I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

CHEMICAL GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

MECHANICAL OPERATIONS

(22313)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

(Mechanical Operations)

(22313)

Semester-III

(CH)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms. ……..…… Roll No. ……..…., of Third Semester of Diploma in ……..…… of Institute, ……..…….……..… (Code: ……...) has completed the term work satisfactorily in course **Mechanical Operations (22313)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:.……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical's to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practical's to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Diploma Chemical engineers (also called technologists) have to work in various process industries like pharmaceutical, petroleum, petrochemical, food, textile, dyes and others. Many Chemical manufacturing processes industries involves small solid particle at some point. Proper handling and design of this fine particle often makes the difference in quality of the product. Many products such as catalyst, pigments and many other are currently manufactured in particulate forms. By learning this subject they will be familiar with different mechanical operation like size reduction, separation, transportation and mixing involved in Chemical industry.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs and PSO are expected to be achieved through the practical's of the (Mechanical Operations) course.

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.
PO 5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Chemical engineering.
PO 6. **Environment and sustainability:** Apply Chemical engineering solutions also for sustainable development practices in societal and environmental contexts.
PO 8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.
PO 10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Chemical engineering and allied industry.

PSO 1. **Chemical engineering equipment:** Operate equipment and materials effectively and efficiently used in chemical reactions.

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List of Industry Relevant Skills-

The following industry relevant skills of the competency '**Use various mechanical engineering equipment in chemical process industry**.' are expected to be developed in you by undertaking the practical's of this practical manual.

1. Identify the equipment for size reductions.
2. Use screen for solid-solid separation.
3. Identify different methods for solid-solid, solid-liquid separation.

Practical- Course Outcome matrix-

	Course Outcomes (COs) a. Use size reduction equipment in chemical process industry. b. Use the relevant separation methods for solid-solid separation. c. Select the method for solid-liquid separations. d. Apply the concept of gas-solid separations. e. Use the relevant method for transportation of solid in industry. f. Select the relevant equipment for agitation and mixing.						
S. No.	**Practical Outcome**	**CO a.**	**CO b.**	**CO c.**	**CO d.**	**CO e.**	**CO f.**
1.	Use Jaw crusher for size reduction of given solid and determine the particle size range of product. Part - I	√	-	-	-	-	-
2.	Use Jaw crusher for size reduction of given solid and determine the particle size range of product. Part - II	√	-	-	-	-	-
3.	Use hammer mill for size reduction of given solid and determine the particle size range of product. Part - I	√	-	-	-	-	-
4.	Use hammer mill for size reduction of given solid and determine the particle size rangeof product. Part - II	√	-	-	-	-	-
5.	Use Ball mill to find average particle size by changing the residence time of material. Part - I	√	-	-	-	-	-
6.	Use Ball mill to find average particle size by changing the residence time of material. Part - II	√	-	-	-	-	-
7.	Use screen for calculation of effectiveness of screen using different size of particles. Part - I	-	√	-	-	-	-
8.	Use screen for calculation of effectiveness of screen using different size of particles. Part - II	-	√	-	-	-	-
9.	Determine the efficiency of Flotation cell for separation of solid in a given solid mixture. Part - I	-	-	√	-	-	-
10.	Determine the efficiency of Flotation cell for separation of solid in a given solid mixture. Part - II	-	-	√	√	-	-
11.	Perform electromagnetic separation applying magnetic Drum separator. Part - I	-	√	-	√	-	-
12.	Perform electromagnetic separation applying magnetic Drum separator. Part - II	-	√	-	√	-	-
13.	Use Grizzlies, Trommels, Vibrating Screen for separation of given solid mixture. Part - I	-	√	-	√	-	-
14.	Use Grizzlies, Trommels, Vibrating Screen for separation of given solid mixture.Part-II	-	√	-	√	-	-

