PHARMACEUTICAL ENGINEERING

UNIT – 1

Flow of Fluids:

Types of Manometers:

1. U-Tube Manometer:

- Consists of a U-shaped tube filled with a manometric fluid, measures pressure difference.

2. Inclined Manometer:

- U-tube inclined at an angle, suitable for measuring small pressure differences.

3. Well-Type Manometer:

- Consists of a well connected to a tube, used for measuring high-pressure differences.

4. Micromanometer:

- High-precision manometer used for very low-pressure measurements.

Reynolds Number and its Significance:

- **Reynolds Number (Re):**
    - Dimensionless quantity that predicts fluid flow patterns.
    - Significance: Determines if flow is laminar (Re < 2000), transitional (2000 < Re < 4000), or turbulent (Re > 4000).

Bernoulli's Theorem and its Applications:

- **Bernoulli's Theorem:**
    - States that in a flowing fluid, an increase in velocity is accompanied by a decrease in pressure.
    - Applications: Explains lift in aircraft, operation of carburetors, flow in pipelines.

Energy Losses:

- **Friction Losses:**
    - Caused by the resistance of fluid against the pipe walls.
- **Expansion Losses:**
    - Occur when fluid expands suddenly.
- **Contraction Losses:**
    - Result from sudden reduction in flow area.

Instruments for Flow Measurement:

1. Orifice Meter:

- **Principle:** Measures flow by the pressure difference across an orifice plate.
- **Applications:** Industrial fluid flow measurement.

2. Venturi Meter:

- **Principle:** Measures flow using a converging-diverging tube.
- **Applications:** Used for accurate flow rate measurement.

3. Pitot Tube:

- **Principle:** Measures fluid velocity at a specific point.
- **Applications:** Used in aerodynamics, aviation, and fluid dynamics.

4. Rotameter:

- **Principle:** Measures flow rate by the position of a float in a tapered tube.
- **Applications:** Commonly used for gas and liquid flow measurement.

Size Reduction:

Objectives:

- **Increase Surface Area:**
    - Facilitates better mixing, dissolution, and extraction.
- **Enhance Reactivity:**
    - Improves the efficiency of chemical reactions.
- **Ease of Handling:**
    - Reduces bulk for easier transport and storage.

Mechanisms & Laws Governing Size Reduction:

1. Kick's Law:

- States that the energy required for size reduction is directly proportional to the reduction in particle size.

2. Rittinger's Law:

- States that the work required for size reduction is directly proportional to the new surface area created.

3. Bond's Law:

- States that the work required is inversely proportional to the square root of the diameter of the product particles.

Factors Affecting Size Reduction:

- **Material Properties:**
    - Hardness, toughness, and brittleness.
- **Moisture Content:**
    - Moist materials may form agglomerates.
- **Temperature:**
    - High temperatures can affect the properties of certain materials.
- **Size and Shape of Feed Particles:**
    - Initial particle size influences the extent of size reduction.

Size Reduction Equipment:

1. Hammer Mill:

- **Principle:** Impact and attrition.
- **Applications:** Crushing brittle materials.

2. Ball Mill:

- **Principle:** Impact and attrition.
- **Applications:** Grinding of various materials.

3. Fluid Energy Mill:

- **Principle:** Fluid energy impact.
- **Applications:** Fine grinding of materials.

4. Edge Runner Mill:

- **Principle:** Crushing and shearing.
- **Applications:** Mixing and blending of viscous materials.

5. End Runner Mill:

- **Principle:** Crushing and shearing.
- **Applications:** Grinding and crushing of materials.

Size Separation:

Objectives:

- **Quality Control:**
    - Ensure uniformity in particle size for consistent product quality.
- **Ease of Handling:**
    - Facilitates easier processing and packaging.

Mechanism of Size Separation:

- **Sieving:** Separation of particles based on size using a mesh or perforated surface.
- **Classification:** Separation based on particle settling rates in a fluid.
- **Elutriation:** Separation based on fluid flow rates.

Official Standards of Powders:

- **USP (United States Pharmacopeia):**
    - Provides standards for pharmaceutical powders.
- **ISO (International Organization for Standardization):**
    - Global standards for various industries.

Instruments for Size Separation:

1. Sieve Shaker:

- **Principle:** Vibrates sieves to separate particles based on size.
- **Applications:** Particle size analysis.

2. Cyclone Separator:

- **Principle:** Centrifugal force separates particles from a gas stream.
- **Applications:** Dust collection, air pollution control.

3. Air Separator:

- **Principle:** Separates particles based on their aerodynamic properties.
- **Applications:** Separation of fine powders.

4. Bag Filter:

- **Principle:** Filters particles from a gas stream using fabric bags.
- **Applications:** Air filtration in various industries.

5. Elutriation Tank:

- **Principle:** Separates particles based on their settling rates in a fluid.
- **Applications:** Particle size classification.

Summary:

The study of fluid flow involves various manometers, Reynolds number calculations, Bernoulli's theorem, and instruments for flow measurement. Size reduction aims to increase surface area, enhance reactivity, and improve handling, with mechanisms and laws governing the process. Size reduction equipment includes hammer mills, ball mills, fluid energy mills, edge runner mills, and end runner mills. Size separation involves sieving, classification, and elutriation, with instruments such as sieve shakers, cyclone separators, air separators, bag

filters, and elutriation tanks. Official standards for powders are provided by organizations like the USP and ISO.