GPAT ONLINE CLASSES

In collaboration with A.P govt.

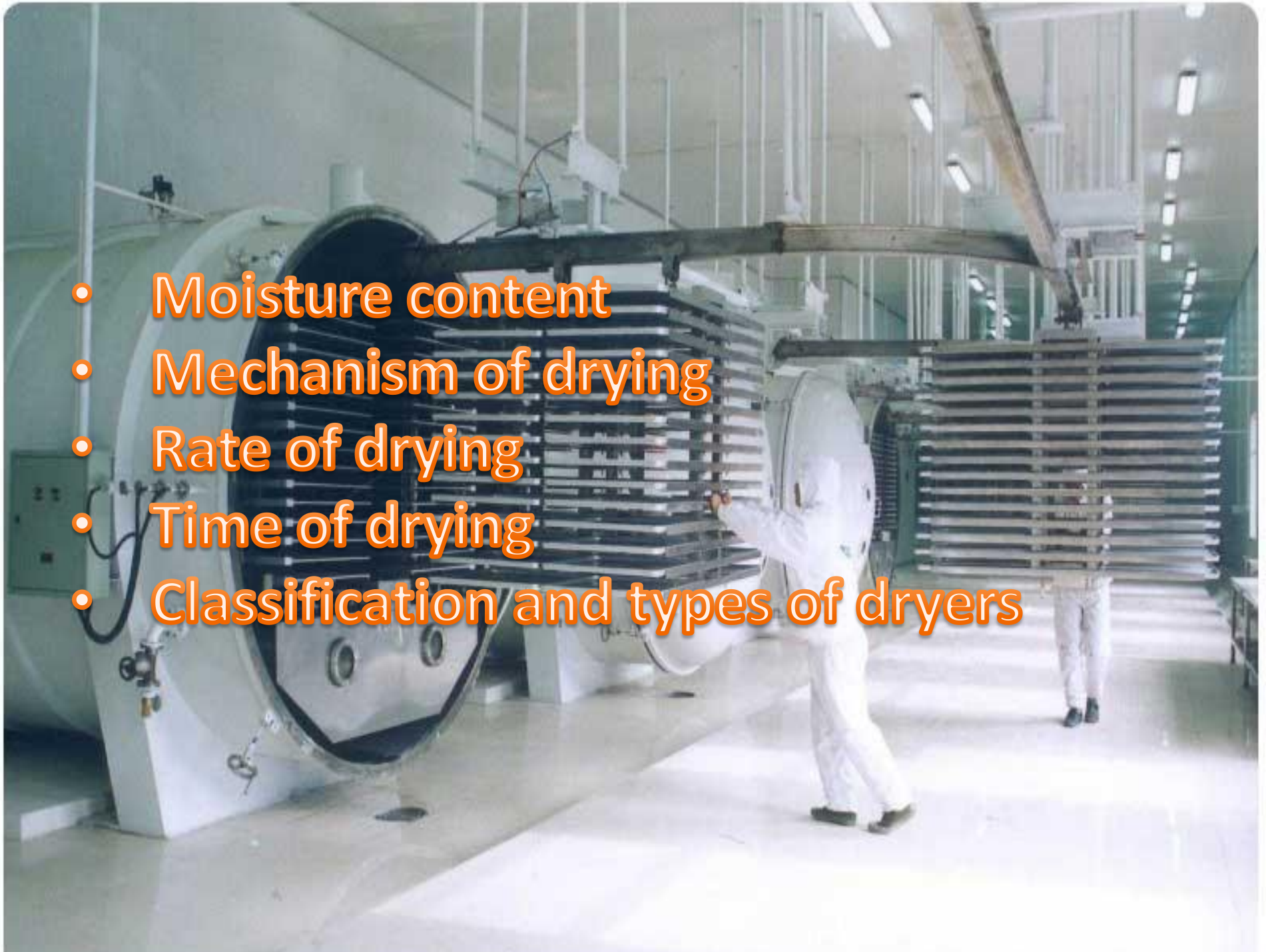
PHARMACEUTICAL ENGINEERING

Presented by
DR. T.E.GOPALA KRISHNA MURTHY
Professor & Principal
Bapatla College of Pharmacy
Bapatla, Andhra Pradesh.

Topics going to cover in this session

5. Drying
6. Size reduction and size separation
7. Extraction
8. Mixing

CHAPTER-5
DRYING


• Moisture content
• Mechanism of drying
• Rate of drying
• Time of drying
• Classification and types of dryers

Moisture content

- **Bound moisture and free moisture**
- **% moisture content=** $\frac{\text{weight of water in samplex100}}{\text{weight of dry sample}}$
- **If exactly 5 g of moist sample is brought to a constant dry weight of 4g, calculate loss on drying and moisture content**
- **Percent MC is more realistic value in determination of dryer load capacity**
- **Equilibrium moisture content depends on**
  - **Temperature and humidity of air**
  - **Properties of the material**

Mechanism of drying

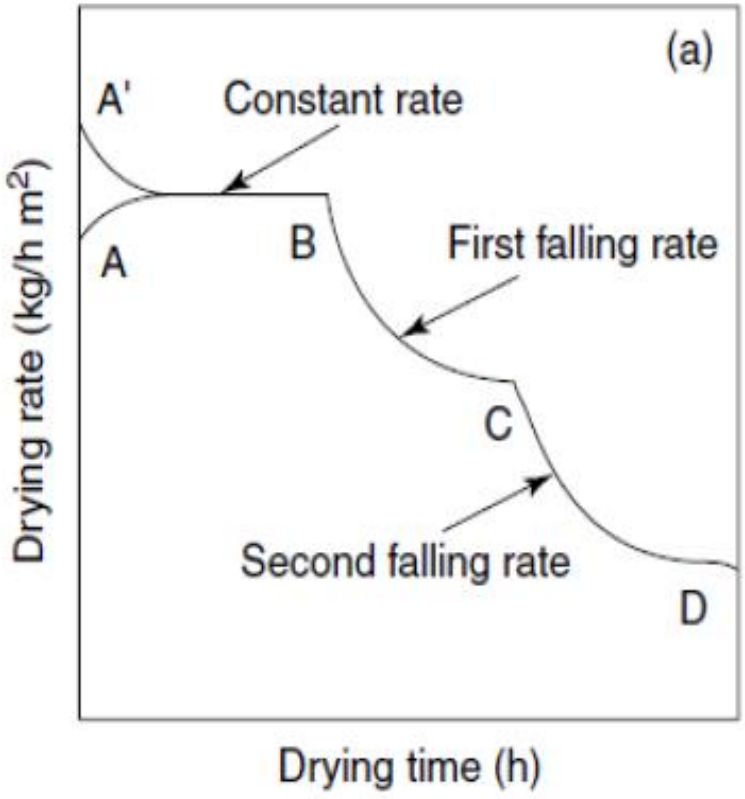
- **Involves both heat and mass transfer**
- **Rate of evaporation is related to rate of heat transfer as**

