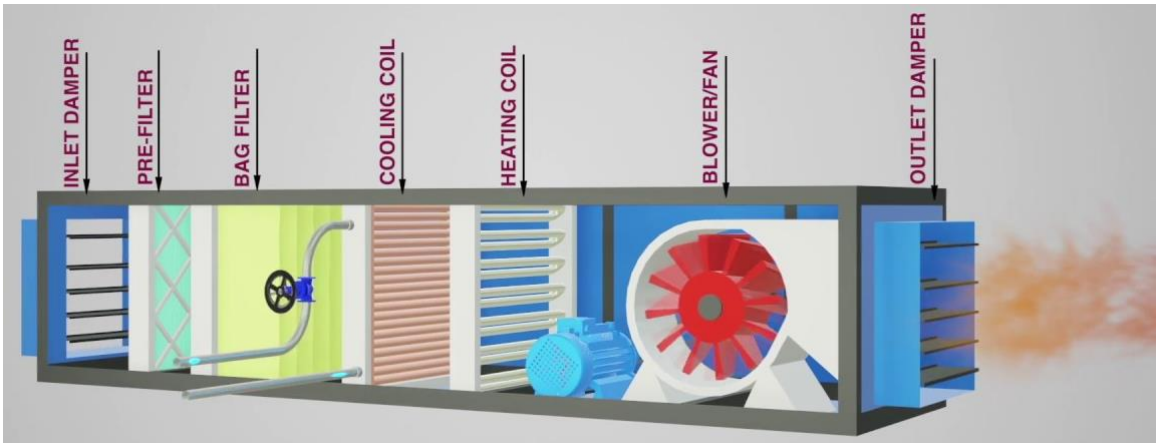
CHAPTER -1: INTRODUCTION TO AIR HANDLING UNITS (AHUs)

An Air Handling Unit (AHU) conditions and circulates air throughout a building. Its primary functions include:

a. Regulates temperature and humidity.
b. Provides ventilation with fresh outdoor air.
c. Filters contaminants for clean air.
d. Delivers conditioned air through ducts.
e. Maintains room pressure differentials.



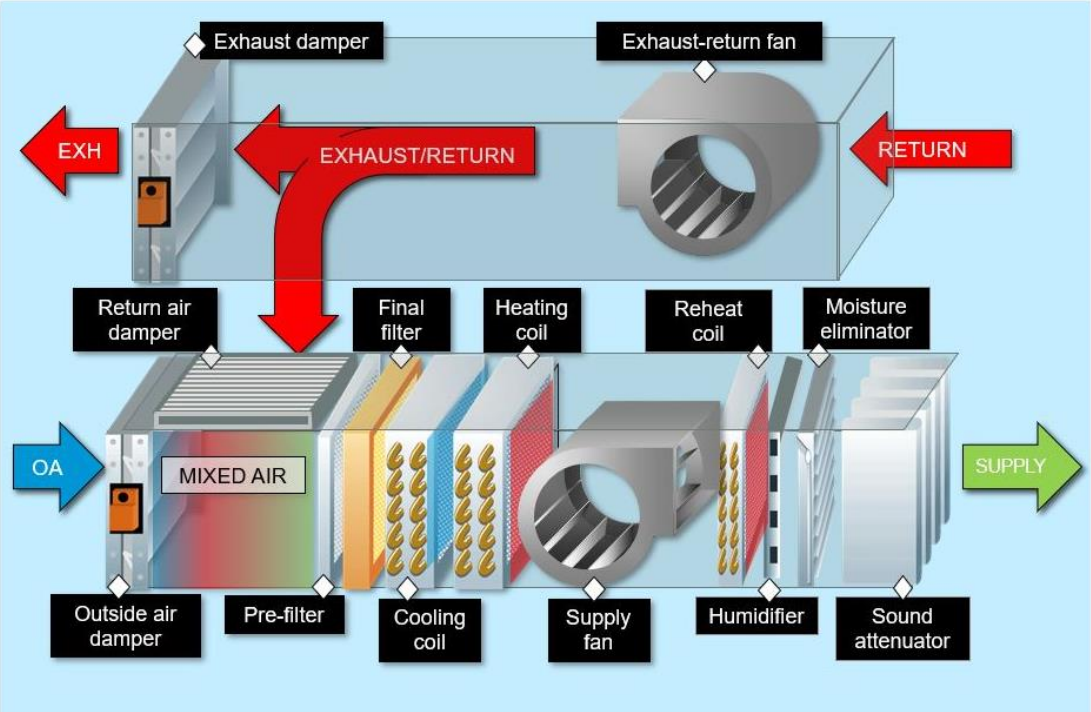
Air Handling Unit (AHU)

