1 CHAPTER -1: INTRODUCTION TO AIR HANDLING UNITS

An Air Handling Unit (AHU) conditions and circulates air in 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.

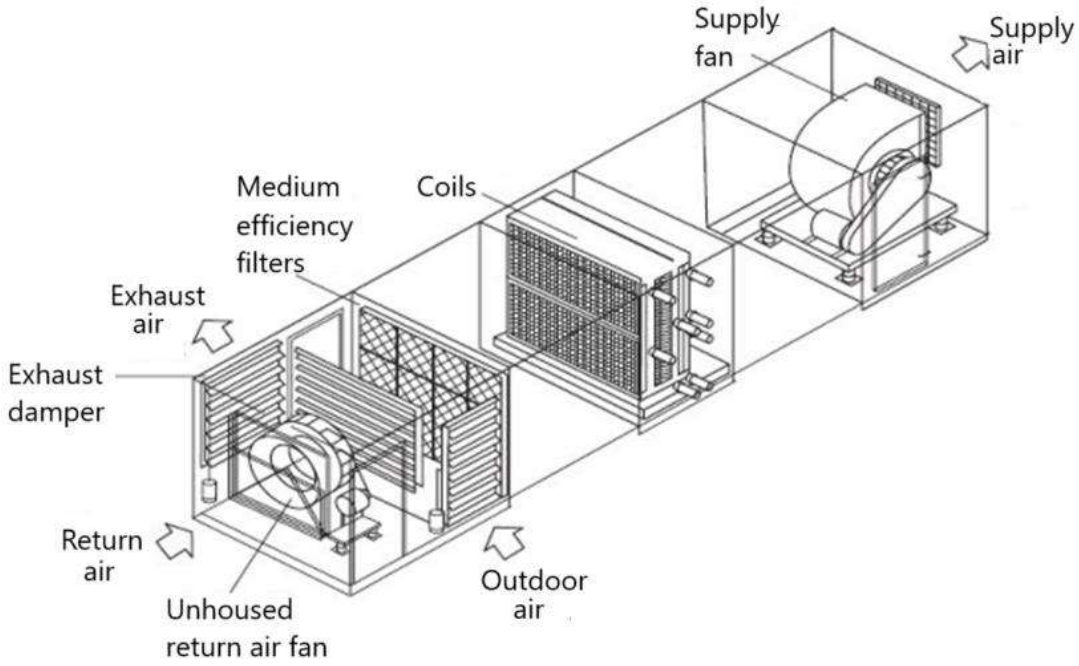

Figure 1. Air Handling Unit

1.1 Description: Key Components and Functions

An AHU is an enclosure with fans, filters, coils, and dampers.