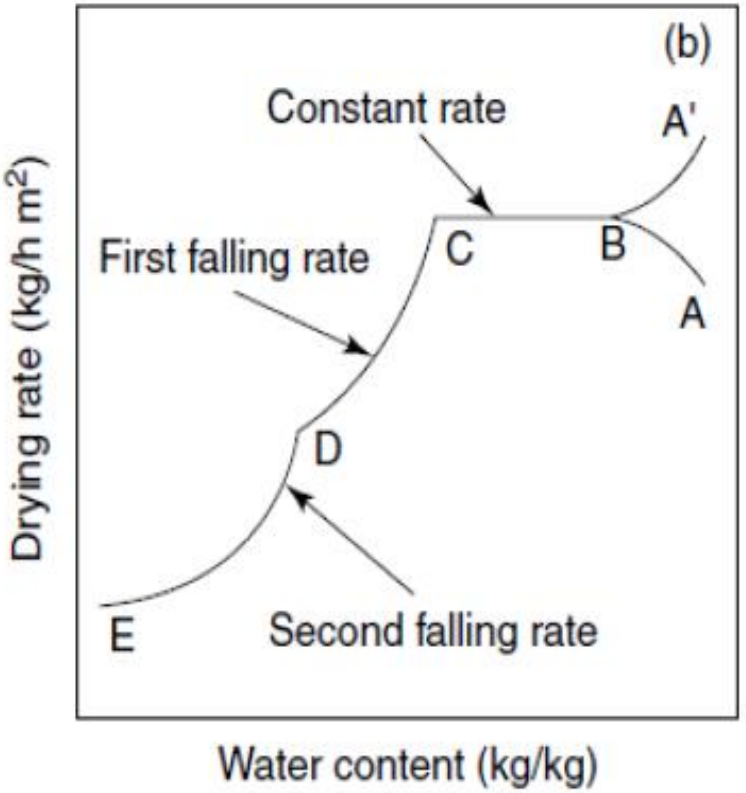
$$dW/d\emptyset = q/\lambda$$

- **The rate equation for mass transfer**

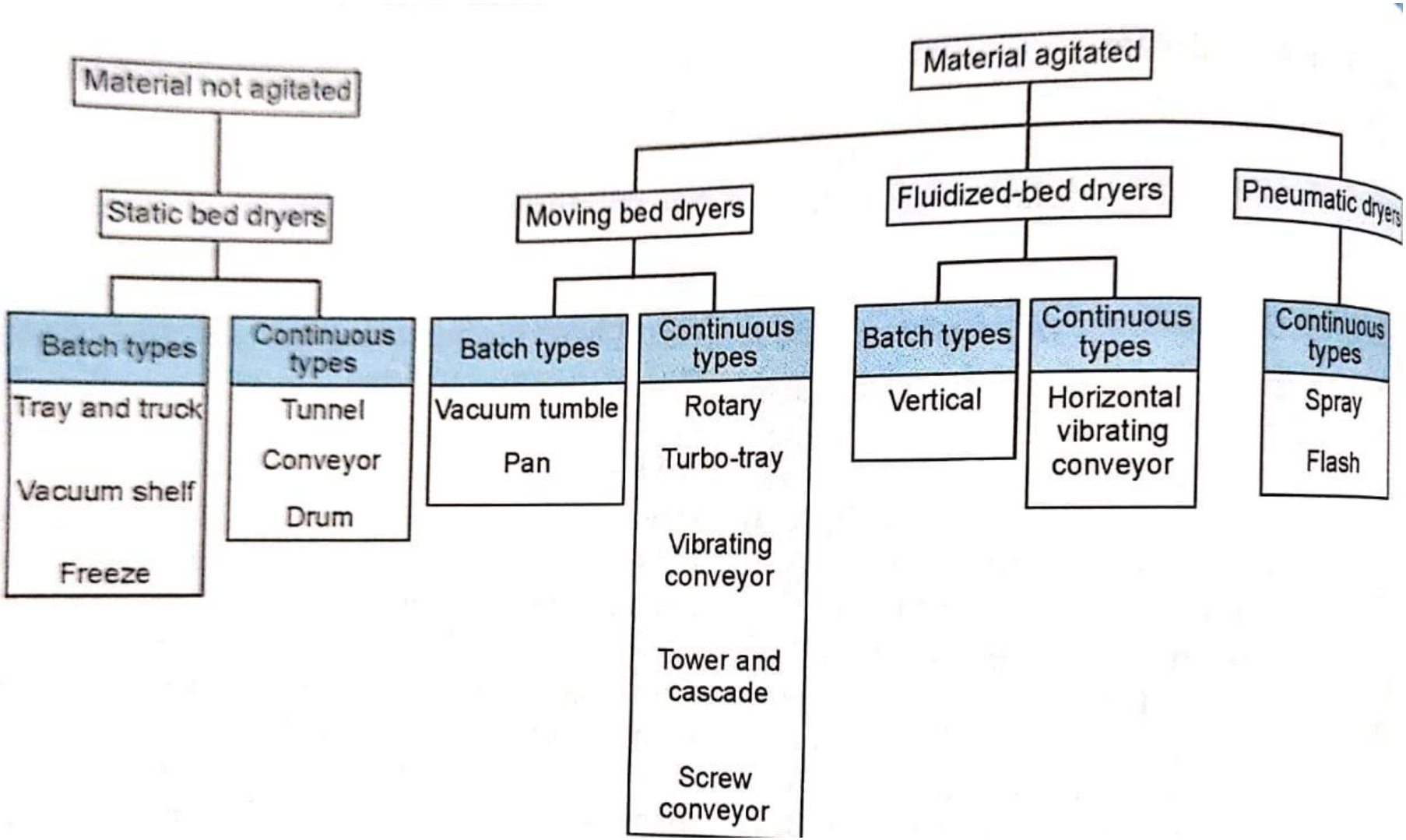
$$dW/d\emptyset = KA\,(H_s - H_g)$$

Rate of drying & Time of drying





Classification and types of dryers



Tray dryer & Fluidised bed dryer

Freeze dryer

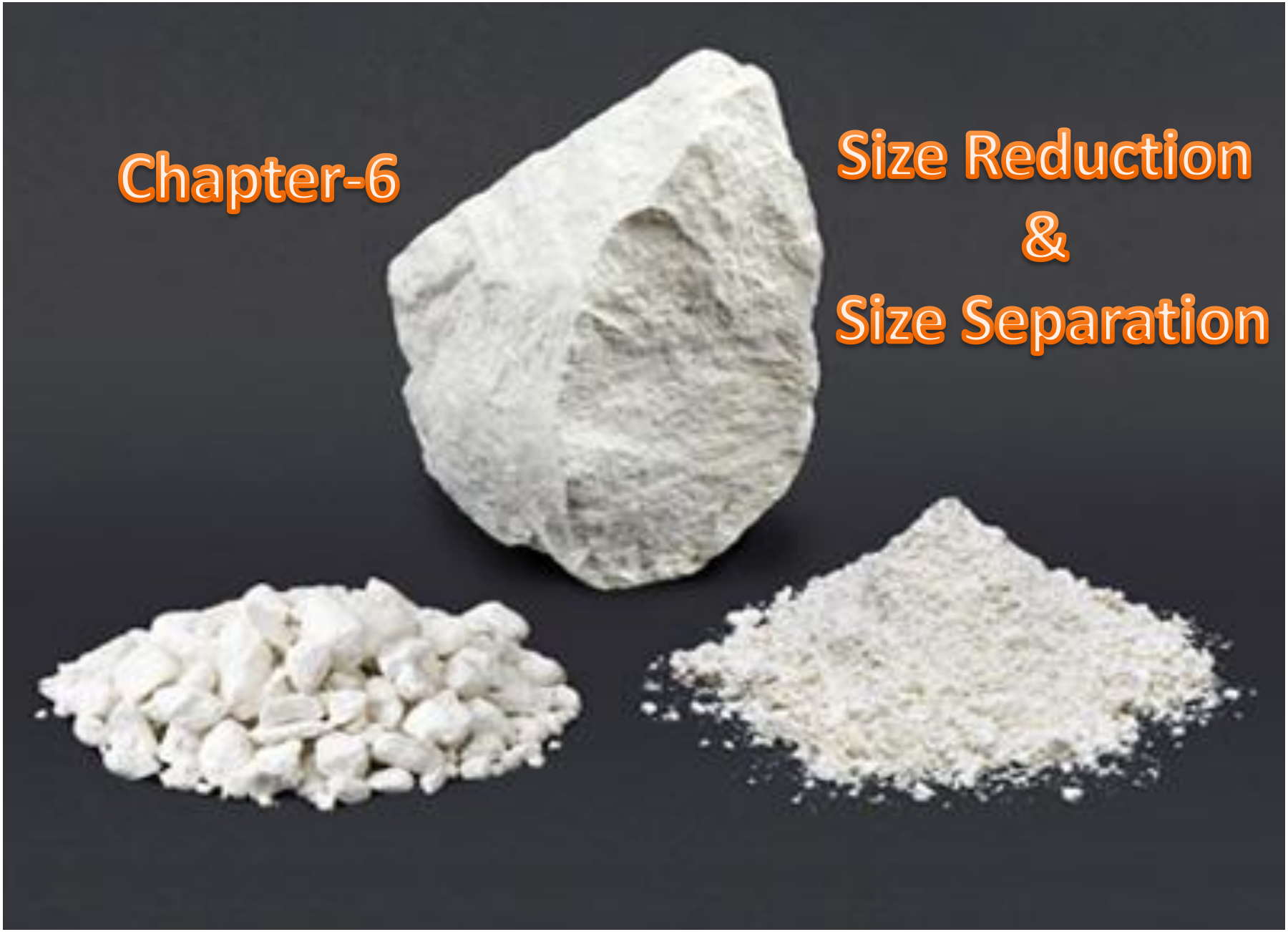
- **Pressure 10- 30 N/M^2**
- **Temperature -10 to -30^0c**
- **Composed of**
  - **Vacuum drying chamber**
  - **Vacuum source**
  - **Heat source**
  - **Vapour removal source**

Stages involved in freeze drying

- **Vacuum**
- **Primary drying**
- **Secondary drying**

Spray drying

- **Feed delivery systems**
- **Atomizer (pneumatic, pressure nozzle, spinning disc)**
- **7000 psi and 3,000 to 50,000 rpm**
- **Heated air supply**
- **Drying chamber**
- **Solid- gas separator**
- **Product collection system**


