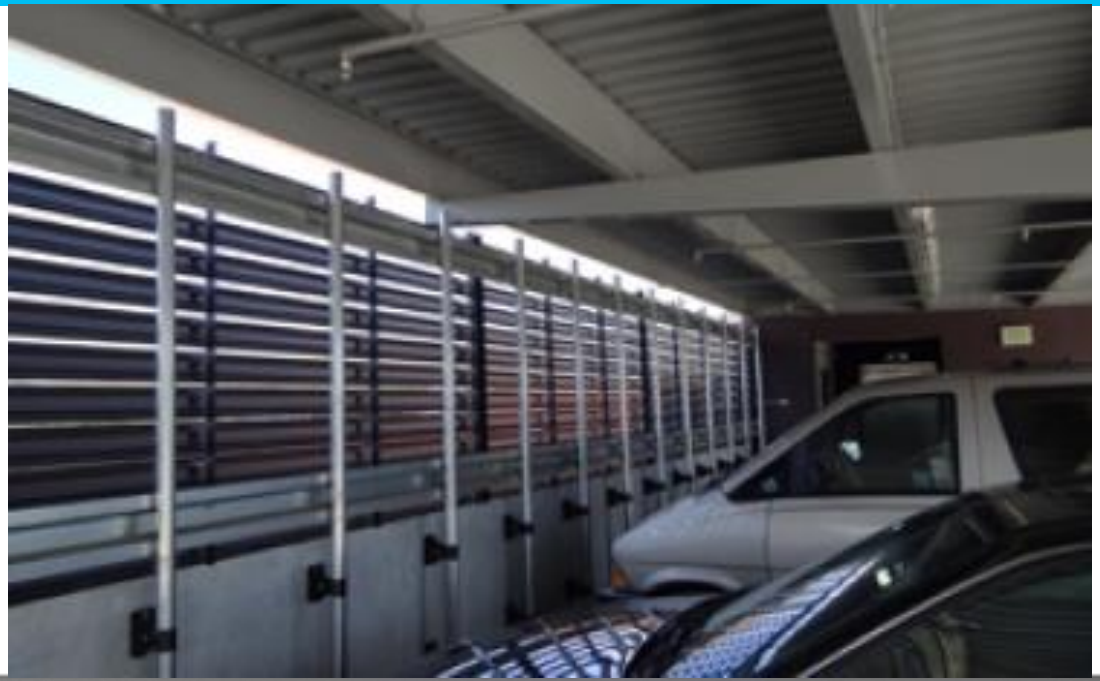
## 2. Ducted system

a) Supply ducts
b) Exhaust ducts
c) Grills



# 3. Louvers





# 2. Steps for designing the mechanical ventilation



1. Calculation of airflow rate (CFM) for jet fan
   - A Computational Fluid Dynamics (CFD) analysis is often required to prove and further refine the design.
2. Selection of supply, exhaust systems based on several parameters (Ducted system)