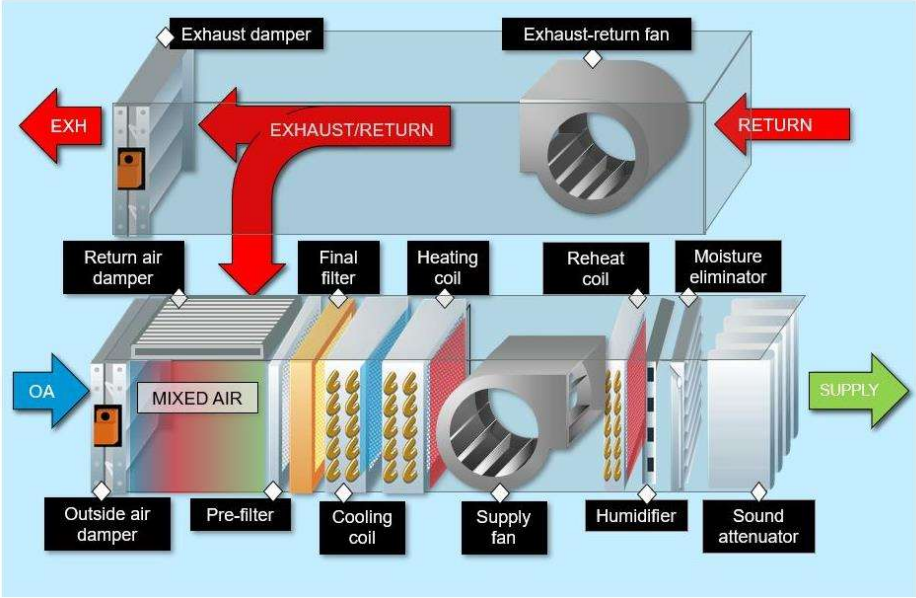

Figure 2. Key Components of an AHU

Table 1. AHU: Key Components and Functions

	Components	Function	Typical Details
	Fan	Circulates air within the AHU and throughout the facility.	Type: Centrifugal or Plug Fan; Capacity: Airflow volume (CFM) or Tonnage; Speed Control: VSD
	Heating/Cooling Coils	Controls air temperature by transferring heat.	Type: Finned Tube Coil; Material: Copper, Aluminum, or Stainless Steel; Capacity: BTU/hr.
	Filters	Removes airborne contaminants and maintains air quality.	Type: Pre-filters, Fine Filters, HEPA Filters; Efficiency: MERV rating; Pressure Drop: Resistance to airflow.
	Humidifiers/Dehumidifiers	Controls and adjusts air humidity levels.	Type: Steam, Spray, or Adiabatic; Capacity: Moisture addition or removal rate (lbs./hr.); Control: Humidistat or Controller
	Mixing Chamber	Mixes return and fresh air for desired conditions.	Design: Plenum Chamber or Mixing Box; Airflow Ratio: Proportion of return and fresh air

	Components	Function	Typical Details
	Air Distribution	Distributes conditioned air to different areas.	Ductwork: Supply and Return Ducts; Dampers: Balancing and Volume Control; Registers: Diffusers and Grilles
	Controls	Monitors and regulates AHU operation.	Sensors: Temperature, Humidity, Pressure; Controller: PLC; Setpoints: Desired temperature, humidity, etc.

1.2 AHU Design Configuration

AHUs can be customized to meet building requirements and come in two basic designs: Recirculation units and 100% Makeup Air Units.

1.2.1 Recirculation Units

Recycle a portion of indoor return air, mixing it with fresh outdoor air for conditioning.

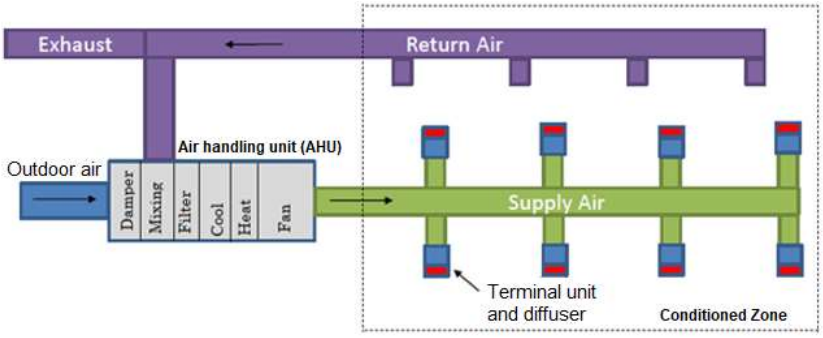

Figure 3. Recirculation Type AHU

1.2.2 100% Makeup Air Units

Exclusively handle fresh outdoor air without recirculating indoor air. Crucial for environments like hospitals, laboratories and cleanrooms.

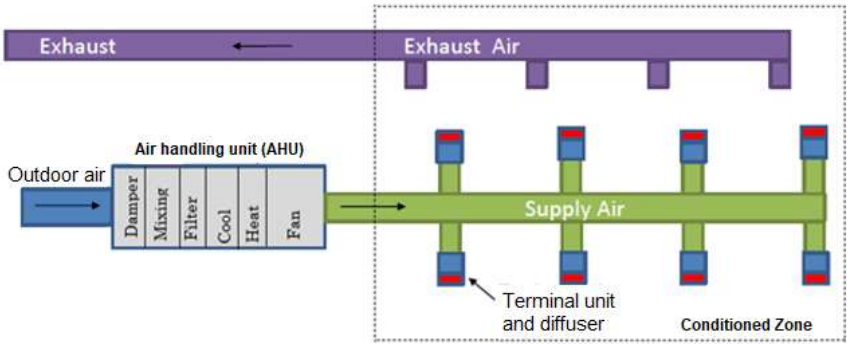

Figure 4. 100% Outdoor Air AHU

Table 2. Recirculation Type Vs. 100% Outside Air AHU

	Parameter	Recirculation Type AHU	100% Outside Air AHU
	Air Source	Mix of return air and outside air	Only fresh air, 100%, no recirculation.
	Ventilation Rates	10-30% outside air, balance room air recirculation (return air).	100% outdoor air, no recirculation.
	Energy Efficiency	Generally, more energy-efficient due to heat recovery from return air.	Lower, due to conditioning entire fresh air volume.
	Indoor Air Quality (IAQ)	Moderate, depends on filtration and air changes. Recommended: Minimum MERV 8+ filters or higher for better IAQ.	Superior, due to constant introduction of outdoor air. Recommended: Minimum MERV 13+ filtration to handle outdoor contaminants.
	Energy Recovery	Optional	Recommended for energy efficiency (per ASHRAE 90.1).
	Applications	Suitable for most residential and commercial buildings.	Suitable for Labs, healthcare, hazardous and high IAQ- spaces.