Chapter-6
Size Reduction
&
Size Separation

Contents

- **Objectives**
- **Factors affecting size reduction**
- **Laws governing size reduction**
- **Classification of mills**
    - **Hammer mill**
    - **Ball mill**
    - **Fluid energy mill or ultra fine grinder or micronizer**
    - **Quadroco mill**
    - **Multi mill**

Objectives

- **Dissolution and therapeutic efficacy**
- **Extraction**
- **Flow ability**
- **Mixing**
- **Formulation**

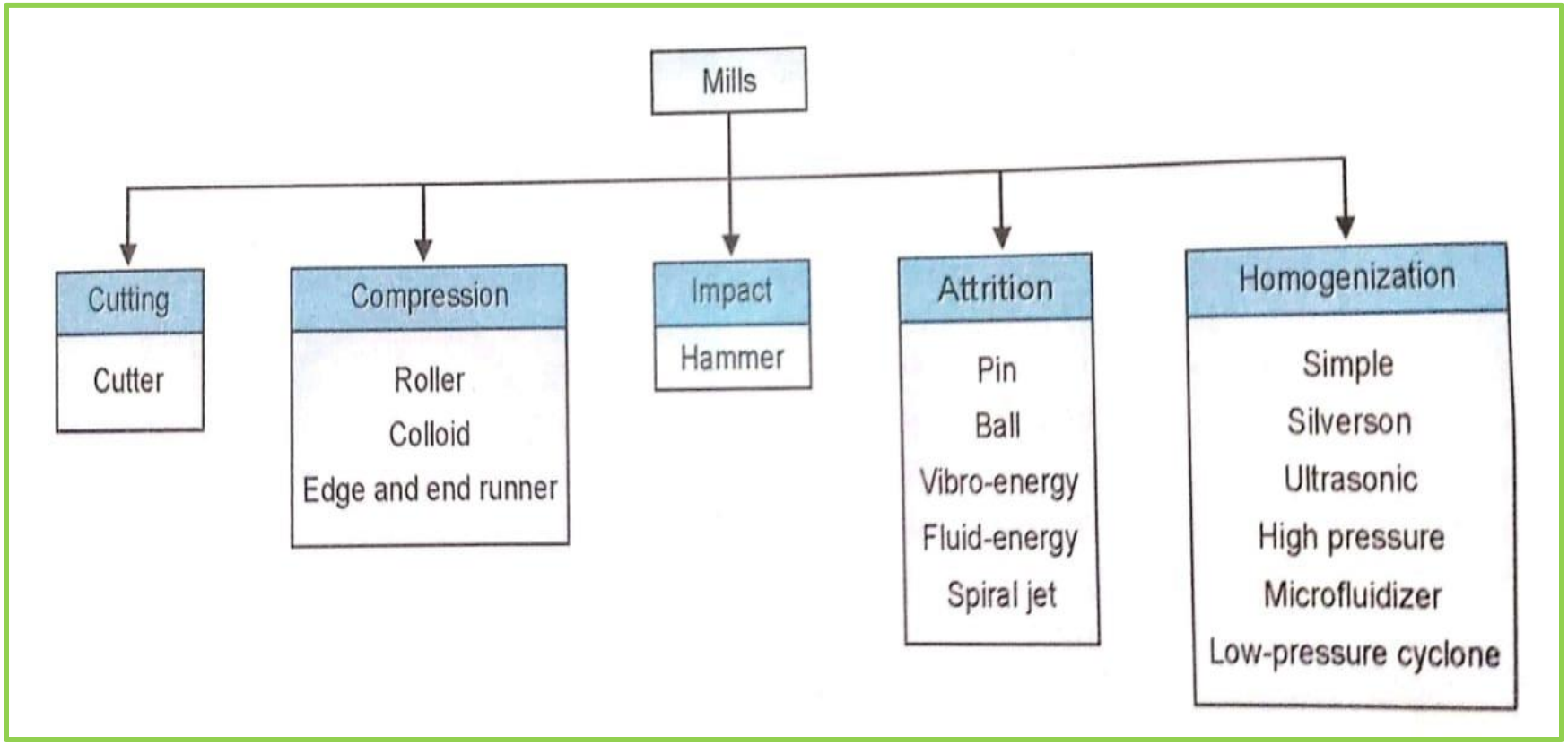
Factors affecting size reduction

- **Nature of material**
  - **Hardness, toughness, abrasiveness, stickiness, material structure, bulk density, physiological effect Particle shape, Polymorphism**
- **Moisture content**
- **Temperature**
- **Feeding rate**
- **Purity required**

Laws governing size reduction

- Griffith Equation → $T = \sqrt{\frac{Y\varepsilon}{\varepsilon}}$
- Kicks Law → $E = CIn\frac{D_1}{D_2}$
- Rittinger's Law → $E = k_1(S_2 - S_1)$
- Bond's Law → $W_t \alpha 1/\sqrt{D_2}$
- Holme's Equation → $W_t = 10W_i\left(\frac{1}{\sqrt{D_2}} - \frac{1}{\sqrt{D_1}}\right)$

Classification of mills

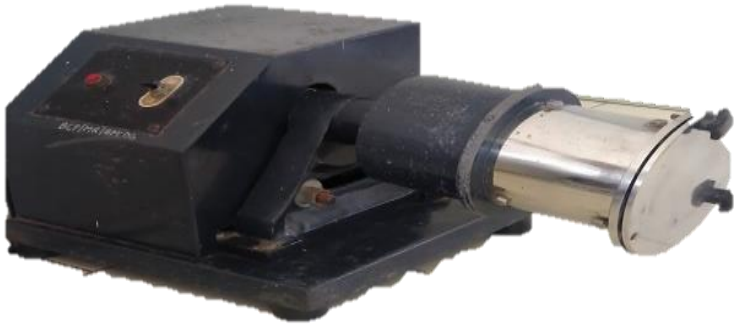


Hammer mill

- **Impact mill using high speed rotor up to 10000 rpm with a peripheral speed up to 7600 meter per minute**
- **Dry materials, wet filter press cake, wet granules, ointments and slurries**
- **Size reduction up to 20 to 40µ**
- **Circular hole design for fibers and herringbone design for crystalline materials and continuous operation jump- gap screen for abrasive and clogging materials.**
- **Micro pulverizer for nonabrasive materials**

Ball mill

- **Both wet and dry grinding, up to 10μ**
- **Pebble, rod mill, tube mill and Hardinge mill**
- **Sliding, cascading and centrifuging**
- **The critical speed is $n=76.6/\sqrt{D}$**
- **Optimum diameter of the ball= $D_{ball}^2=KD$ (feed particle)**