15.	Use Plate and Frame filter press for solid liquid separation to draw rate of filtration curve. Part - I	-	-	√	√	-	-
16.	Use Plate and Frame filter press for solid liquid separation to draw rate of filtration curve. Part - II	-	-	√	-	-	√
17.	Use Basket Centrifuge for solid liquid separation (with graphical representation). Part - I		-	√			
18.	Use Basket Centrifuge for solid liquid separation (with graphical representation). Part - II		-	√			
19.	Use vacuum filter for determination of the rate of filtration for solid liquid mixture. Part - I			√			
20.	Use vacuum filter for determination of the rate of filtration for solid liquid mixture. Part - II			√			
21.	Determine terminal settling velocity for different concentration of calcium carbonate slurry using batch sedimentation test. Part - I			√			
22.	Determine terminal settling velocity for different concentration of calcium carbonate slurry using batch sedimentation test. Part - II			√			
23.	Use Centrifuge for calculation of percentage of solids recovered from given slurry using centrifuge. Part - I		√	√			
24.	Use Centrifuge for calculation of percentage of solids recovered from given slurry using centrifuge. Part - II		√	√			
25.	Determine efficiency of Cyclone Separator for the given solid gas mixture. Part - I				√		
26.	Determine efficiency of Cyclone Separator for the given solid gas mixture. Part - II				√		
27.	Use conveyor for transport of given solids. Part - I					√	
28.	Use conveyor for transport of given solids. Part - II					√	
29.	Use Ribbon Blender to determine solid-solid mixing index. Part - I						√
30.	Use Ribbon Blender to determine solid-solid mixing index. Part - II						√
31.	Use Sigma mixer for determination of solid -solid mixing index. Part - I						√
32.	Use Sigma mixer for determination of solid -solid mixing index. Part - II						√

Guidelines to Teachers -

1. Teacher need to ensure that a dated log book for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to submit for assessment to the teacher in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practical's.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Note: Kindly do add specific guidelines for effective implementation of practical's depending upon your course, if needed.

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a dated log book for the whole semester, apart from this laboratory manual which s/he has to submit for assessment to the teacher in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, student need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practicals.

Note: Kindly do add specific instructions for students for effective implementation of practicals depending upon your course, if needed.

Content Page-

List of Practicals and Progressive Assessment Sheet

25.	Determine efficiency of Cyclone Separator for the given solid gas mixture. Part - I	129					
26.	Determine efficiency of Cyclone Separator for the given solid gas mixture. Part - II	134					
27.	Use conveyor for transport of given solids. Part - I	139					
28.	Use conveyor for transport of given solids. Part - II	144					
29.	Use Ribbon Blender to determine solid-solid mixing index. Part - I	148					
30.	Use Ribbon Blender to determine solid-solid mixing index. Part - II	154					
31.	Use Sigma mixer for determination of solid -solid mixing index. Part - I	160					
32.	Use Sigma mixer for determination of solid -solid mixing index. Part - II	166					
Total							

Note: To be transferred to Performa of CIAAN-2017.

Practical No. 1: Use Jaw crusher for size reduction of given solid and determine the particle size range of product. Using feed material -1 [Brick] Part - I

I Practical Significance

Size of particle plays important role in reaction rate. In chemical engineering size of particle is very important. Much Chemical industry requires reduced size of particle as raw material. Jaw crusher is important equipment used in industry for size reduction. By performing this practical, student will able to understand the particle size determination.

II Relevant Program Outcomes :

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Use size reduction equipment in chemical process industry ':

1. Identify different size reduction equipments.
2. Interpret Jaw crusher.

IV Relevant Course Outcome(s)

Use various mechanical engineering equipment in chemical process industry.

V Practical Outcome

- Calculate particle size range obtain from Jaw crusher.