$$CFM)_{exh} = \frac{Volume\ of\ Room\ (ft^3) x\ ACH}{60}$$

As car park should be negative pressure (ASHREA) so

$$CFM)_{fresh} \cong 0.85\ CFM)_{exh}$$

3. Divide total CFM to a number of fans then select them
4. Design Coordination

# Design Coordination

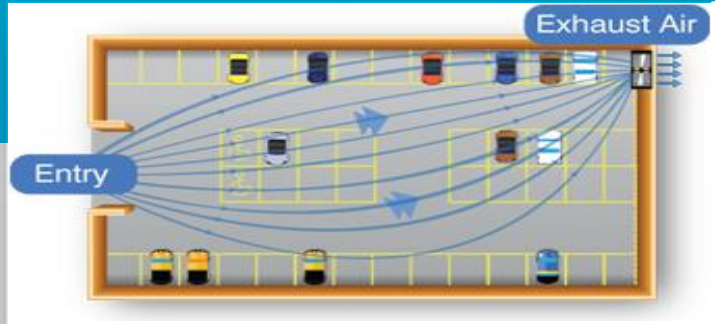



Fig1 (a) preferred natural path

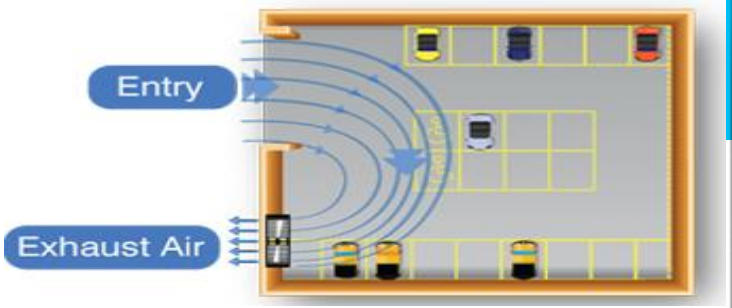



Fig1 (b) natural air path to be avoided

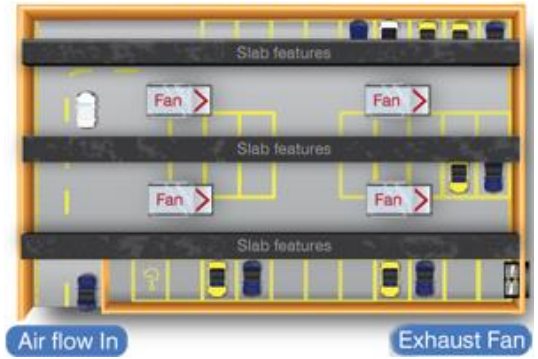



Fig 2(a). Fan's air movement parallel to beams is most effective

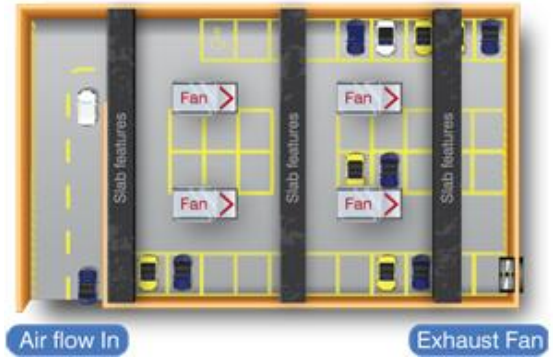



Fig 2(b). Beams is less effective

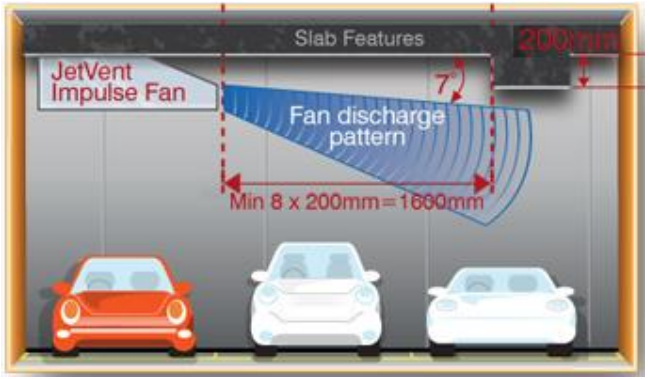



Fig 3(a). Obstruction too close

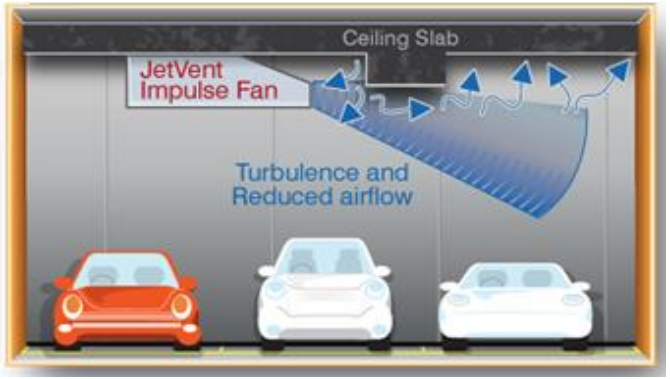
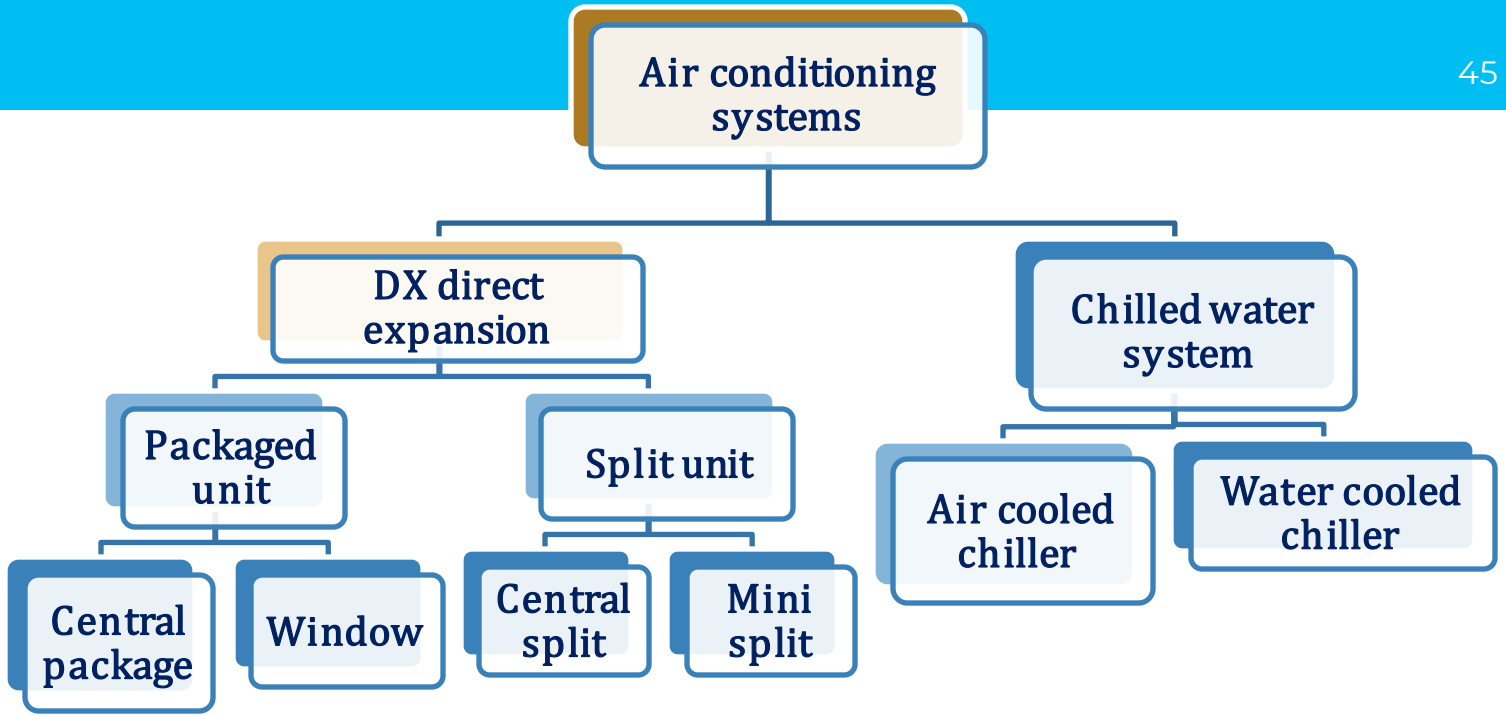


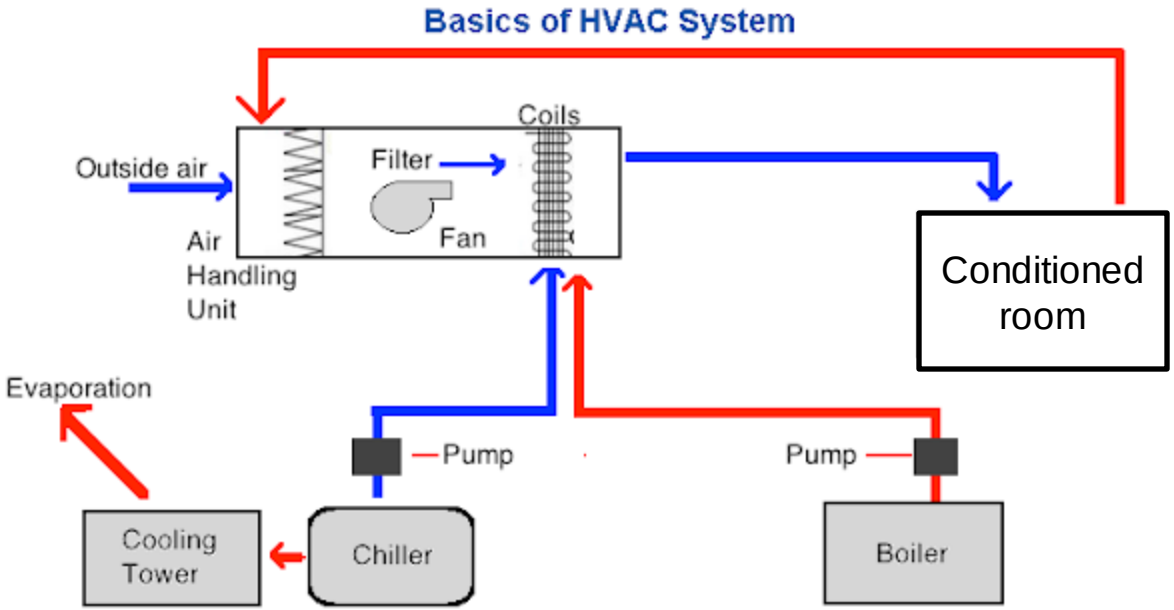

Fig 3(b). Obstruction out of the way


Air conditioning systems
DX direct expansion
Chilled water system
Packaged unit
Split unit
Air cooled chiller
Water cooled chiller
Central package
Window
Central split
Mini split

# Chilled water System Components



- Chillers
- Air Handling Unit
- Fan Coil Units
- Pumps
- Cooling Tower in case of water cooled chiller.