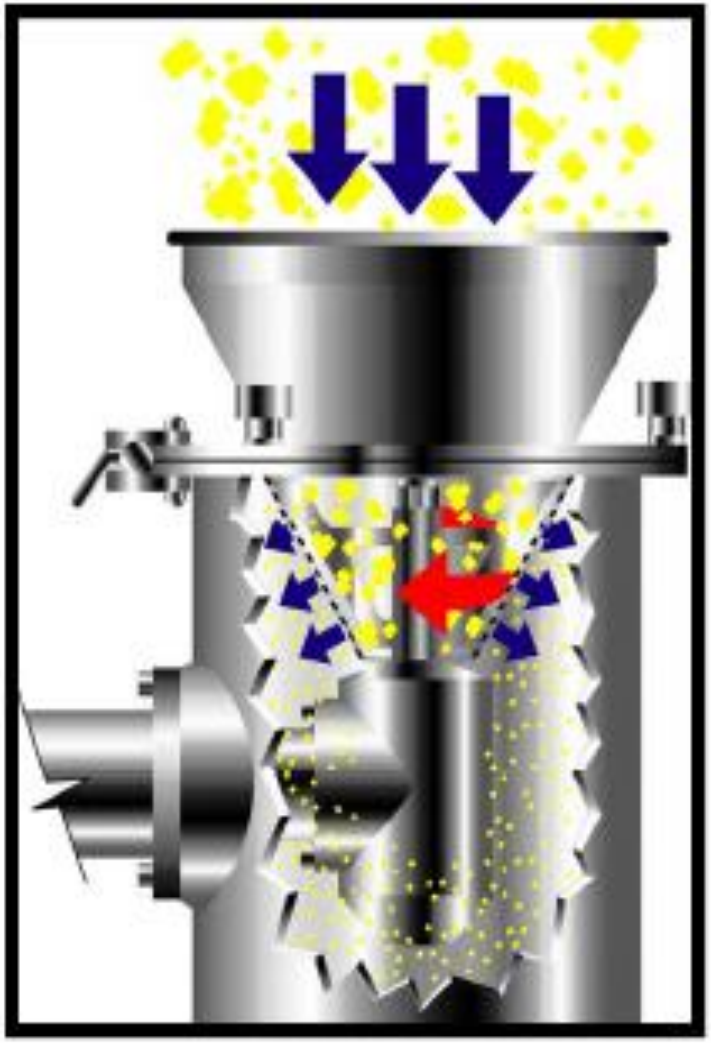


Fluid energy mill or ultra fine grinder or micronizer

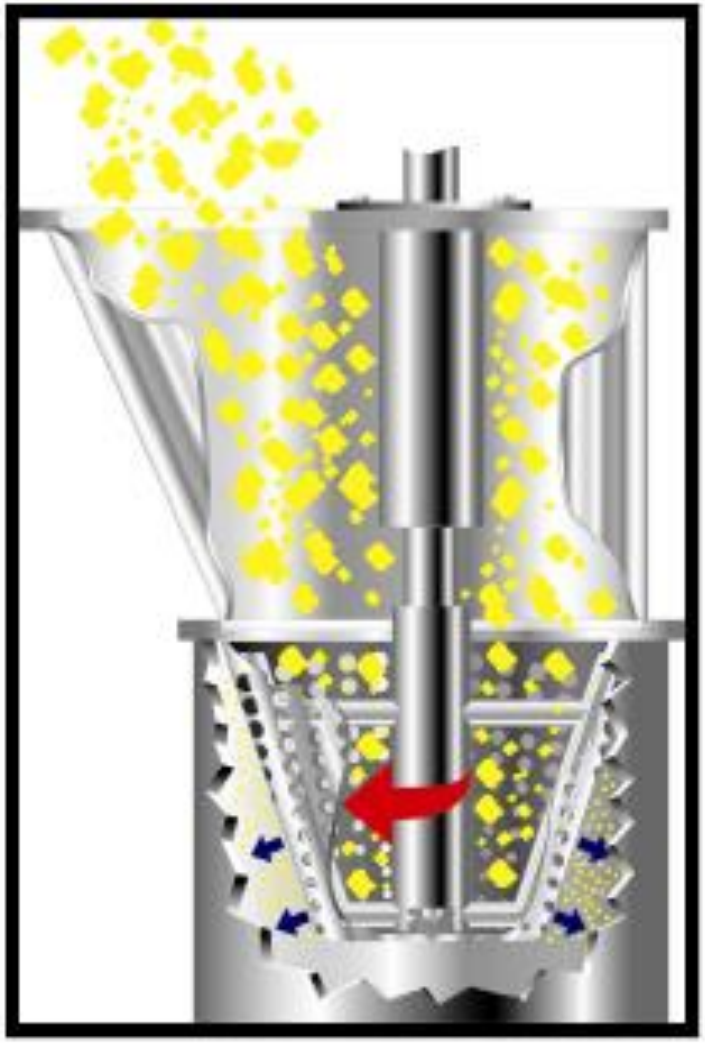
- **Air or steam at pressure of 100- 150 psi**
- **Particle size to 1-20µ**
- **Feed should be pre milled to 20 to 100 mesh**
- **Nozzle design and direction of air jets**
- **Efficiency of air compressors**
- **Efficiency of filters and separators**

Quadro co mill

- **Control feed product into upper conical screen chamber**
- **A rotating impeller calibrates incoming material**
- **Calibrated product then passes through to the lower chamber**
- **A second intensifying impeller accelerates the particles.**
- **Particles are continuously delivered to “action zone” between screen and impeller**
- **Particles are size reduced (as fine as 150 micron) and instantly discharged through screen openings**



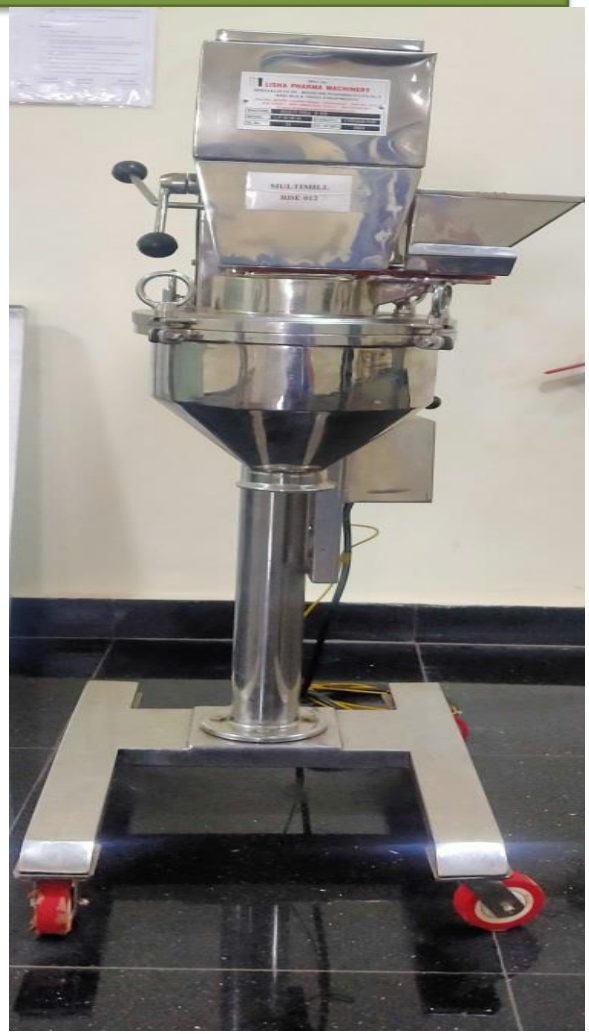
Underdriven Comil
(Invented 1990)



Overdriven Comil
(Invented 1976)

Multi mill

- Multi mill machines are widely used for wet and dry granulation, pulverization etc.
- SS beaters having knife and impact edges rotate within a selected screen
- The material fed in the hopper enters into the processing chamber where it moves to the pentery and passes through screen
- Output & quality of final products depend on (I) shapes of beaters (Knife/ impact edge) (ii) speed (iii) size of screen

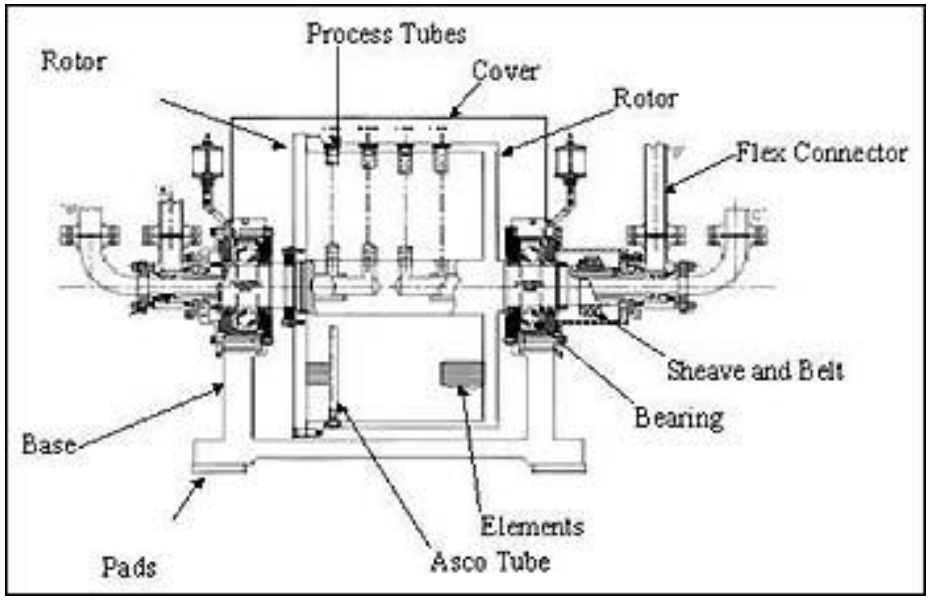


Chapter-7

Extraction

- Theory of Extraction
- Extraction methods
- Equipment for extraction

- Liquid- liquid extraction
  - Podbielniak extractor



- Solid- liquid extraction
  - Knowledge on botanical structure
  - Differences in active constituents
  - Different forms of insoluble matter
  - Mixture of components
  - Microbial growth

Theory of Extraction

- Size reduction
- Penetration of the drug by solvent
- Solution of the soluble matter within the cells
- Escape of removable material through the cell walls
- Separation of solution and the exhausted drug

