

Air Handling Systems

Air Handling Units (AHUs)

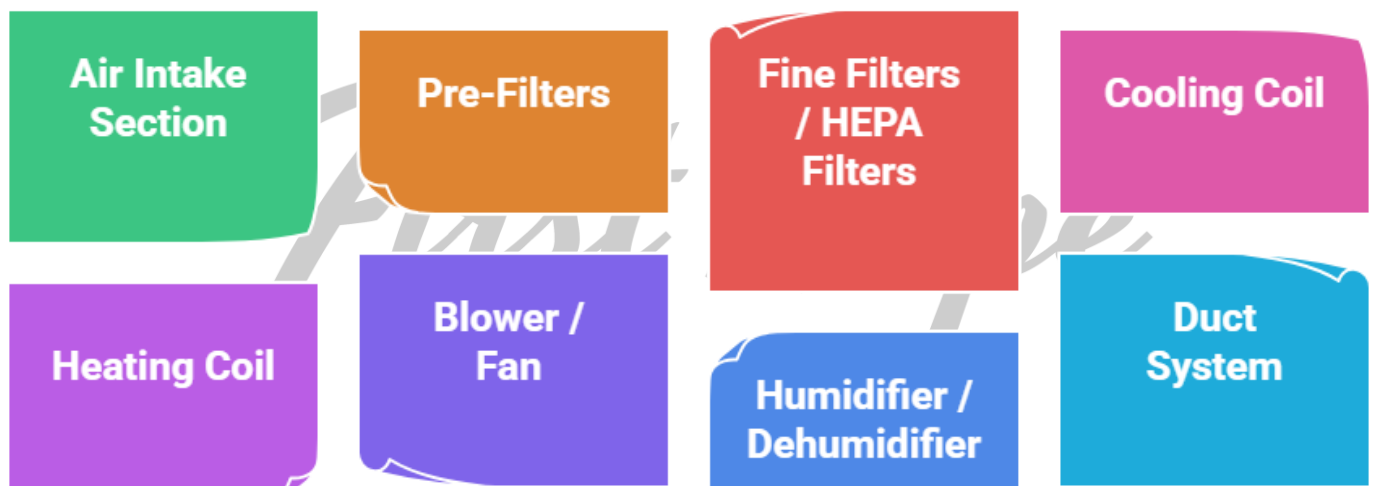
- Air Handling Units (AHUs) are the main systems used in pharmaceutical industries to control and maintain clean air conditions inside production areas, especially in sterile and non-sterile manufacturing.

Purpose of AHU:

- Supply clean and filtered air
- Maintain temperature and humidity
- Remove dust and contaminants
- Maintain pressure differences between rooms

Main Components of AHU:

AHU Components



1. Air Intake Section

- Takes in fresh air from outside
- May mix with return air (recirculated air)

2. Pre-Filters

- Remove large dust particles
- Protect finer filters downstream

3. Fine Filters / HEPA Filters

- Remove very small particles and microorganisms
- HEPA filters remove 99.97% of particles ≥ 0.3 microns

4. Cooling Coil

- Uses chilled water to cool air

- Helps in temperature and humidity control

5. Heating Coil

- Heats air if required
- Used in cold environments or for humidity control

6. Blower / Fan

- Circulates air throughout the system
- Maintains required air flow

7. Humidifier / Dehumidifier

- Adds or removes moisture from air

8. Duct System

- Distributes air to different rooms

Working of AHU:

1. Air is drawn from outside or return air
2. Passes through filters (removal of dust)
3. Air is cooled or heated
4. Humidity is adjusted
5. Clean air is supplied to production area

Types of AHU:

- Recirculating AHU (reuses air)
- Fresh Air AHU (uses only outside air)
- Packaged AHU (compact unit)

Importance in Pharmaceutical Production:

- Maintains sterile conditions
- Prevents contamination
- Ensures product quality

Temperature Control

Importance:

- Prevents degradation of drugs
- Ensures proper functioning of equipment

- Maintains comfort for workers

Methods of Temperature Control

- Cooling coils (chilled water system)
- Heating coils (electric or steam heating)
- Thermostats for monitoring

Typical Range:

- Usually 18–25°C (depends on product)

Effects of Improper Temperature

- High temperature → drug degradation, microbial growth
- Low temperature → process inefficiency

Humidity Control

Importance:

- Prevents microbial growth
- Maintains physical properties of materials
- Prevents static electricity

Problems Due to Improper Humidity:

A. High humidity:

- Stickiness in tablets
- Microbial growth

B. Low humidity:

- Static charge
- Powder segregation

Humidity Control Methods:

1. Humidification

- Adding moisture using steam or water spray

2. Dehumidification

- Removing moisture using cooling coils or desiccants

Types of Dehumidification

- Refrigeration type

- Desiccant type

Effects of Improper Humidity

- High humidity → stickiness, microbial growth
- Low humidity → brittleness, static charge

Relative Humidity (RH):

- Expressed as percentage
- Typically maintained between 40–60%

Control Systems:

- Sensors measure temperature and humidity
- Automatic systems adjust conditions

Monitoring and Control Systems

- Sensors for temperature and humidity
- Automated control systems
- Continuous monitoring

Air Filtration Systems

- Air filtration is a critical part of maintaining cleanroom conditions in pharmaceutical production.

Purpose of Air Filtration

- Remove dust, microorganisms, and contaminants
- Maintain required air quality

Types of Filters:

1. Pre-Filters

- Remove large particles (>10 microns)
- Extend life of HEPA filters

2. Fine Filters

- Remove smaller particles (1–10 microns)

3. HEPA Filters (High Efficiency Particulate Air)

Characteristics:

- Remove 99.97% of particles ≥ 0.3 microns

Uses:

- Clean rooms
- Laminar airflow units

4. ULPA Filters

- Remove even smaller particles
- Higher efficiency than HEPA

Filtration Mechanisms:

- Interception
- Impaction
- Diffusion

Air Flow Types:

1. Laminar Flow

- Air moves in one direction
- Used in sterile areas

2. Turbulent Flow

- Air moves randomly
- Used in less critical areas

Filter Maintenance:

- Regular replacement
- Integrity testing (leak test)
- Monitoring pressure drop

Laminar Air Flow (LAF)

Principle

- Air flows in uniform direction at constant velocity

Types

- Horizontal flow
- Vertical flow

Use

- Aseptic operations



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