VI Minimum Theoretical Background

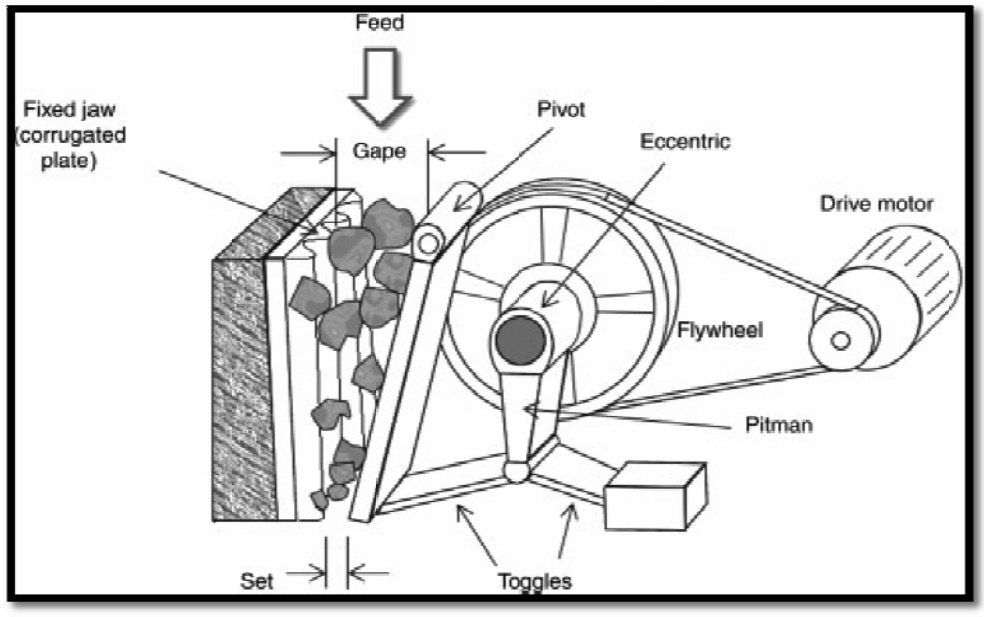
A jaw crusher uses compressive force for breaking of particle. This mechanical pressure is achieved by the two jaws of the crusher of which one is fixed while the other reciprocates. A jaw or toggle crusher consists of a set of vertical jaws, one jaw is kept stationary and is called a fixed jaw while the other jaw called a swing jaw, moves back and forth relative to it, by a cam or pitman mechanism, acting like a class II leveror a nutcracker. The volume or cavity between the two jaws is called the crushing chamber. The movement of the swing jaw can be quite small, since complete crushing is not performed in one stroke. The inertia required to crush the material is provided by a weighted flywheel that moves a shaft creating an eccentric motion that causes the closing of the gap.

Jaw crushers are heavy duty machines and hence need to be robustly constructed. The outer frame is generally made of cast iron or steel. The jaws themselves are usually constructed from cast steel. They are fitted with replaceable liners which are made of manganese steel, or Ni-hard (a Ni-Cr alloyed cast iron). Jaw crushers are usually constructed in sections to ease the process transportation if they are to be taken underground for carrying out the operations.

Jaw crushers are classified on the basis of the position of the pivoting of the swing jaw

1. Blake crusher-the swing jaw is fixed at the upper position
2. Dodge crusher-the swing jaw is fixed at the lower position
3. Universal crusher-the swing jaw is fixed at an intermediate position

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Jaw Crusher		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that crusher will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Weigh the known amount of sample for crushing.
2. Start the jaw crusher and feed the sample in jaw crusher in the hopper.
3. Stop the jaw crusher after the crushing is completed.
4. Collect the product from crusher and feed it into the screen stake/sieve shaker.
5. Start the sieve shaker and set for a standard time.
6. Accurately weigh the material retained on each screen.
7. Find out weight fraction.

8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.
9. Draw a graph of differential analysis and cumulative analysis.
10. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

1. Weight of sample from crushing……..gms
2. Time required for crushing……..sec.
3. Observations for differential screen analysis:

Sr. No.	Mesh No.	Screen opening in mm/micron	Average particle Diameter	Weight of particles retained on the screen in gm	Weight Fraction $\Delta\phi$
1					
2					
3					
4					
5					
6					
7					
8					
9					

4. Observations for cumulative screen analysis:

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight Fraction to be taken from Differential analysis $\Delta\phi$	Cumulative fraction of retained particles ϕ (Oversize)	Cumulative fraction Passing through screen $1-\phi$ (Undersize)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

$$\text{Differential weight fraction of material } \Delta\phi = \frac{\text{Weight of material in gms}}{\text{Total weight of sample in gms}}$$