Examples

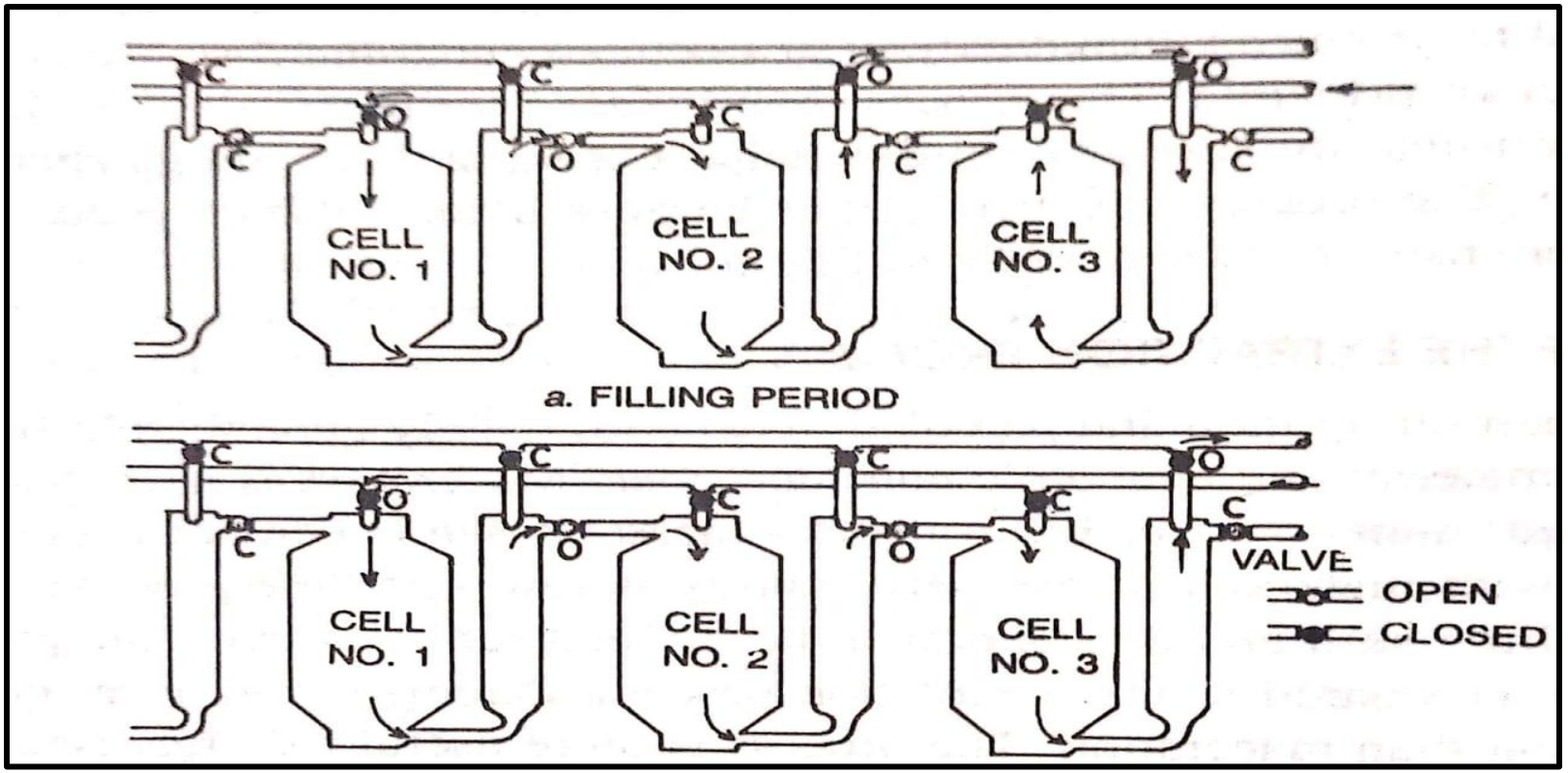
- Sliced/bruised condition for soft drugs such as gention
- Coarse powder for belladonna
- Moderately fine powder for hard and woody drug ipecacuanha
- The cohesive forces of cellulose form micellae
- Vacuum is used to remove air from the pores of the drug
- The solvent would be cheap, non toxic, stable and selective

Extraction methods

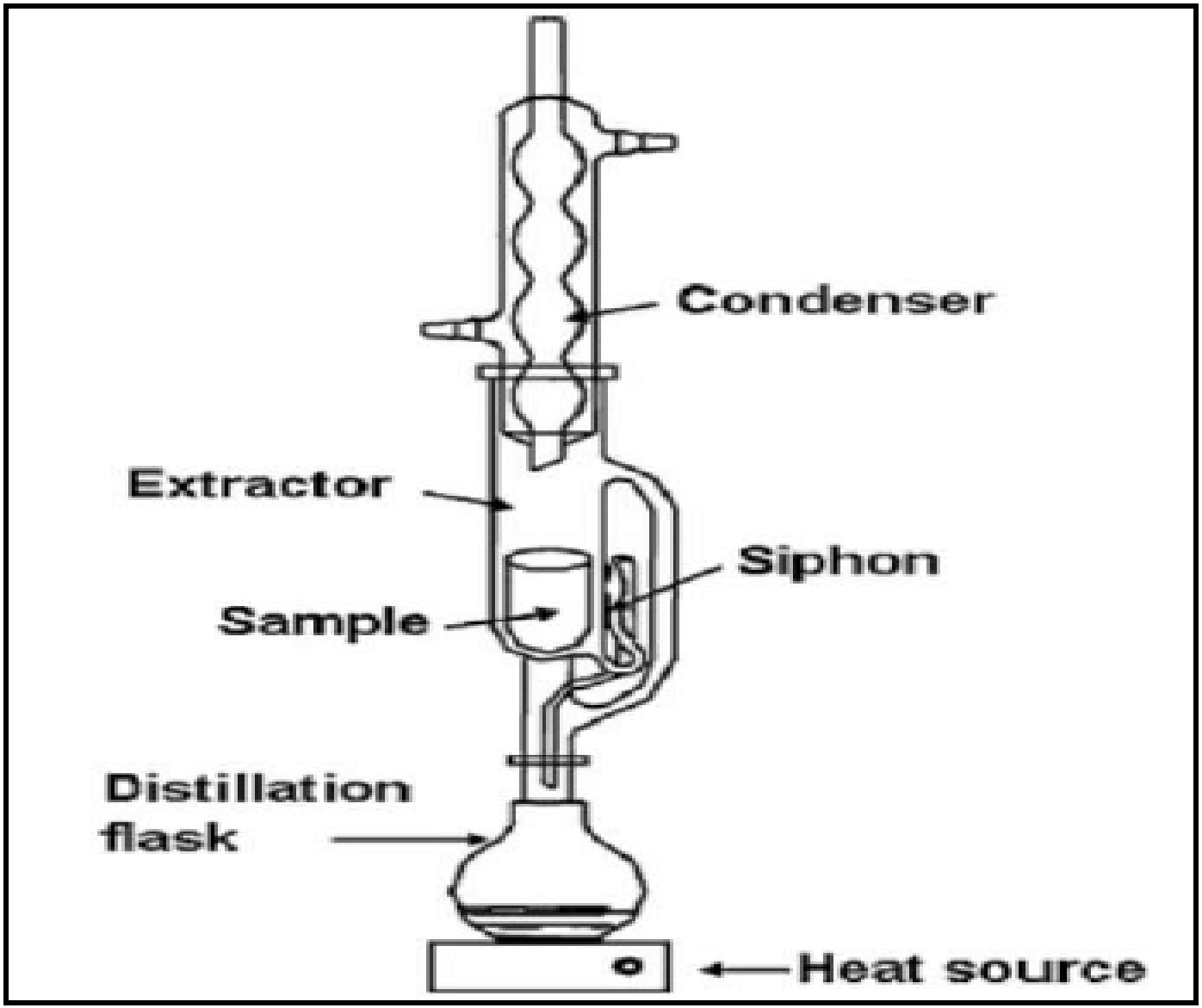
- Maceration
- Percolation
- Reserved percolation
- Cover and run down method
- Conical vs cylindrical percolator
- Significance of imbibition in percolation
- Role of filter paper and sand on the surface of packed drug