1.1 Basic Components of an AHU

An AHU is an enclosure with fans, filters, coils, and dampers. The various components include:

a. Air intake: Pulls in outside air for circulation.
b. Mixing chamber: Blends the return and fresh air streams.
c. Filter: Cleans the air by removing particles and contaminants.
d. Blower or fan: Moves the conditioned air through the ducts.
e. Heat exchangers: Transfer heat between fluids to adjust temperature.
f. Cooling coil: Dehumidifies and cools the air.
g. Heating coil: Raises the temperature of the air during winter months.
h. Reheat coil: Regulates air temperature, activating when the cooling coil over-cools the air for dehumidification. It is located downstream of the cooling coil.
i. Humidifiers: Add humidity to dry air during winter months or in dry regions.

j. Dampers: Dampers control the flow of air within the AHU, directing it to different sections as needed.



Components of Air Handling System

The air handler connects to ductwork that in turn, distributes the conditioned (and heated or cooled) air throughout the building before returning it to the AHU.

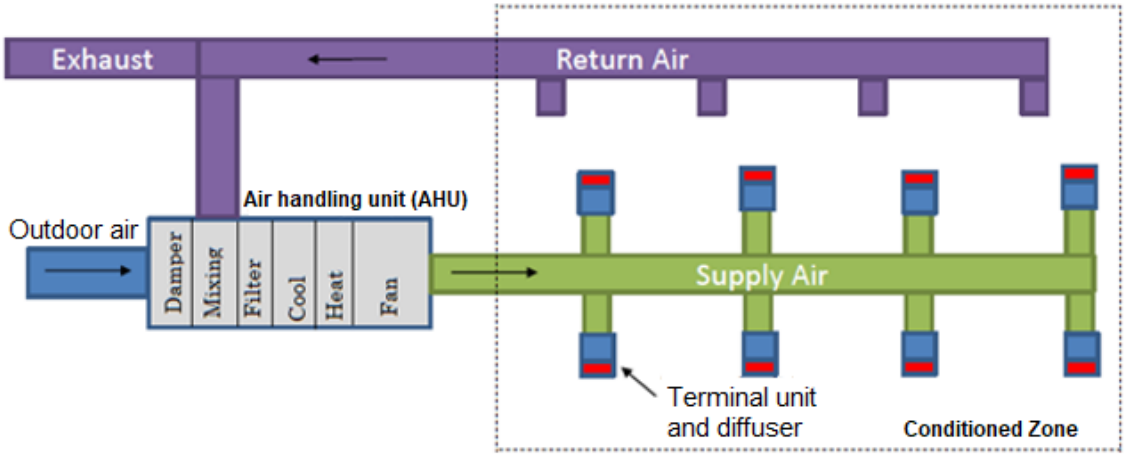
1.2 Type of AHUs

AHUs are versatile and can be customized based on the specific requirements of a building. There are three basic types of an air handling unit.

a. Recirculation units
b. 100% makeup air units
c. Terminal units

1. Recirculating Type Units

Recirculation type AHU units recycle a portion of the air within a space, mixing it with fresh outdoor air for conditioning.