Cumulative weight fraction is

$$\phi = \Delta\phi_1 + \Delta\phi_2 + \Delta\phi_3 \ldots\ldots \Delta\phi_n = \Sigma\Delta\phi_n$$

Where:

$\Delta\phi$= Cumulative fraction on screen (Oversize) ……

$1-\phi$= Cumulative fraction passing through screen (undersize)……

XV Results

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term size reduction.
2. State the difference between crushing and grinding
3. State the principle of operation of jaw crusher.
4. Differentiate oversize and undersize particles.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.2: Use Jaw crusher for size reduction of given solid and determine the particle size range of product. Using feed material-2 [Rocks] Part - II

I Practical Significance

Size of particle plays important role in reaction rate. In chemical engineering size of particle is very important. Much Chemical industry requires reduced size of particle as raw material. Jaw crusher is important equipment used in industry for size reduction. By performing this practical, student will able to understand the particle size determination.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Use size reduction equipment in chemical process industry ':

1. Identify different size reduction equipments.
2. Interpret Jaw crusher.

IV Relevant Course Outcome(s)

Use various mechanical engineering equipment in chemical process industry.

V Practical Outcome

- Calculate particle size range obtain from Jaw crusher.

VI Minimum Theoretical Background

A jaw crusher uses compressive force for breaking of particle. This mechanical pressure is achieved by the two jaws of the crusher of which one is fixed while the other reciprocates. A jaw or toggle crusher consists of a set of vertical jaws, one jaw is kept stationary and is called a fixed jaw while the other jaw called a swing jaw, moves back and forth relative to it, by a cam or pitman mechanism, acting like a class II leveror a nutcracker. The volume or cavity between the two jaws is called the crushing chamber. The movement of the swing jaw can be quite small, since complete crushing is not performed in one stroke. The inertia required to crush the material is provided by a weighted flywheel that moves a shaft creating an eccentric motion that causes the closing of the gap.

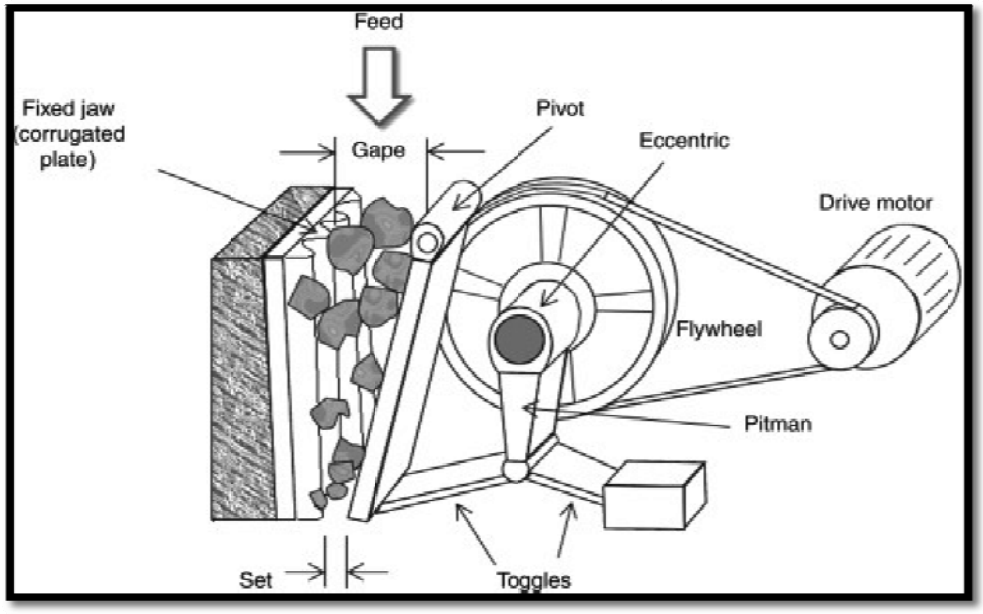
Jaw crushers are heavy duty machines and hence need to be robustly constructed. The outer frame is generally made of cast iron or steel. The jaws themselves are usually constructed from cast steel. They are fitted with replaceable liners which are made of manganese steel, or Ni-hard (a Ni-Cr alloyed cast iron). Jaw crushers are usually

constructed in sections to ease the process transportation if they are to be taken underground for carrying out the operations.