Equipment for extraction

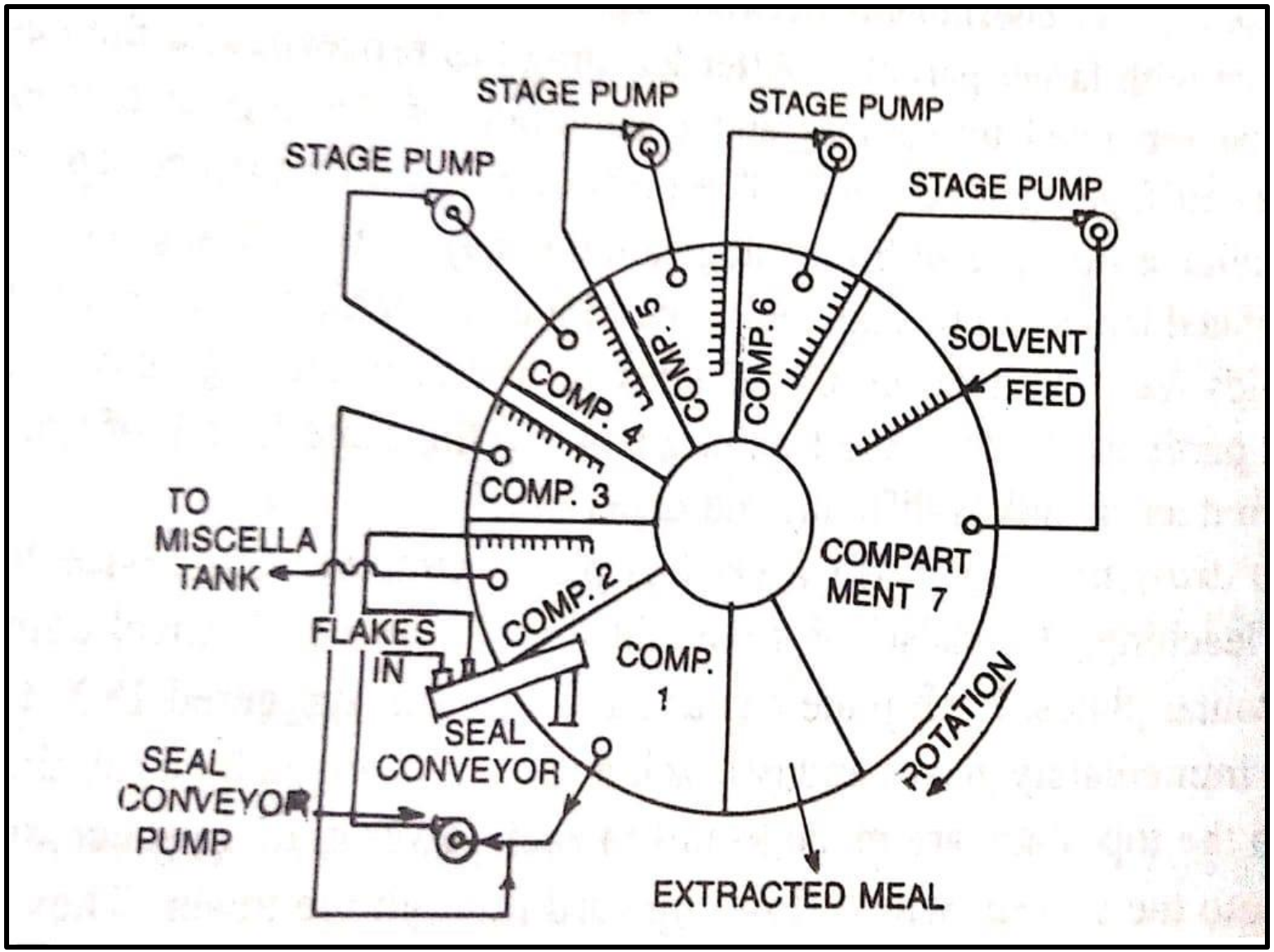
- Extraction battery
  - Represents drug/ solvent ratio 1:1
  - If N vessels are used, the drug receives 2N-1 extraction stages