Basics of HVAC System
Coils
Outside air
Filter
Fan
Air
Handling
Unit
Conditioned
room
Evaporation
Pump
Pump
Cooling
Tower
Chiller
Boiler

# AHU

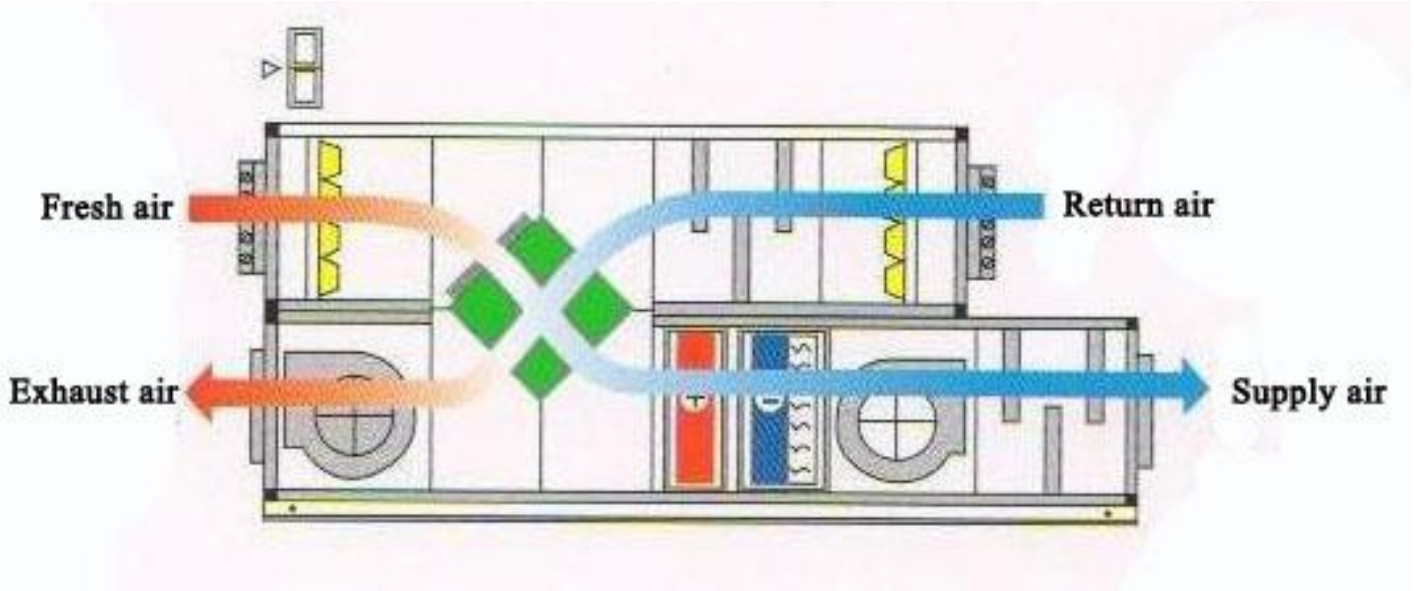
## Purpose of an air handling system

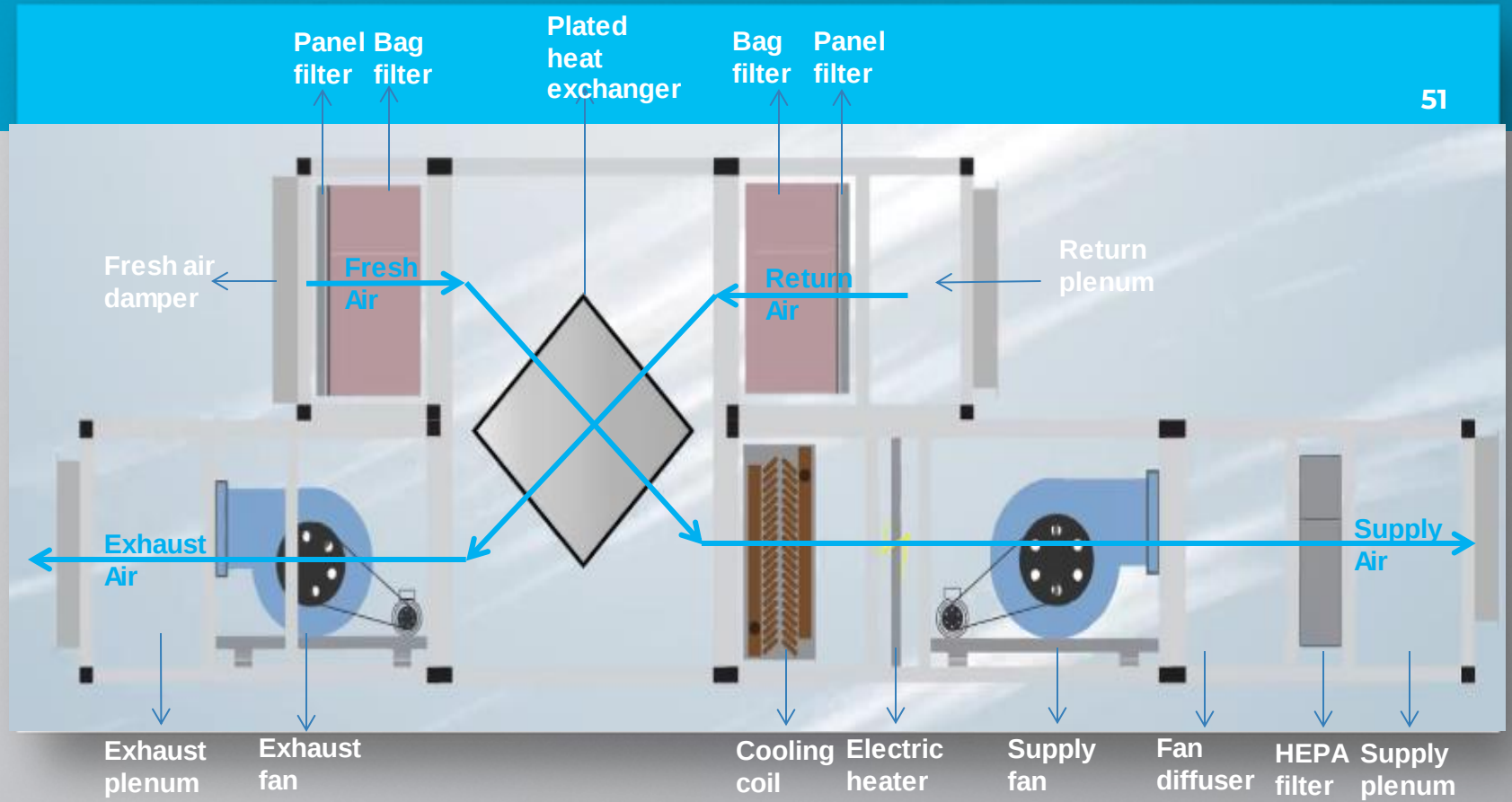


The function of the AHU is take in outside air, re-condition it and supply it as fresh air to a building.