1.3 AHU Selection

You need to consider the following parameters when selecting an AHU.

Table 3. Key Factors affecting AHU Selection

	Parameters	Rules of Thumb
	Heating & Cooling Load	Calculated in BTU/hr. or tons; high latent loads need more coil rows. Heating/cooling loads influences airflow rate and coil size. High latent loads need more coil rows.
	Airflow Rate	Determines AHU size and fan capacity; higher airflow needs larger coils and cross-sectional area.
	Filtration Level	Use MERV 8+ for pre-filters, MERV 13+ for fine filters to enhance air quality.
	Static Pressure	Typical range: 1-10 in. WG; impacts fan power and duct design.
	Energy Efficiency	Optimize with short ducts, efficient fans, motors, and VFDs.
	Noise Level	Control with sound attenuators, insulation, and air velocities <1500 fpm (main), <800 fpm (branch).

Table 4. Performance Standards & Codes

	Standard/Code	Application
	ASHRAE Standard 62.1	Outdoor air ventilation for acceptable Indoor Air Quality
	ASHRAE Standard 52.2	Filter efficiency ratings
	ASHRAE Standard 90.1	Energy efficiency ratings for equipment (fan, motors, dampers etc.)
	AHRI 410/430	Standard for air handling units
	AMCA 210	Standard for air handling units, including sound and vibration limits
	Eurovent	European standard for AHU performance and energy efficiency
	NFPA 90	Installation of Air Conditioning and Ventilating Systems
	ISO 16814	International standard for AHU design and testing
	ISO 14001	Environmental Management System
	ISO 50001	Energy Management System
	SMACNA Standards	HVAC Systems and Equipment Duct design, installation, and testing.

1.4 Space Planning for AHUs

AHU is a bulky equipment and it's important that the space requirements are evaluated upfront while meeting clearance, access, and safety requirements. Here's what to consider:

Table 5. AHU Space & Installation Considerations

	Factors	Rules of Thumb
	Size & Configuration	Ensure AHU fits allocated space, considering dimensions and special configurations.
	Clearance	Maintain at least 36 inches for accessibility, maintenance, and inspection.
	Headroom	Verify adequate headroom for installation and ductwork routing, especially in low-ceiling areas.
	Access	Ensure easy access for installation and maintenance; check door widths, hallways, and elevators.
	Support	Provide a sturdy foundation or support to handle AHU weight.
	Airflow & Ductwork	Optimize duct size, routing, and insulation to reduce pressure drops and improve airflow.
	System Integration	Coordinate with electrical, plumbing, and fire systems to prevent conflicts and ensure integration.
	Code Compliance	Follow local codes for installation, clearance, fire safety, and energy efficiency.

1.5 Airflow Rate of the AHU

The AHU airflow rate depends on the sensible load (Q) and the temperature difference (ΔT) between supply and return air.

Equation 1. Airflow Rate

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

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.

Table 6. Estimating Cooling Load and Airflow Rates

	AHU Size/Capacity	Rules of Thumb
	Cooling Loads (Ton/sq. ft.)	1 Ton for ≈ 200 sq. ft. of floor area (thumb rule for conceptual design). For modern energy-efficient buildings, 1 Ton may cover up to 400–500 sq. ft.
	Airflow Rate (CFM/Ton)	400 CFM/Ton (comfort cooling), 350–400 CFM/Ton (dehumidification and high latent load applications).
	Airflow Rate (CFM/sq. ft.)	1–2 CFM/sq. ft. (floor area), 1.2 CFM/sq. ft. for energy-efficient buildings, consider 2 CFM for conceptual design.

Table 7. Typical Cooling Loads and Airflow Rates for Various Buildings

	Type of Building	Air Conditioning Load (sq. ft/ton)			AHU Air flow Rates (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