MECHANICAL OPERATION

ENCH 251

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The objective of this course is to provide basic understanding of particulate solid characterization, storage, and handling. It aims to equip students with knowledge of the principles of size reduction and mixing, along with the operation of equipment commonly used for these processes in industry. The course focuses on understanding the working principles of solid-liquid, solid-gas, and solid-solid mechanical separation processes and the associated equipment.

1 Particles Properties (4 hours)

1.1 Characterization of solid particle, different ways of expression of particle size, shape factor, sphericity, particle size analysis
1.2 Screen analysis, standard screen series, properties of particulate masses, pressure in masses of particles, angle of internal friction and angle of repose

2 Storage and Conveying of Solids (4 hours)

2.1 Bulk storage, pressures in bins and silos, flow out of bins/silo, types of storage
2.2 Conveyors, types of conveyors (Belt, screw, and bucket)

3 Mixing of Particulate Solid (3 hours)

3.1 Solid-solid mixing operation
3.2 Mixers for cohesive and non-cohesive solids
3.3 Mixing effectiveness
3.4 Measures of mixer performance, mixing index, rate of mixing

4 Mechanical Separation (4 hours)

4.1 Screening, motion of screen, comparison of ideal and actual screens, screen capacity, effectiveness of screens, material balances over screen
4.2 Industrial screening equipment: Stationary screen, trommels

5 Size Reduction and Enlargement (7 hours)

5.1 Comminution: Principles and characterization, bond crushing law and work index, crushing efficiency, open-circuit and closed-circuit operation, crusher, grinder

5.2 Characteristics of comminuted product, energy and power requirements in comminution

5.3 Size reduction equipment: Jaw crusher, gyratory crusher, roll crusher, hammer mill, ball mill, cutting machines

5.4 Principles of particle size enlargement, industrial equipment: drum granulator, pan granulator, spray dryer or prilling, briquetting, compacting

6 Settling (9 hours)

6.1 Gravity settling process, gravity and sorting classifiers, rate of sedimentation, batch sedimentation

6.2 Equipment for sedimentation: Clarifiers and thickeners, clarifier and thickener design considerations

6.3 Principle of centrifugal sedimentation, centrifugal sedimentation equipment: cyclones, cyclone design considerations, centrifugal decanters

7 Agitation and Mixing of Liquids (5 hours)

7.1 Principles of agitation, flow patterns in agitated vessels, types of impeller, prevention of swirling, draft tubes, standard turbine design, power consumption in agitated vessels

7.2 Blending and mixing, suspension of solid particles, dispersion operation

7.3 Agitation equipment: Mechanical mixer, jet mixer, static mixer, gas sparger

8 Filtration (9 hours)

8.1 Mechanisms of filtration, filter media, filter aids

8.2 Principles of cake filtration, constant-pressure filtration, constant-rate filtration, filtration equipment: Gravity filters, pressure filters, plate and frame filter press, discontinuous vacuum filters, rotary-drum vacuum filters, horizontal belt filters

8.3 Principles of clarification, liquid clarification, gas clarification

8.4 Principles of membrane separation process, types of membranes, membrane fouling, equipment: Reverse osmosis

8.5 Principle of centrifugal filtration equipment: Batch and continuous filters

Tutorial

(15 hours)

1. Particles properties and transportation of fluids
2. Handling and storage of particulate solid
3. Mixing of particulate solid
4. Size reduction and enlargement

5. Problems related to settling
6. Agitation and mixing of liquids
7. Problems related to filtration

Practical **(22.5 hours)**

1. Verify the laws of crushing and size reduction ratio in Jaw crusher
2. Determination of the critical speed of ball mill
3. Screen analysis for the product obtained from ball mill in the form of cumulative and fractional distribution plots
4. Separation of fine solid dust particle from the air using cyclone separator
5. Determination of efficiency of magnetic separator
6. Batch filtration using plate and frame filter press
7. Demonstration of various flow patterns exhibited by different types of impellers using baffles in the mixing tank

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	4	6
2	4	6
3	3	4
4	4	6
5	7	8
6	9	12
7	5	6
8	9	12
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. McCabe, W. L., Harriott, P., Smith, Johan C. (2005). Unit operations of chemical engineering. Boston: Mcgraw-Hill Higher Education.
2. Ortega-Rivas, E. (2011). Unit Operations of Particulate Solids: Theory and Practice. CRC Press.
3. Rhodes, M. J. (2008). Introduction to Particle Technology. Wiley.
4. Sinnott, R. K. (1999). Coulson and Richardson's Chemical Engineering Volume 2, Chemical Engineering Design. Butterworth-Heineman, Oxford.
5. Sinnott, R. K. (1999). Coulson and Richardson's Chemical Engineering Volume 6, Chemical Engineering Design. Butterworth-Heineman, Oxford.