# Operation For AHU






Panel filter
Bag filter
Plated heat exchanger
Bag filter
Panel filter
Fresh air damper
Fresh Air
Return Air
Return plenum
Exhaust Air
Supply Air
Exhaust plenum
Exhaust fan
Cooling coil
Electric heater
Supply fan
Fan diffuser
HEPA filter
Supply plenum

# Components OF AHU

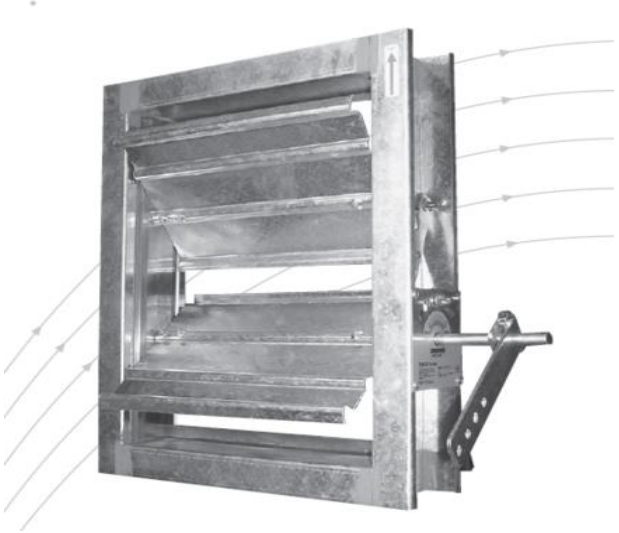


1. Fresh air damper
2. Mixing box
3. Filters
4. Heat exchanger
5. Cooling coils
6. Heating coils
7. Supply fan
8. Fan diffuser
9. HEPA filter
10. Sound attenuator
11. Supply plenum

# 1. Air damper



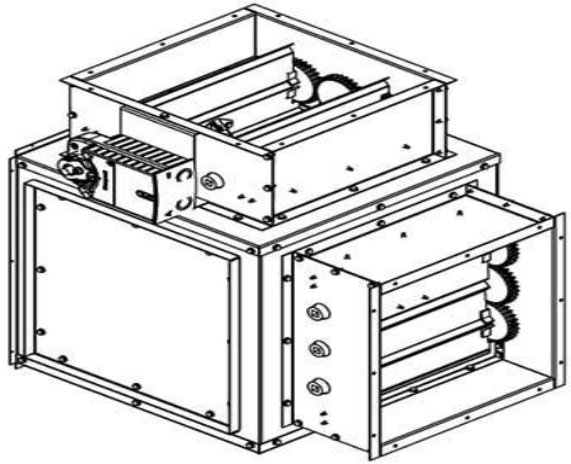
A damper is a valve or plate that stops or regulates the flow of air inside a duct, chimney, air handler

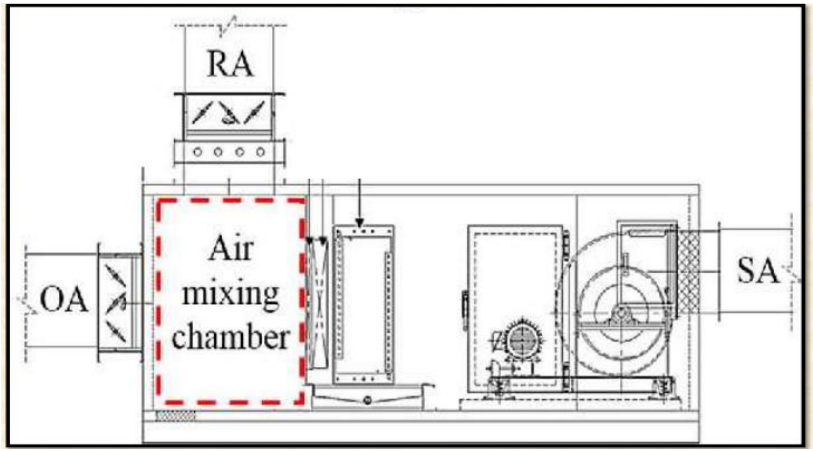


# 2. Mixing box



Mix the return air and fresh air from outside for re-sending into the air-conditioned





# 3. Filters types



Its one of the important parts of AHU it removes dirt, dust and smoke

## 1. Standard Filters

i ▪ Coarse Filters ..G1,G2,G3,G4 It includes

a. Mesh Filters (Aluminum Washable)

b. Pre Filters(Panel Filters/Primary Filters )

ii. Fine filters (M5,M6 ,F7,F8,F9)
(Bag Filters/Secondary Filters)

# 2. Absolute Filters



They are super efficient , they meet standard that remove at least 99.7% of airborne particles

i. Efficient Particulate Air Filters (EPA) E10,E11,E12

ii. High Efficient Particulate Air Filters (HEPA) H13,H14

# Classification of filters, filter properties and typical examples of use



| The filter group | The level of filtration | The examples of separated particles material | Recommendation for application of air filters |
|---|---|---|---|
| G<br>**Filters for coarse dust particles**<br>Efficient for particles ≥ 10 μm<br>***EN 779*** | **G1**<br>**G2** | • Leaves<br>• Insects<br>• Textile fibres<br>• Sand<br>• Flying ash<br>• Mist<br>• Hair | Only for simplest application (e.g. protection against insects) |
| | **G3**<br>**G4** | • Flower pollen<br>• Pollen<br>• Fog | • Waste air of painting boxes and kitchens<br>• Protection against the pollution of air conditioning and compact instruments (e.g. window air conditioning, fans)<br>• Pre - filters for the filtration classes F7 and F8( it is necessary only for heavy polluted input air)<br>• Pre filters and circulation filters for public protection equipments |

| | | | |
|---|---|---|---|
| F<br>**Filters for fine dust.**<br>Efficient for particals<br>≥ 1 µm<br>***EN 779*** | **M5** | • spore<br>• Cement dust<br>• Particles creating stain or dust sediment-ation | • Entering filters for the areas with low demand(e.g. workshops,storages,garage)<br>• Pre-filters for the filtration class F8 and F9. |
| | **M6** | • Bacterium<br>• Embryo on the carrying parts<br>• | • The entering filters for the area with low demand(e.g. selling areas,specific production area)<br>• Pre-filters for the class filtration F9 and E10<br>• Filters for waste air for heat exchanger and recuparator |
| | **F7**<br>**F8** | • Acumulated carbon black<br>• So called dust going through lung<br>•<br>• | • Circulating filters in air conditioning<br>• End filters in air conditioning pro average request e.g. shops,offices and specific production areas.<br>• Pre filters for the filtration class E11 and E12. |
| | **F8**<br>**F9** | • Tobacco smoke (roase fractions)<br>• Metal oxide smoke(soarse fractions)<br>• Oil smoke<br>• | • The end filters in air conditioning for higher requests e.g. offices, workshops, telecommunication centres, laboratories etc.<br>• Outside air equipments in hospitals<br>• Digital phone exchanges<br>• Pre-filters for the filtration class H13 and H14<br>• Pre-filters for adsorbable filters(e.g. filters with active carbon)<br>• Pre-filters in pharmacy |

# 4. Heat exchanger



## What is a heat exchanger?

A device used to transfer (exchange) thermal energy between exhaust air and fresh air.

