

Gujarat Technological University

COURSE NAME : MECHANICAL OPERATION (C.E.O.- I)

1. RATIONALE :

Mechanical Operation is a basic course for Diploma in Chemical Engineering to develop skills required in them as operators of plant. Efforts are made to design the course content in such a way that it is having enough theoretical as well as practical exposure. Design of practicals to be done, study of models are done in accordance with the requirement of an operator, who will handle all these equipment in the plant continuously during operation as well as during shut down. It also includes elementary knowledge of maintenance like cleaning, flushing of equipment etc.

2. SCHEME OF TEACHING

Topic No.	Name of Topic	No. of Hours		
		Lect.	Pract.	Total
1.	Introduction	1	-	1
2.	Properties of particulate solids.	3	4	7
3.	Screen analysis	3	-	3
4.	Size reduction	9	12	21
5.	Sedimentation	4	12	16
6.	Filtration	7	12	19
7.	Separation of solid particles	6	8	14
8.	Agitation	4	4	8
9.	Mixing	5	4	9
		42	56	98

3. TECHNOLOGY RELATED SKILLS : (TRS)

TRS 1 : Operate various unit operations and process equipment efficiently.

EOs

- 1.1 Select the appropriate raw materials for the finished (Lab.Exp.) product.
- 1.2 Select the appropriate process for the finished product.(")
- 1.3 Locate the faults / fluctuations of working parameters (") in the manufacturing process.
- 1.4 Correlate the effect of different operating parameters.
(Topic 4,6,7,8,9 & Lab.Exp.)
- 1.5 Regulate / rectify the faults by correcting the working parameters in process equipment. (Topic 2,3,5,6 & Lab.Exp.)
- 1.6 Optimise the rate of production by maintaining quality. (")

TRS 2 : Perform the assigned job during scheduled and unscheduled shutdown efficiently.

EOs

- 2.1 Identify the faults during scheduled and unscheduled shutdown.
(Topic 2,3,5,6 & L.E)
- 2.2 Plan & schedule the assigned job during shutdowns effectively.
(Topic 4,6,7,8,9 & L.E)

Gujarat Technological University

4. COMMUNICATION SKILLS:

1. Ask pertinent questions as well as to answer them.
2. Face oral examinations confidently.
3. Write reports on experiments conducted in laboratories/ workshops/ and reports on field and industrial visits.
4. Build rapport with individuals and the group, e.g to start with statements that most of them will accept.

5. TOPICS/ SUB-TOPICS

1 INTRODUCTION OF MECHANICAL OPERATION : 1 hrs.

- 1.1 Definition of Unit operation & Unit process.
- 1.2 Difference of Unit operation & unit process.
- 1.3 Examples of unit operation & unit process.

2 PROPERTIES OF PARTICULATE SOLIDS 3 hrs.

- 2.1 Specific properties of solids.
- 2.2 Density and Bulk density.
- 2.3 Definitions and calculation of particle diameter.
Sphericity equivalent diameter, specific surface area, volume surface mean diameter, mass mean diameter, volume and surface mean diameter, shape factor.
- 2.4 Calculation of no. of particles particulate solids.

3 SCREEN ANALYSIS 3 hrs.

- 3.1 Need of screen analysis.
 - 3.1.1 Types of screen analysis.
- 3.2 Applications of screen analysis.
- 3.3 Types of screen, trommel, Grizzlies, vibrating screen etc.
- 3.4 Explain : Ideal & actual screen.
- 3.5 Capacity & effectiveness of screen.
 - 3.5.1 Derivation of formula for overall effectiveness of screen
- 3.6 Calculation of capacity and effectiveness of screen.
- 3.7 Faults in screening.

4 SIZE REDUCTION 9 hrs.

- 4.1 Definition and need of size reduction.
- 4.2 Principles of size reduction.
- 4.3 Characteristics of comminuted products.
- 4.4 Energy and power requirement in comminution.
- 4.5 Explain (i) Rittingers law,
(ii) Bond's law
(iii) Kick's law.
- 4.6 Calculation of power for size reduction on the basis of above laws.
- 4.7 Work index and its calculations.
- 4.8 Types of Equipment for size reduction.
- 4.9 Principles of size reduction in various equipment.

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- 4.10 Construction and working of Jaw crusher, Gyratory crusher, roll crusher, Ball mill, Fluid Energy mill.
- 4.11 Derivation of equation of angle of nip in roll crusher of critical speed.
- 4.12 Derivation of equation of critical speed in ball mill and its calculations.
- 4.13 Calculation of angle of Nip, capacity and Ribbon factor.
- 4.14 Differentiate : open and close circuit grinding.