Recirculation Type Air Handling Unit

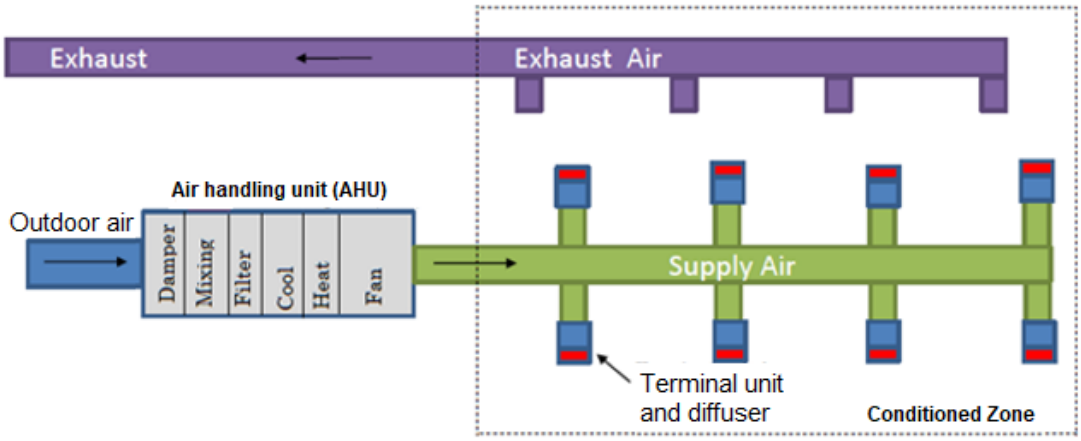
Pros: Reduces the load on heating and cooling systems, enhancing energy efficiency.
Cons: May lead to a buildup of CO_2 levels and indoor pollutants.

Rules of Thumb

	Recirculation AHUs save energy but require fresh air compliance with local building codes and ASHRAE 62.1 standards for minimum outdoor air ventilation.
	A common rule of thumb is to target 15 to 20% fresh outdoor air intake, but this can vary depending on building occupancy, climate, and code requirements.

2. 100% Makeup Air Units

100% makeup air AHUs are a specific type of air handling unit that provides complete air replacement within a space. Unlike recirculation AHUs, they do not re-use any conditioned air. Instead, they condition 100% of the incoming outdoor air to meet the desired temperature and humidity levels before distributing it throughout the building.



100% Makeup Air Handling Unit

Pros: Improved indoor air quality, odor, and contaminant control.
Cons: Increased HVAC load, high energy consumption.

Rules of Thumb

	100% fresh air AHUs prioritize air quality but use more energy. These are recommended for high occupancy areas, cleanrooms, and contaminant-generating processes (e.g., welding shops, paint booths), or high heat gain areas that need constant exhaust.

1.3 Key Factors in AHU Selection

Select or choose an AHU fan that meets your airflow (CFM) needs, satisfies thermal load (Btu/h or tons of refrigeration), and overcomes all resistance (inch - W.G.) in the system (ducts, filters).

1. Airflow Rate

The airflow rate refers to the volume of air that the AHU conditions within a given time, typically measured in cubic feet per minute (CFM) or cubic meters per hour (m^3/h).

	The airflow rate influences the physical size, i.e., the length, width, and height of an AHU.

2. Heating and Cooling Capacity (Load)

The heating and cooling capacity of an AHU indicates its ability to heat or cool the airflow. Heating capacity is usually measured in BTU/h or in kW, while cooling capacity is measured in tons of refrigeration (TR), where 1 ton equals 12,000 BTU/hr.

	*AHU coil design depends on building heating and cooling load. More rows and cross-sectional area of the coil is required to meet stronger heating/cooling demands.*

3. Filtration Level

The filtration level refers to the effectiveness of its filtration system in removing airborne particles and contaminants from the air passing through it. Filtration levels are typically expressed in terms of Minimum Efficiency Reporting Value (MERV) ratings.

	*High MERV filters (13+) trap more particles for better air quality. Choose AHUs with pre-filters (MERV 8+) and fine filters (MERV 13+) for comfort and superior air quality.*

4. Static Pressure

The static pressure refers to the resistance to airflow within the ductwork and components of the AHU. It is a measure of the pressure exerted by the air as it moves through the system, and it is typically measured in inches of water gauge (in. W.G.) or pascals (Pa). The static pressure influences the selection of fan.

	*AHU static pressure depends on resistance from:* *a. Internal components (filters, coils, dampers)* *b. Ductwork (length, diameter)* *Typically, it ranges from 1 to 10 inches of water gauge (in W.G.).*

5. Energy Efficiency

The energy efficiency indicates how effectively the AHU converts energy input (such as electricity or fuel) into useful work. It is typically measured in terms of its energy efficiency ratio (EER), seasonal energy efficiency ratio (SEER), coefficient of performance (COP), or kilowatts per ton (kW/ton). These metrics assess the AHU's performance relative to the amount of energy it consumes to deliver a certain level of heating or cooling output.

	*AHU efficiency: Optimize system design (shorter duct lengths = less air resistance) + efficient parts (fans, motors, coils, heat recovery, variable speed drives etc.) = Big energy savings!*

6. Noise Level

Noise refers to unwanted sound generated by the AHU and air delivery ductwork during its operation.