## What is The main function of a heat exchanger?

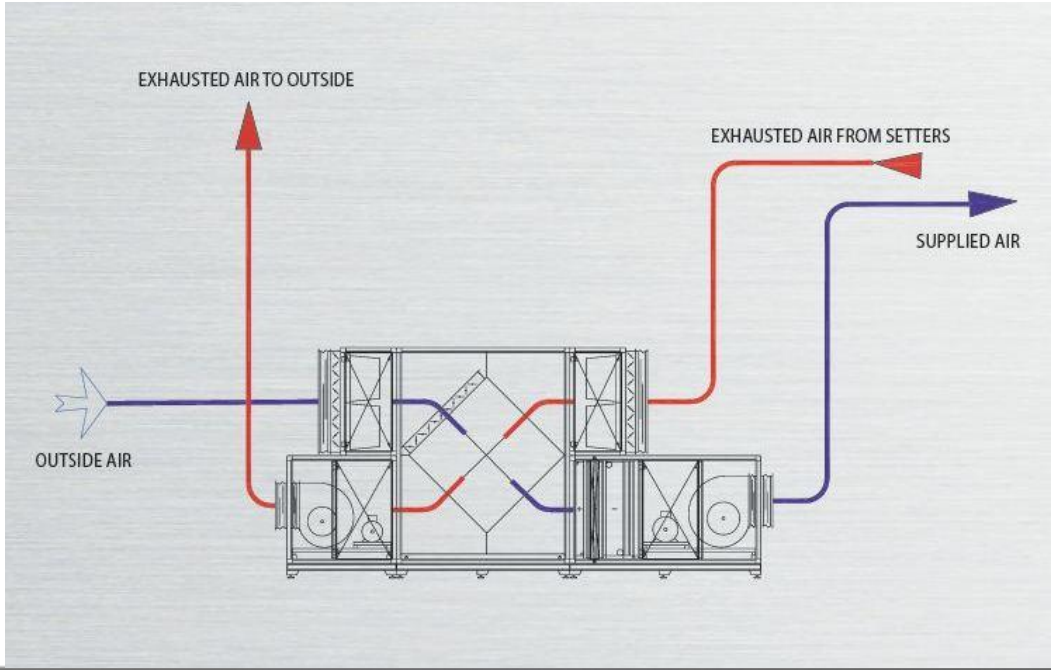
It is to increase the energy efficiency of a cooling system by transferring heat ,thus reducing energy bills.

# Types of heat exchangers.

## 1. Plate heat exchangers



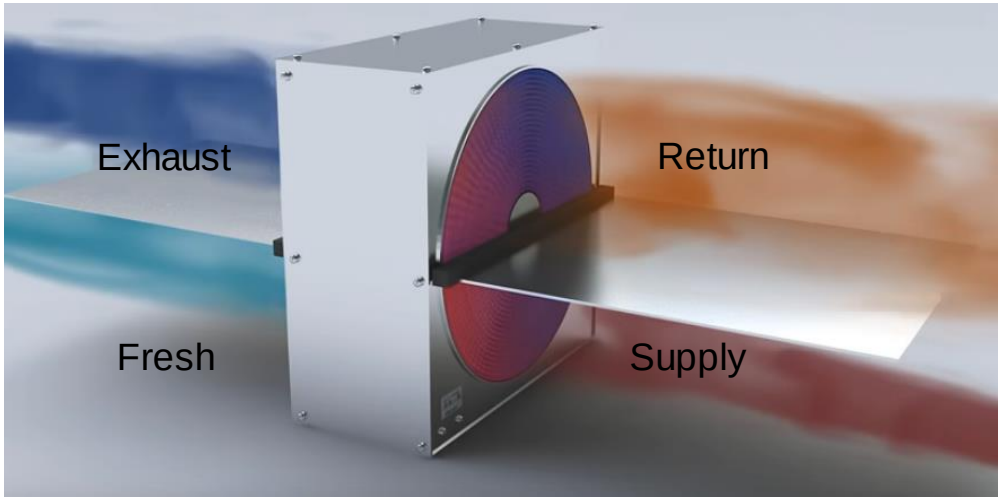
Heat exchanger where heat is transferred from the flow of exhaust air to the incoming air fresh air.


EXHAUSTED AIR TO OUTSIDE
EXHAUSTED AIR FROM SETTERS
SUPPLIED AIR
OUTSIDE AIR

# 2. Rotary wheel heat exchanger



**As the wheel rotates, heat is picked up from the exhaust air stream on the rotation.**



The advantage

High efficiency

The disadvantages

Direct contact between fresh air and return air

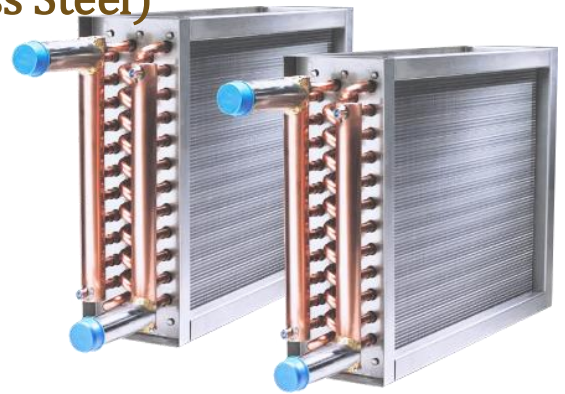
# 5. Cooling coils



1. Refrigerant Coils
2. Chilled Water Coils

Materials

1. Tubes (copper or stainless steel )
2. Fins (copper or aluminum )
3. Casing (Galvanized steel, Aluminum, or Stainless Steel)

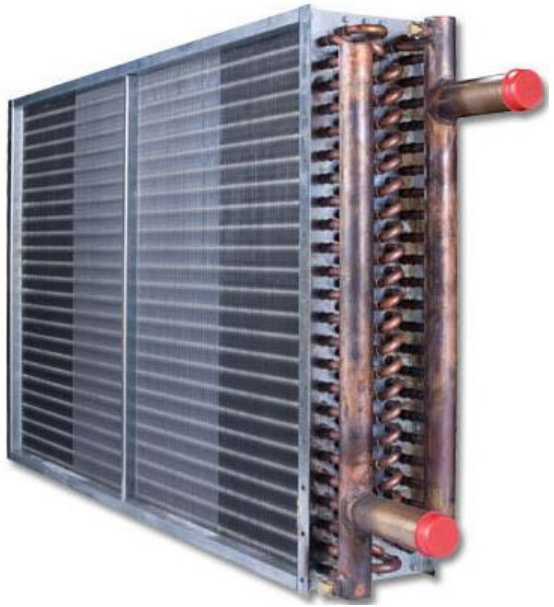


| | Copper Tube & Fins | Aluminium Tube & Fins | Copper Tube & Aluminium Fins |
|---|---|---|---|
| **Cost** | High | Low | Mid |
| **Efficiency** | High | Mid | Mid |
| **Resistant to Corrosion** | No | Yes | No |
| **Durability** | Durable | Probably Durable | Less durable |
| **Repair Difficulty** | Easy | Extremely hard | It depends where leaks |