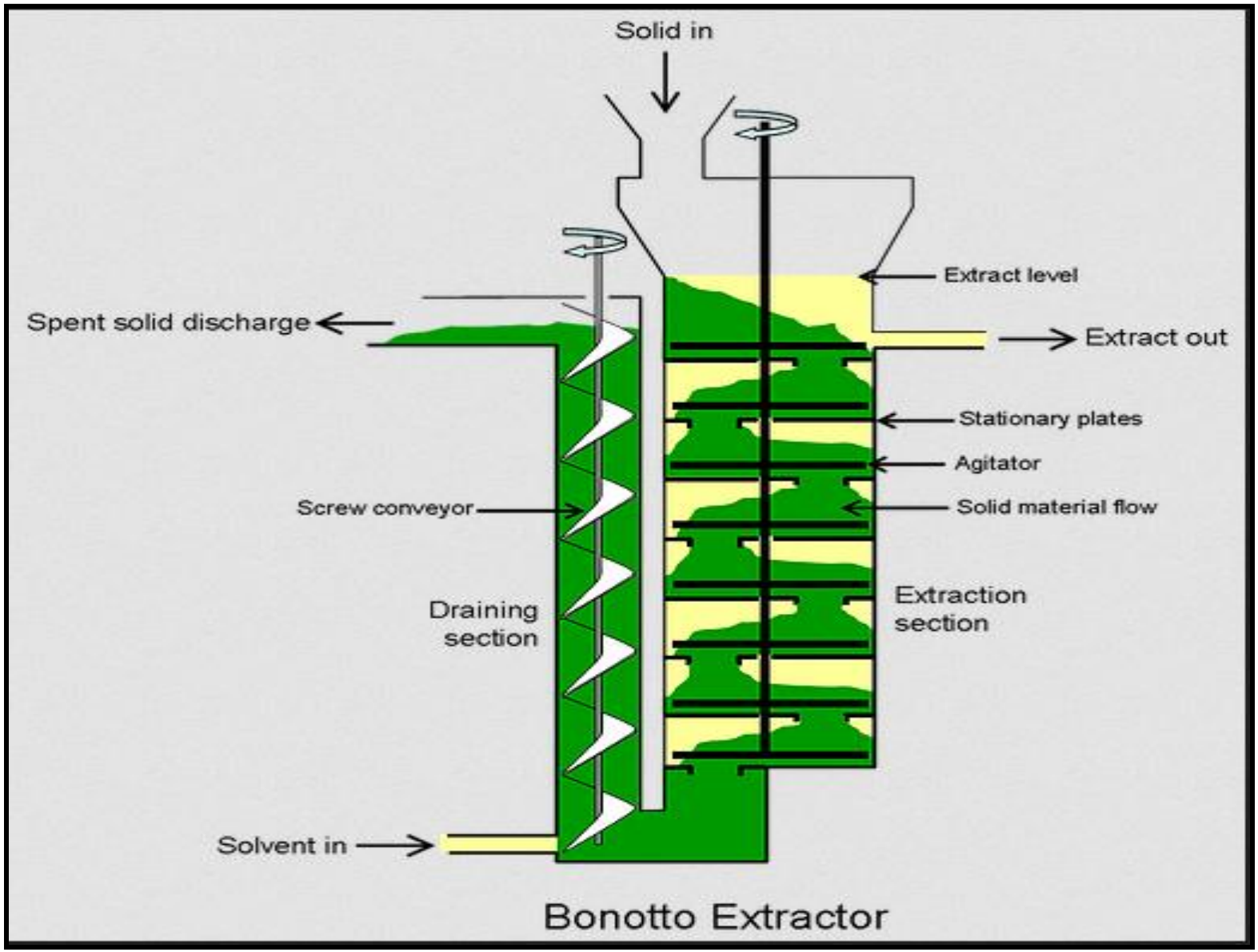
Soxhelt apparatus



Rotocell extractor



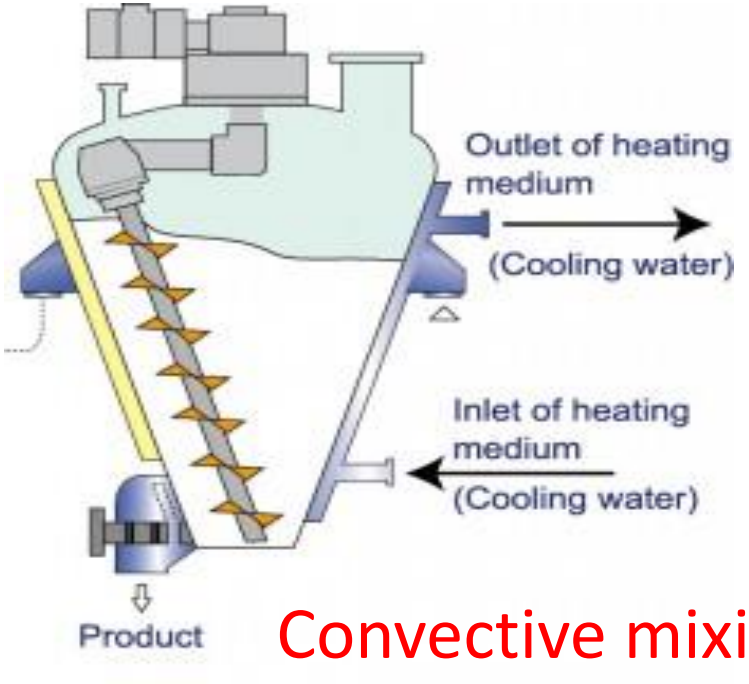
Bonotto extractor



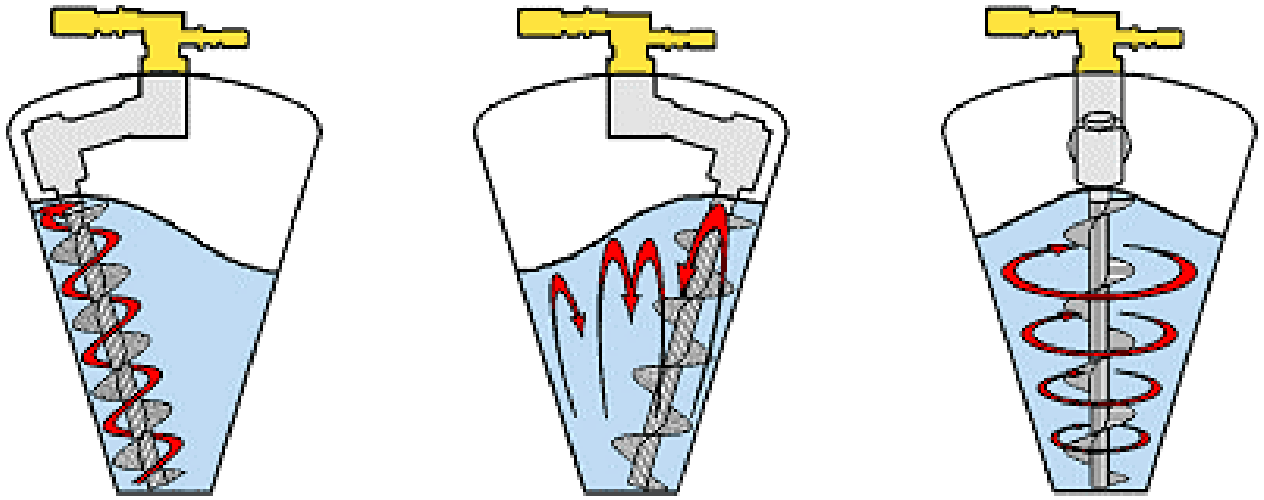
8. MIXING

- Theory of mixing
- Solid- solid mixing
- Solid- liquid mixing
- Liquid- liquid mixing
- Mixing equipment
- Solid mixing equipment
- Solid – liquid mixing
- Liquid mixing

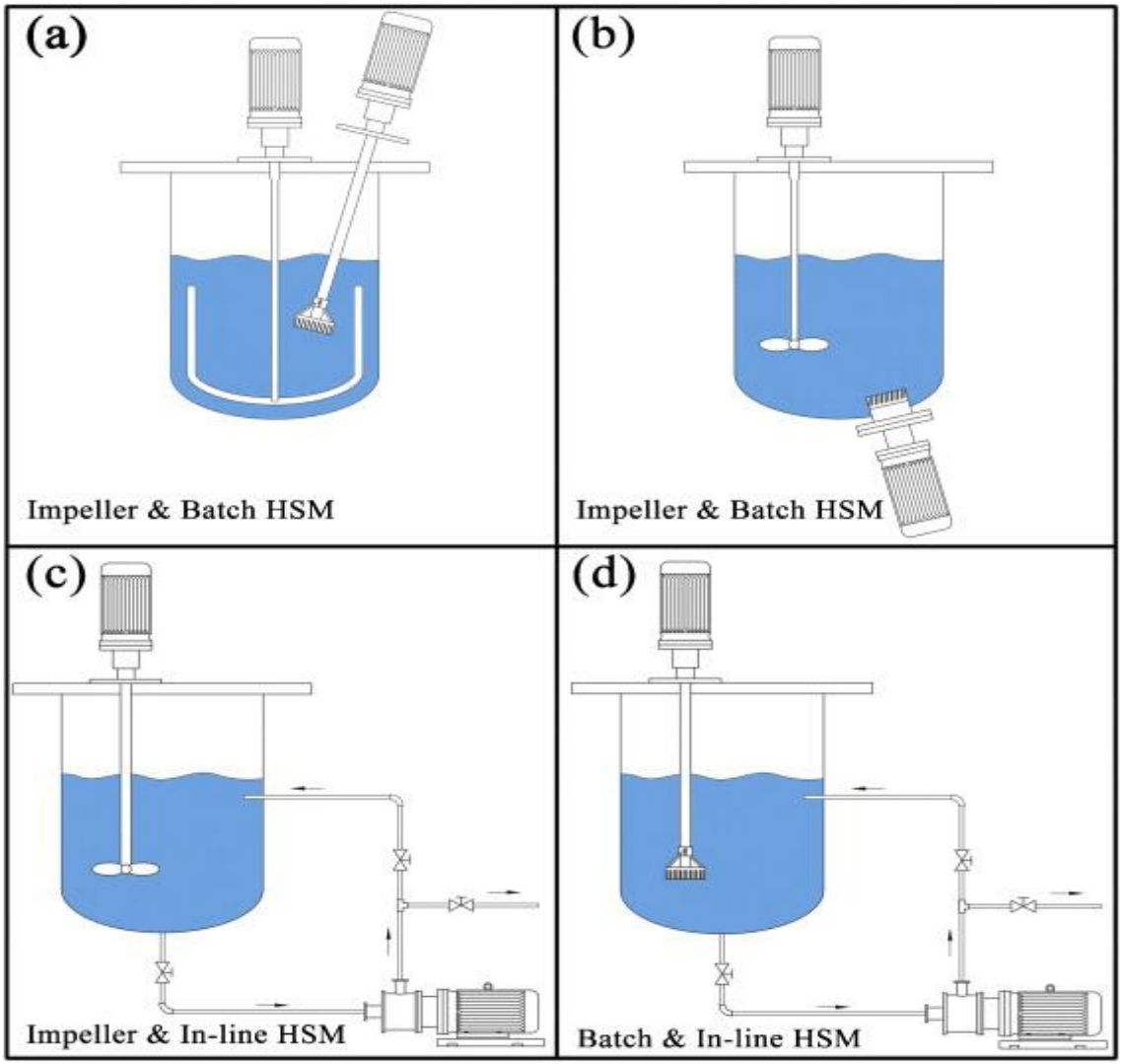
- **Theory of mixing**
- **Solid- solid mixing**
  - Convective mixing
  - Shear mixing
  - Diffusive mixing



Convective mixing



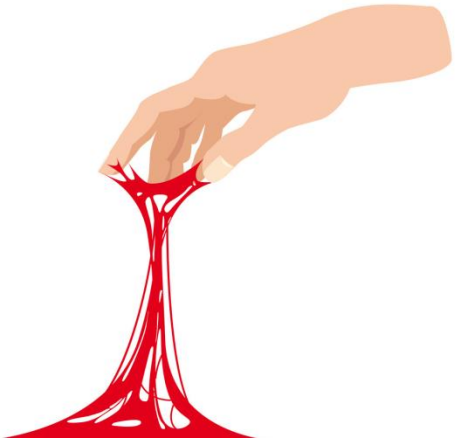
Shear mixing



Diffusive mixing

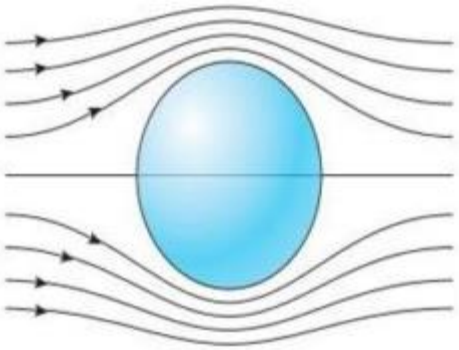
Solid- liquid mixing

- Pellet and powder state
- Pellet state
- Plastic state
- Sticky state
- Liquid state