Jaw crushers are classified on the basis of the position of the pivoting of the swing jaw

1. Blake crusher-the swing jaw is fixed at the upper position
2. Dodge crusher-the swing jaw is fixed at the lower position
3. Universal crusher-the swing jaw is fixed at an intermediate position

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Jaw Crusher		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that crusher will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Weigh the known amount of sample for crushing.
2. Start the jaw crusher and feed the sample in jaw crusher in the hopper.
3. Stop the jaw crusher after the crushing is completed.
4. Collect the product from crusher and feed it into the screen stake/sieve shaker.
5. Start the sieve shaker and set for a standard time.

6. Accurately weigh the material retained on each screen.
7. Find out weight fraction.
8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.
9. Draw a graph of differential analysis and cumulative analysis.
10. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of sample from crushing……..kg/gms
b. Time required for crushing……..sec.
1. Observations for differential screen analysis:

Sr. No.	Mesh No.	Screen opening in mm/micron	Average particle Diameter	Weight of particles retained on the screen in gm	Weight Fraction $\Delta\phi$
1					
2					
3					
4					
5					
6					
7					
8					
9					

2. Observations for cumulative screen analysis:

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight Fraction to be taken from Differential analysis $\Delta\phi$	Cumulative fraction of retained particles ϕ (Oversize)	Cumulative fraction Passing through screen 1- ϕ (Undersize)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

$$\text{Differential weight fraction of material } \Delta\phi = \frac{\text{Weight of material in gms}}{\text{Total weight of sample in gms}}$$

Cumulative weight fraction is

$$\phi = \Delta\phi_1 + \Delta\phi_2 + \Delta\phi_3 \ldots\ldots \Delta\phi_n = \Sigma\Delta\phi_n$$

Where:

$\Delta\phi$ = Cumulative fraction on screen (Oversize) ……

2- ϕ= Cumulative fraction passing through screen (undersize)……

XV Results

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term size reduction.
2. State the difference between crushing and grinding
3. State the principle of operation of jaw crusher.
4. Differentiate oversize and undersize particles.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 3: Use hammer mill / pulverizer for size reduction of given solid and determine the particle size range of product using feed material-1 [Rocks] Part – I

I Practical Significance

Size of particle plays an important role in process industry, like cement. Increased rate of reaction will helpful in big and small industry. Energy conservation another area where attention required. Hammer mill is used to reduce the size up to the mark, to ready for processing. By doing this practical student will able to understand, working of hammer mill and calculation of particle size.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Use size reduction equipment in chemical process industry :

1. Identify different materials for size reduction.
2. Interpret Hammer mill. .

IV Relevant Course Outcome(s)

Use various mechanical engineering equipment in chemical process industry.

V Practical Outcome

- Calculate size of particle obtained from Hammer mill / pulverizer.

VI Minimum Theoretical Background

A hammer mill is a mill whose purpose is to shred or crush aggregate material into smaller pieces by the repeated blows of little hammers. These machines have many sorts of applications in many industries, including: Ethanol plants (grains), A farm machine, which mills grain into coarse flour to be fed to livestock, Fluff pulp defiberizing, Fruit juice production, Grinding used shipping pallets for mulch, Milling grain, Sawmills, size reduction of trim scrap and planer shavings into boiler fuel or mulch, Shredding paper, Shredding scrap automobiles.

The basic principle is straightforward. A hammer mill is essentially a steel drum containing a vertical or horizontal rotating shaft or drum on which hammers are mounted. The hammers are free to swing on the ends of the cross, or fixed to the central rotor. The rotor is spun at a high speed inside the drum while material is fed into a feed hopper. The material is impacted by the hammer bars and is thereby shredded and expelled through screens in the drum of a selected size.