# 6. Heating coils



1. Steam Coils
2. Hot Water



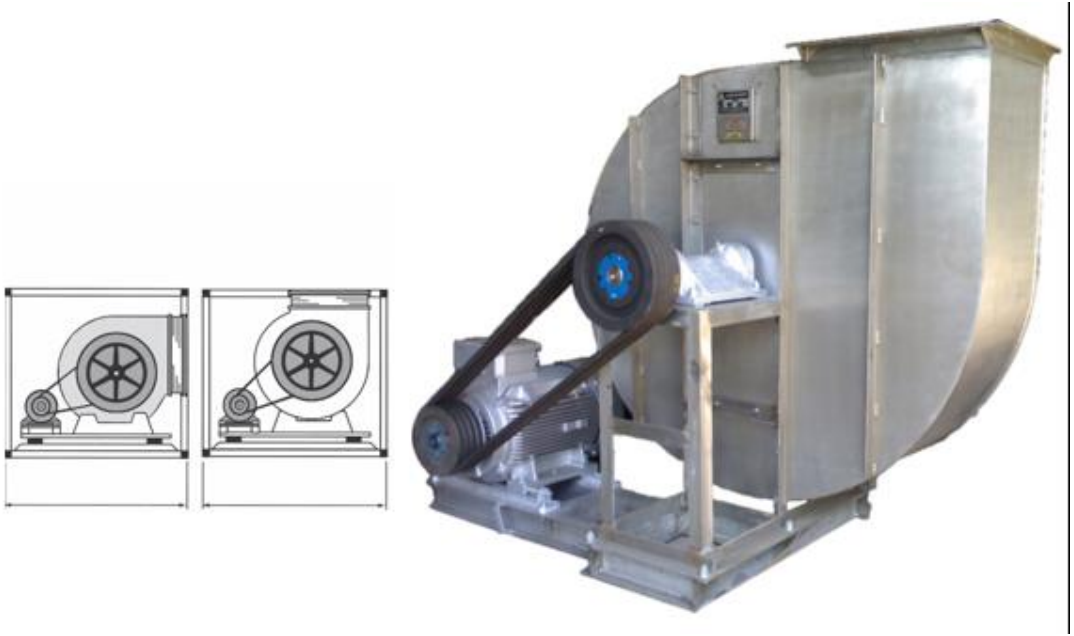
Materials

1. Steam Tubes (steel or stainless steel )
2. Hot water tubes (copper or aluminum )
3. Fins (copper or aluminum ,Steel)
4. Casing (Galvanized steel, Aluminum, or Stainless Steel)

# 7. Supply fan

The centrifugal fan is the common usage (backward and forward)





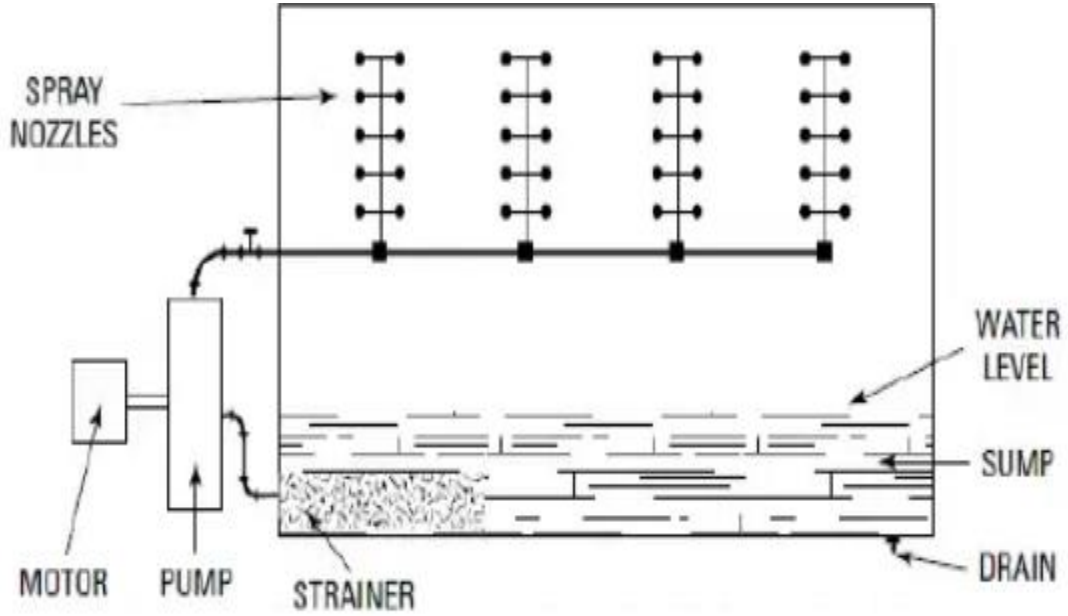
# 8. Humidifiers



1. Spray type air washer
2. Steam humidifiers
3. Wet deck humidifier

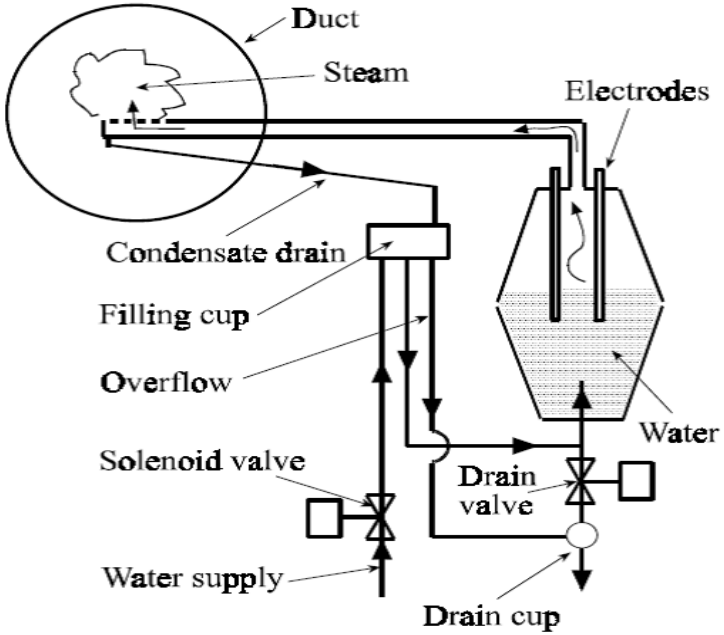
# 1. Spray type air washer





# 2. Steam humidifiers





# 3. Wet deck humidifier



Wet Film Humidifier

# 10. Sound attenuators



- Some air conditioners are noisier than others, proper installation of the systems ensure they run smoothly and produce less noise.