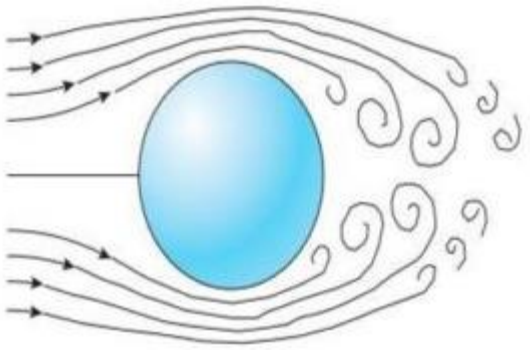


Liquid- liquid mixing

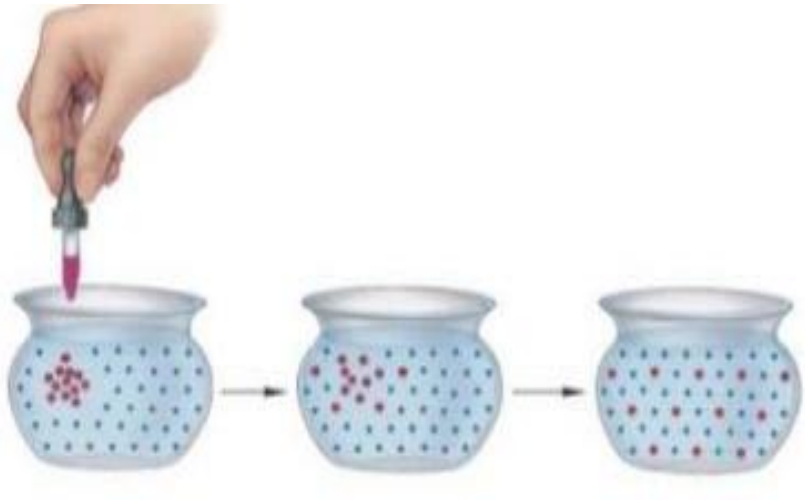
- Bulk transport
- Turbulent mixing
- Laminar mixing
- Molecular diffusion



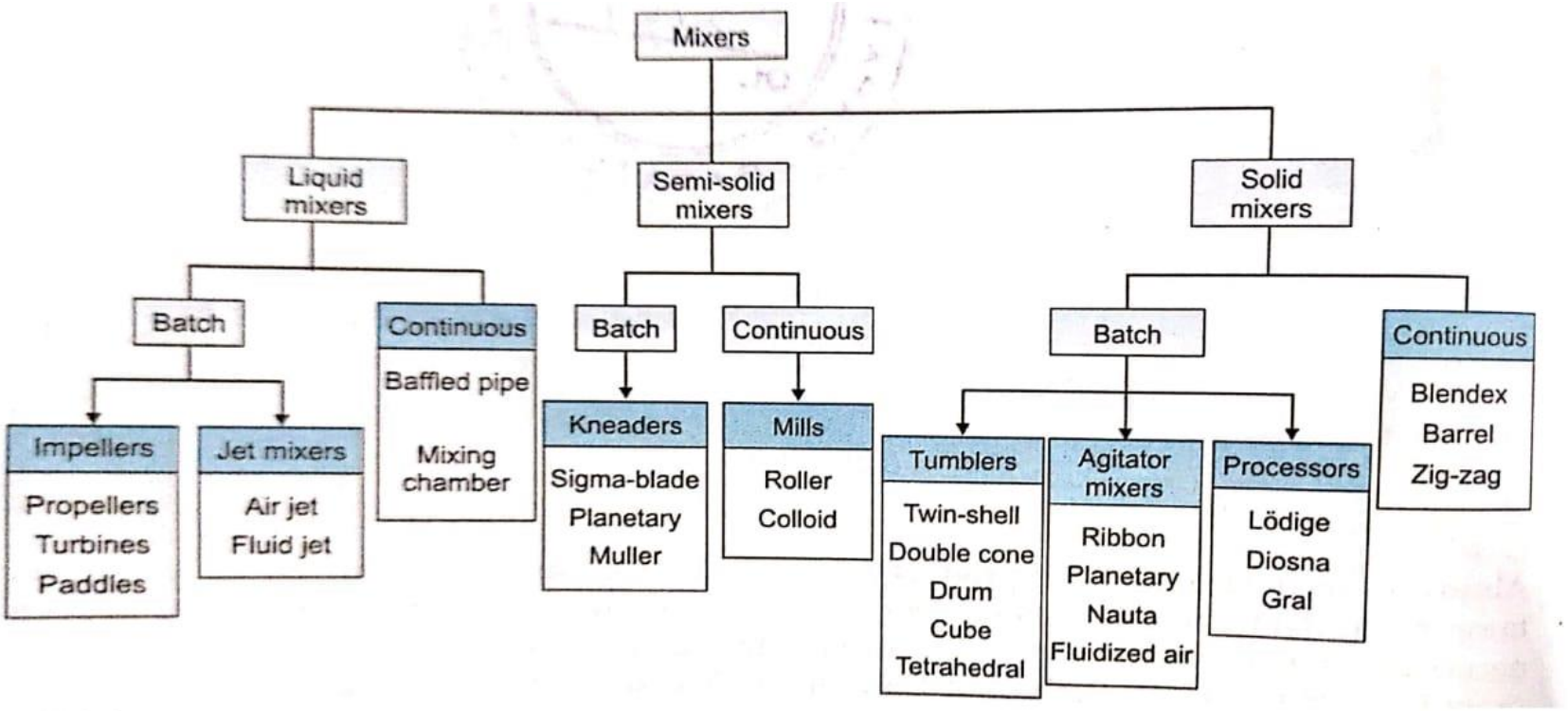
Laminar mixing



Turbulent mixing



Mixing equipment



Solid mixing equipment

- Tumblers/Blenders
- Agitator mixers
- Continuous mixers

Tumblers/Blenders

- Twin- shell (v shape)
- Double cone
- Drum
- Cube and tetrahedral blenders
- Twin shell blender is commonly employed
- Bulk transport and shear
- May consists of baffles and agitator
- Depends on speed of rotation (30-100 rpm)
- Rpm depends on size; shape of the tumbler and on the type of material

Agitator mixers

- Mixing by means of moving screws, paddles or blades
- Mixing of wet, sticky or plastic solids
- Ribbon mixer/ blender
- Planetary mixer
- Nauta mixer
- Fluidized air mixer
- RMG
- Lodge mixer
- Diosna mixer granulator
- Gral mixer granulator

Continuous mixers

- Zig- zag continuous blender
- Blendex
- Barrel type continuous mixer

Solid – liquid mixing

- Segregation or demixing
- Particle size, shape, density and charge
  - Kneaders (Agitator mixers)
  - Mills (shear mixers)
  - Ultrasonic mixers

Liquid mixing

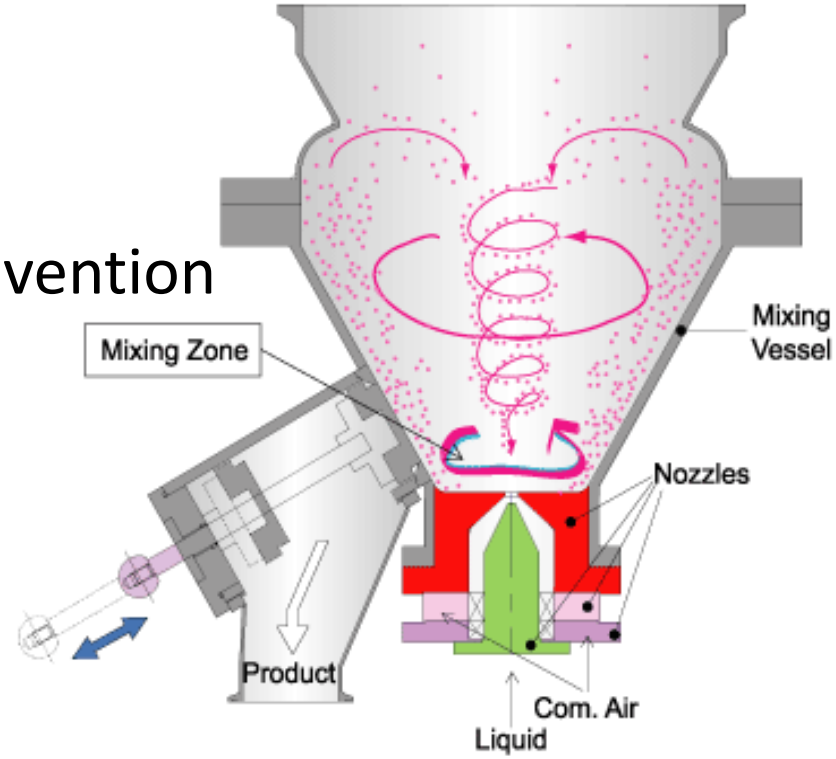
- Impellers
- Jet mixers

Impellers

- Propellers
  - Three blade designs is common
  - Primary effect is axial flow
  - Up to 8000 rpm
  - Propeller to container ratio is 1:20
  - High speed with low viscous fluids (<5N/m^2)
- Turbines
  - Radial flow
  - Diffuser ring may be fitted
  - Deal up to 100 N/m^2
- Paddles
- Large surface are with 50 rpm
- Primarily tangential

Jet mixers

- Air jets
- Liquid jets
  - Vortex formation and prevention
    - Offset
    - Angled
    - Side- entering
    - Push- pull
    - Baffled



THANK YOU

@ UNIVERSITY LINK