5 SEDIMENTATION

4 hrs.

- 5.1 Definition of sedimentation.
- 5.2 Theory of batch sedimentation.
- 5.3 Interphase height and time curve.
- 5.4 Flocculation principle.
- 5.5 Gravity thicker : Principle, construction and working
- 5.6 Explain : free and hindered settling.
- 5.7 Explain : Bowl, nozzle discharge, disk, tubular, centrifuge (construction and working).
- 5.8 Explain : Cyclone separator, principle, construction and working, cut diameter, efficiency of cyclone.
- 5.9 Definition of stocks law and Newton's law for terminal settling velocity.

6 FILTRATION

7 hrs.

- 6.1 Definition and applications of filtration.
- 6.2 Classify : Equipment for liquid-solid separation.
- 6.3 Principle, construction and working of filter press.
- 6.4 Principle, construction and working of leaf filters.
- 6.5 Principle, construction and working of Rotary vacuum filter.
- 6.6 Principle, construction and working of cartridge filter.
- 6.7 Filter media and its required characteristics.
- 6.8 Filter aids and method of application. Pre coating.
- 6.9 Calculation of special cake resis, filter media resis, porosity for constant rate, constant pressure system and vacuum drum.
- 6.10 Explain : Constant rate filtration and constant pressure filtration.
- 6.11 Centrifuges : * Classification of centrifugal equipment.
 - * Principle, construction and working of batch centrifuge.
 - * Advantages and disadvantages of centrifuge over filter press.

7 SEPARATION OF SOLID PARTICLES

6 hrs.

- 7.1 Definition and application of solid separation.
- 7.2 Factors affecting selection of equipment.
- 7.3 Working principle of
 - a) Jigging
 - b) Elutriation
 - c) Double cone classifier
 - d) Electrostatic precipitator
 - e) Magnetic separator
 - f) Froth flotation cell
- 7.4 Explain : Differential settling methods.
- 7.5 Explain : Sink and float method.

8 AGITATION

4 hrs.

- 8.1 Define : Agitation and mixing, and give their definitions, applications.

Gujarat Technological University

- 8.2 Classify Impellers
- 8.3 Explain : Vortex formation and swirling, methods of Vortex prevention.
- 8.4 Principle, working and construction of Agitation vessel.
- 8.5 Derivation of equation for power consumption.
- 8.6 Calculations of power consumption in Baffled and unbaffled tank.
- 8.7 Derivation of equation for flow number.
- 8.8 Factors affecting agitation.

9 MIXING

5 hrs.

- 9.1 Purpose of mixing solids and pastes.
 - 9.2 Factors considered in selection of equipment.
 - 9.3 Rate of mixing and mixing index for pastes and powder.
 - 9.4 Principle, construction and working of
 - a) Ribbon blender b) Kneaders
 - c) Pug mill d) Banbury mixer
 - e) Muller mixer
 - 9.5 Calculation of mixing index.
- Note : The General preventive maintenance of the equipment involved in the respective course must be taught while teaching the students in theory classes and should be strengthened during industrial visits or during laboratory experiments or during projects, wherever the scope found to be.

6. LABORATORY EXPERIENCES

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| 1. Measure separation of particles by measuring volume, surface mean diameter, mass mean dia. etc in sieve shaker. | 4 hrs. |
| 2. Test Rittinger's law for grinding in ball mill and measure critical speed. | 4 hrs. |
| 3. Test Kicks law for crushing in jaw crusher. | 4 hrs. |
| 4. Test Bond's law for crushing in roll crusher. | |
| 5. Test effect of liquid height on power consumption in agitation vessel. | 4 hrs. |
| 6. Measure efficiency of separation in cyclone separator. | 4 hrs. |
| 7. Measure efficiency of separation in froth flotation cell. | 4 hrs. |
| 8. Find out rate of settling by sedimentation. | 4 hrs. |
| 9. Measure rate of filtration by gravity filtration method. | 4 hrs. |
| 10. Measure rate of filtration by vacuum filtration method. | 4 hrs. |
| 11. Measure cake resistance, filter media resistance in filter press. | 4 hrs. |
| 12. Measure rate of filtration in centrifuge. | 4 hrs. |
| 13. Evaluate mixing index in double cone mixer. | 4 hrs. |
| 14. Compute separation efficiency in magnetic separator. | 4 hrs. |

7. REFERENCES

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| 1. Unit Operations in Chemical Engineering | Mc Cabe and Smith |
| 2. Introduction to Chemical Engineering | Walter L. Badger and Julius T Banchemo |