Rectangular(splitter type)

# Hygienic AHU

## The main differences between AHU and Hygienic AHU :



1. Double Skin Panel requirements

I. Outer skin >>>Galvanized or Galvanized painted

II. Panel sandwich >>> Foam or Rockwood or Fiberglass

III. Inner panel >>>Stainless steel or Aluminum or Galvanized

- Inner panel should be round edges to avoid accumulation of bacteria's on corners

## 2. Using the Absolute filters ( HEPA & EPA)

## 3. Fixing of filters

The efficiency in filtration (Air leakage factor)

ZERO INFILTERATION

## 4. Supply fan >>>(Plug fan)

- Supply fan should be Plug fan type(without belt drive ) to avoid existing of pollutants caused by belt drive or casing

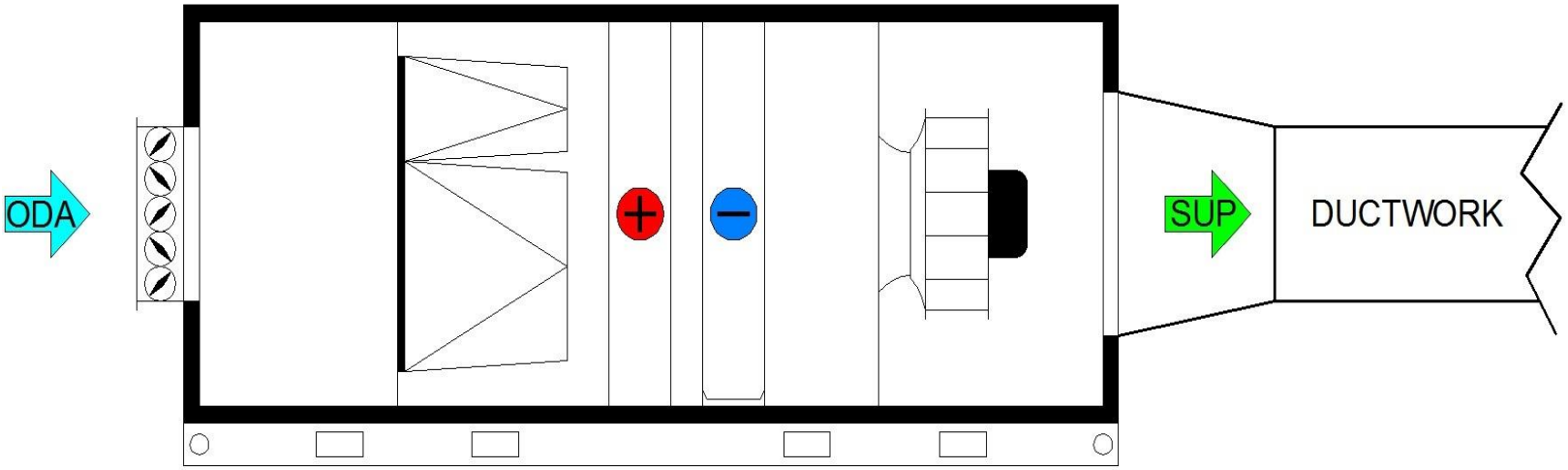
## Hygienic air handling units are used in :

- Surgical operating rooms
- Clean rooms, food
- Medicine
- Chemistry facilities, Etc.