	*Quiet AHU: Opt for sound attenuators, acoustic insulation, conservative duct size and low air velocities (below 1500 fpm main, 800 fpm branch).*

7. Basic Parameters for AHU Selection

Here's an example of how you might specify the rating of an AHU:

a. Supply airflow rate: 5,000 CFM
b. Fresh airflow rate: 1000 CFM

c. Cooling Capacity: 10 Tons (chilled water)
d. Heating Capacity: 300 MBH (hot water)
e. Static Pressure: 2-inch W.G (water gauge)
f. Fan Speed: Variable Speed Drive (VSD)
g. Filtration Level: MERV8 (prefilters) and MERV13 (fine filters)
h. Equipment configuration: Horizontal, recirculation type
i. Additional Features: Humidification capability, economizer, heat recovery wheel

8. Rating Standards

AHUs performance, efficiency, and testing is according to various industry standards like:

a. ASHRAE standards address performance (Std 70), energy efficiency (Std 90.1), ventilation (Std 62.1), filter efficiency ratings (MERV) (Std 52.2).
b. AHRI Std 430 rates fan performance.
c. Eurovent Certification covers overall AHU functionalities and performances.

1.4 Space Considerations

AHU placement isn't just about function - it's about fit! Here's what to consider:

a. **Size:** Make sure the AHU fits the designated area without blocking anything. (Think tight spaces in city buildings!)
b. **Clearance:** Leave enough space around the AHU for airflow, maintenance, and safety.
c. **Headroom:** Check for low ceilings that might limit AHU or ductwork installation.
d. **Access:** Easy access is crucial for getting the AHU in, maintaining it, and fixing it.
e. **Support:** The AHU needs a strong foundation to handle its weight and vibrations.
f. **Airflow:** Plan ductwork to optimize air movement and minimize pressure drops.
g. **Integration:** Coordinate with other building systems like electrical and plumbing.
h. **Codes**: Follow local building codes for installation, clearance, and fire safety.

	*Tight on space? Consider customizing the AHU size, configuration, or location for a perfect fit.*

1.5 Airflow Rate of the AHU

The airflow rate of AHU correlates with the sensible load (Q) and desired temperature difference (ΔT) between supplied and returned air, mathematically represented as:

$$Airflow\ (CFM) = \frac{Sensible\ load\ (Q)}{1.08\ x\ \Delta T}$$

Where:

- Q is the sensible cooling load in BTU/h.
- ΔT is the temperature difference between the desired room temperature and the supply air temperature from the AHU in °F.
- 1.08 is a constant based on the air density and specific heat of the air.

Airflow in AHUs: 400 CFM per ton of cooling for a standard product.

1. Rules of Thumb for Estimating Cooling Load and Airflow Rate

Airflow: Most areas, start with 1 CFM per square foot.

Air conditioning load: 200 sq. ft. per ton and for superior construction 400 – 500 sq. ft. per ton dependent on the climate zone.

Specific areas (gyms, offices, etc.) might have different needs. Following industry guidelines are available:

Type of Building	**Air Conditioning Load (sq. ft/ton)**			**Air Quantities (CFM/sq. ft)**		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
Apartments, Hi Rise	500	425	350	0.8	1.0	1.3
Auditoriums, Churches, Theaters	400	300	150	1.0	1.8	2.5
Educational Facilities	400	300	200	0.8	1.2	1.8
Factories - Light Manufacturing	350	250	150	1.2	1.6	2.0
Factories - Heaving Manufacturing	150	100	75	2.5	3.5	4.5
Hospitals - Patient Rooms	350	250	180	0.5	0.75	0.9
Hospitals - Public Areas	300	250	150	0.8	1.0	1.1
Hotels, Motels, Dormitories	500	400	300	0.9	1.2	1.4
Libraries & Museums	400	350	300	0.9	1.0	1.1
Office Buildings	500	400	300	0.7	0.9	1.2
Residential Buildings	600	400	300	0.5	0.7	1.0
Beauty & Barber Shops	300	250	200	0.9	1.3	2.0
Department Stores	500	400	300	0.9	1.4	2.0
Drug Stores	250	200	150	0.7	1.0	1.3
Shoe Stores	400	300	200	0.8	1.0	1.2
Malls	450	350	250	1.1	1.6	2.0