The hammermill can be used as a primary, secondary, or tertiary crusher. Small grain hammer mills can be operated on household current. Large hammer mills used in automobile shredders may be driven by diesel or electric motors ranging from 2000 to over 5000 horsepower (1.5 - 3.7MW).

The screenless hammer mill uses air flow to separate small particles from larger ones. It is designed to be more reliable, and is also claimed to be much cheaper and more energy efficient than regular hammermills. The design & structure of the hammermill is alwaysdetermined by the end use.

VII Diagram

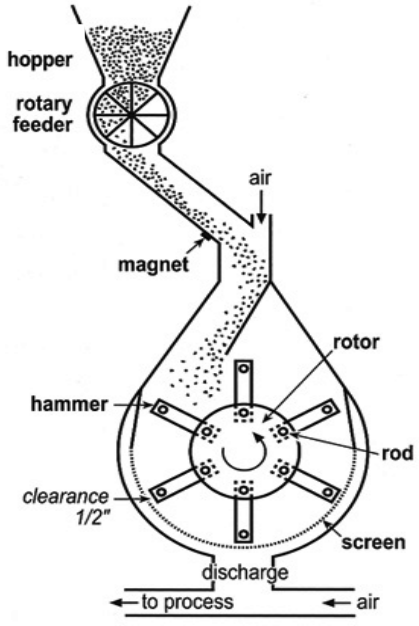

Fig.: Hammer Mill

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hammer Mill		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that mill will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Start the Hammer mill / pulverizer without feed
2. Take 500 gms of feed sample and drop it in the hopper
3. Stop the Hammer mill / pulverizer after the grinding is completed.
4. Collect the product from Hammer mill / pulverizer and feed it into the screen stake/sieve shaker.
5. Start the sieve shaker and set for a standard time.
6. Accurately weigh the material retained on each screen.
7. Find out weight fraction.

8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.
9. Draw a graph of differential analysis and cumulative analysis.
10. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Sample Table:

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight in grams	Cumulative Weight Fraction oversize	Cumulative Weight Fraction undersize
1			$W_1 =$	$W_1 =$	$W_1 + W_2 + W_3 + W_4 + W_5 + W_6 + W_7 =$
2			$W_2 =$	$W_1 + W_2 =$	$W_1 + W_2 + W_3 + W_4 + W_5 + W_6 =$
3			$W_3 =$	$W_1 + W_2 + W_3 =$	$W_1 + W_2 + W_3 + W_4 + W_5 =$
4			$W_4 =$	$W_1 + W_2 + W_3 + W_4 =$	$W_1 + W_2 + W_3 + W_4 =$
5			$W_5 =$	$W_1 + W_2 + W_3 + W_4 + W_5 =$	$W_1 + W_2 + W_3 =$
6			$W_6 =$	$W_1 + W_2 + W_3 + W_4 + W_5 + W_6 =$	$W_1 + W_2 =$
7			$W_7 =$	$W_1 + W_2 + W_3 + W_4 + W_5 + W_6 + W_7 =$	$W_1 =$

Actual Table:

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight in grams	Cumulative Weight Fraction oversize	Cumulative Weight Fraction undersize
1					
2					
3					
4					
5					
6					
7					

$$\text{Weight fraction} = \frac{\text{Weight of material in gms}}{\text{Total weight of sample in gms}}$$

XV Results

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term grinding
2. State the principle of Hammer mill / pulverizer.

3. In industry which type of Equipments used for grinding
4. Differentiate crushing and grinding
5. For what purpose screening operation is used in industry?
6. State the applications of grinding in industry.