# Different Configurations AHU



## Inline - Supply 100% Outdoor Air

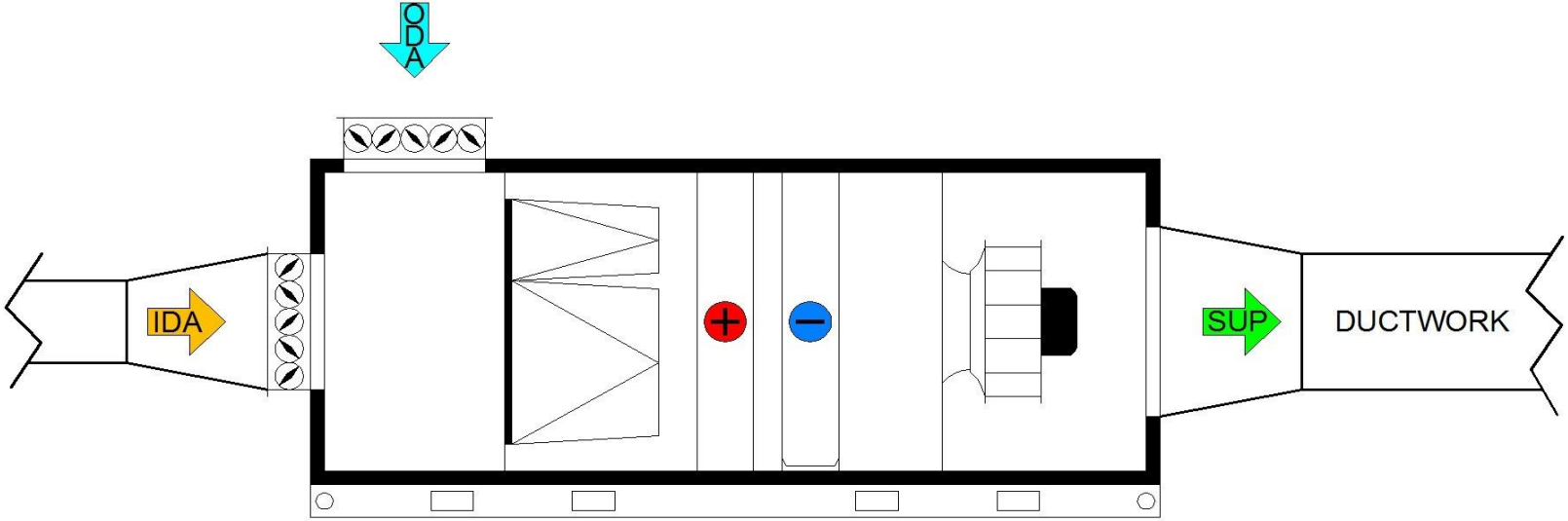



ODA - Outdoor Air
SUP - Supply Air

Note: Front View

# Inline - Supply Mixed Air



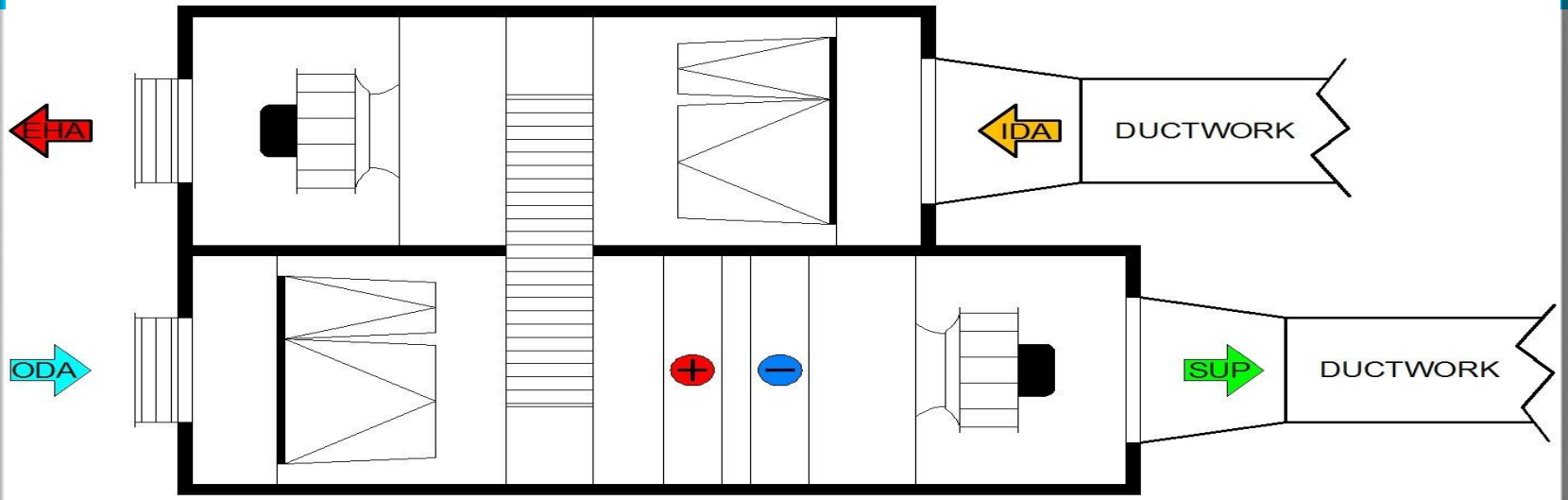



Note: Front View

ODA - Outdoor Air
SUP - Supply Air
IDA - Indoor Air

# Double deck- 100% Outdoor Air

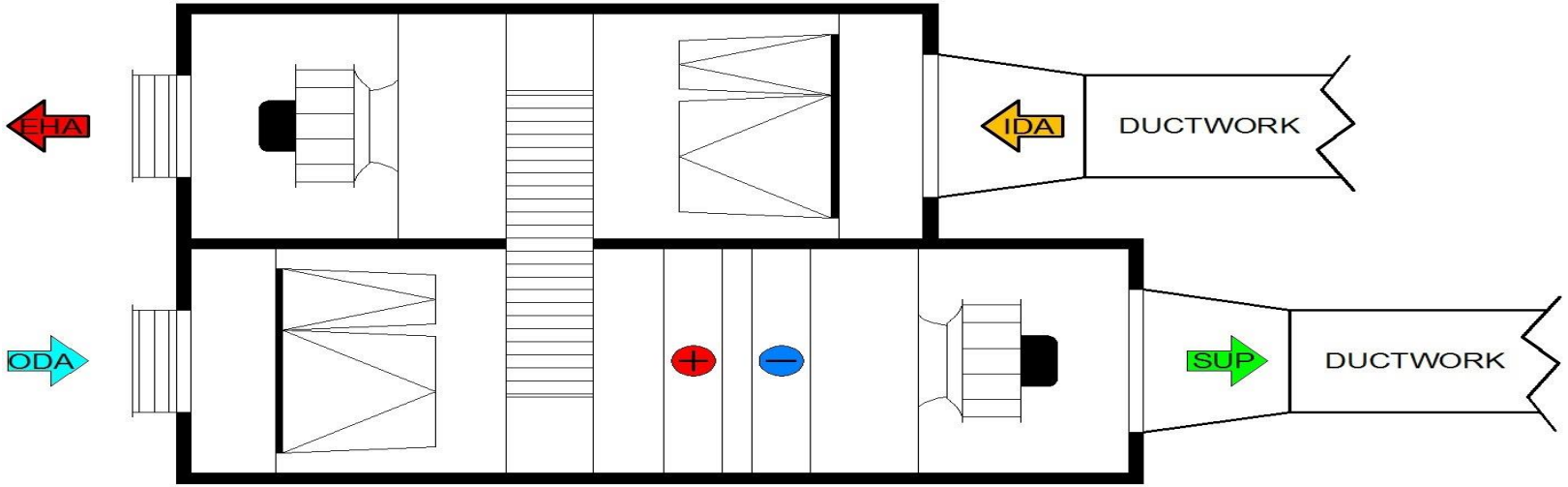





ODA - Outdoor Air
SUP - Supply Air
IDA - Indoor Air
EHA - Exhaust Air

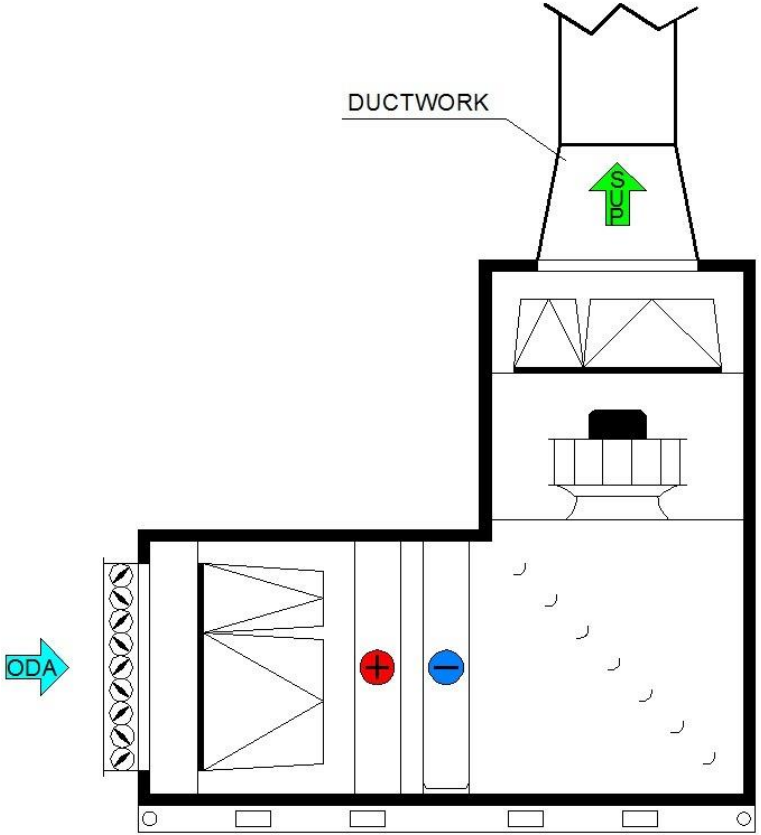
# U Shape - Supply 100% Outdoor Air






ODA - Outdoor Air
SUP - Supply Air
IDA - Indoor Air
EHA - Exhaust Air

# L Shape - Supply 100% Outdoor Air




ODA - Outdoor Air
SUP - Supply Air

Note: Front View


thanks