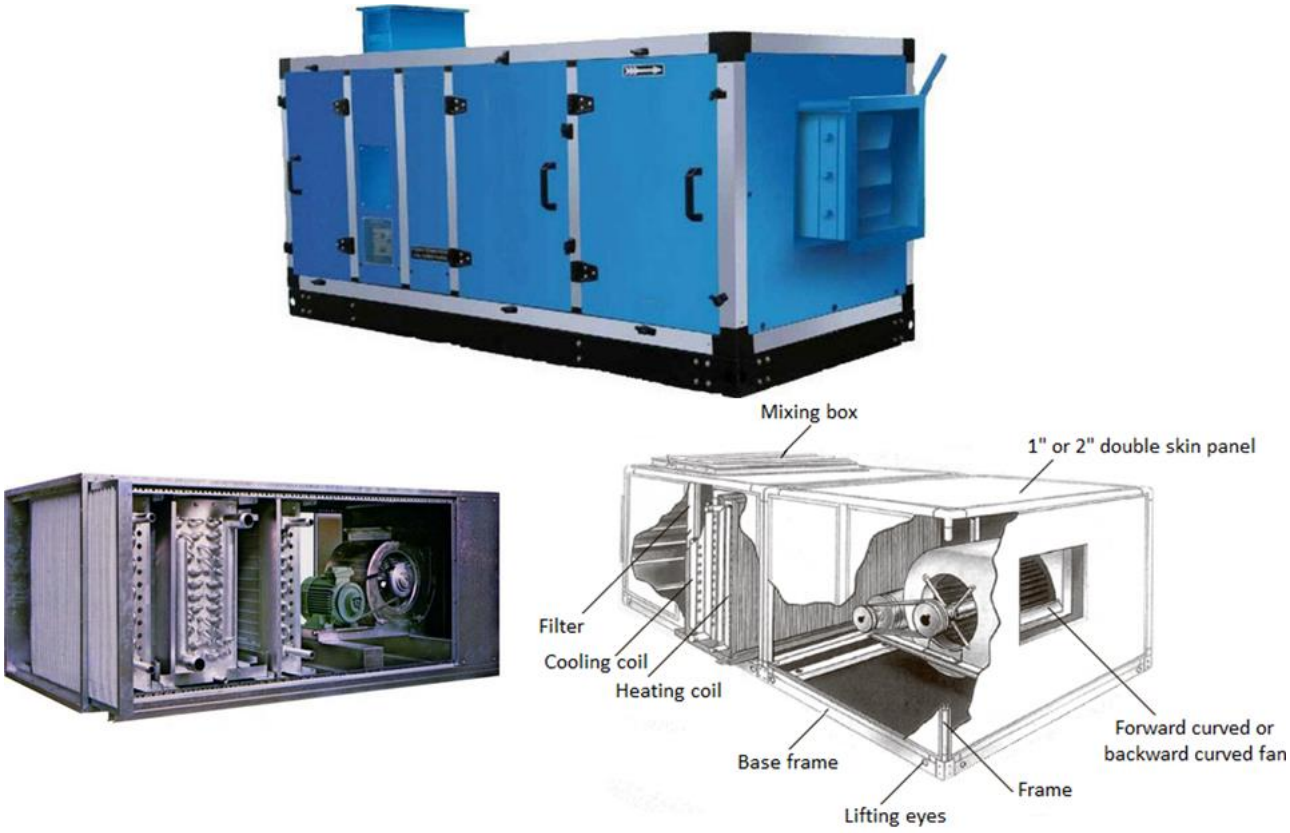
1.6 Design Configurations

AHUs design offers flexibility in assembly, with various options depending on:

a. **Placement:** Horizontal or vertical to fit your space.
b. **Airflow:** Draw-through or blow-through for different needs.
c. **Configuration:** Pre-built options (fan coils, packages, rooftop units) or custom designs.
d. **Control:** Constant or variable airflow with variable frequency drives (VFDs) for efficiency.

1.7 Horizontal and Vertical AHU

AHUs can be configured in either horizontal or vertical orientations to optimize space utilization. Horizontal is standard default unit with capacities up to 100+ tons of cooling. The airflow ranges from 2,000 to 40,000 CFM.



Horizontal Air Handling Unit