Space for Answer:

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XIX References / Suggestions for Further Reading

1. *https://www.slideshare.net/clkbro/how-does-a-hammer-mill-workslsh*
2. *pharmapproach.com/hammer-mill/*
3. *https://www.saintytec.com/working-principle-hammer-mills/*

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.4: Use hammer mill / pulverizer for size reduction of given solid and determine the particle size range of product using feed material -2 [Bricks] Part - II

I Practical Significance

Size of particle plays an important role in process industry, like cement. Increased rate of reaction will helpful in big and small industry. Energy conservation another area where attention required. Hammer mill is used to reduce the size up to the mark, to ready for processing. By doing this practical student will able to understand, working of hammer mill and calculation of particle size.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Use size reduction equipment in chemical process industry :

1. Identify different materials for size reduction.
2. Interpret Hammer mill. .

IV Relevant Course Outcome(s)

Use various mechanical engineering equipment in chemical process industry.

V Practical Outcome

- Calculate size of particle obtained from Hammer mill / pulverizer.

VI Minimum Theoretical Background

A hammermill is a mill whose purpose is to shred or crush aggregate material into smaller pieces by the repeated blows of little hammers. These machines have many sorts of applications in many industries, including: Ethanol plants (grains), A farm machine, which mills grain into coarse flour to be fed to livestock, Fluff pulp defiberizing, Fruit juice production, Grinding used shipping pallets for mulch, Milling grain, Sawmills, size reduction of trim scrap and planer shavings into boiler fuel or mulch, Shredding paper, Shredding scrap automobiles

The basic principle is straightforward. A hammer mill is essentially a steel drum containing a vertical or horizontal rotating shaft or drum on which hammers are mounted. The hammers are free to swing on the ends of the cross, or fixed to the central rotor. The rotor is spun at a high speed inside the drum while material is fed into a feed hopper. The material is impacted by the hammer bars and is thereby shredded and expelled through screens in the drum of a selected size.

The hammermill can be used as a primary, secondary, or tertiary crusher. Small grain hammer mills can be operated on household current. Large hammer mills used in automobile shredders may be driven by dieselor electric motors ranging from 2000 to over 5000 horsepower (1.5 - 3.7MW).

The screenless hammer mill uses air flow to separate small particles from larger ones. It is designed to be more reliable, and is also claimed to be much cheaper and more energy efficient than regular hammer mills. The design & structure of the hammer mill is always determined by the end use.

VII Diagram

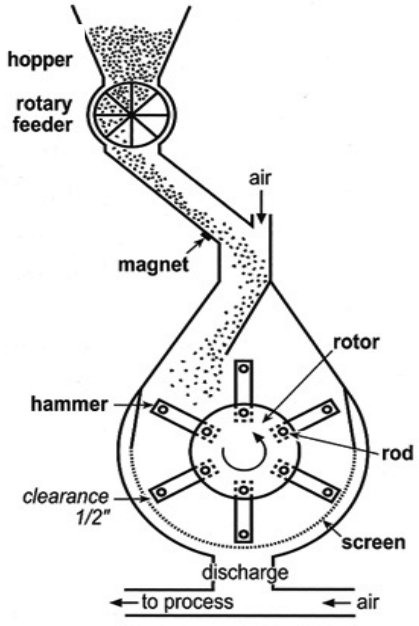

Fig.: Hammer Mill

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hammer Mill		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that mill will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Start the Hammer mill / pulverizer without feed
2. Take 500 gms of feed sample and drop it in the hopper
3. Stop the Hammer mill / pulverizer after the grinding is completed.
4. Collect the product from Hammer mill / pulverizer and feed it into the screen stake/sieve shaker.
5. Start the sieve shaker and set for a standard time.
6. Accurately weigh the material retained on each screen.
7. Find out weight fraction.
8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.

9. Draw a graph of differential analysis and cumulative analysis.
10. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight in grams	Cumulative Weight Fraction oversize	Cumulative Weight Fraction undersize
1					
2					
3					
4					
5					
6					
7					

$$\text{Weight fraction} = \frac{\text{Weight of material in gms}}{\text{Total weight of sample in gms}}$$

XV Results

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term grinding
2. State the principle of hammer mill.
3. In industry which type of Equipments used for grinding
4. Differentiate crushing and grinding
5. For what purpose screening operation is used in industry?
6. State the applications of grinding in industry.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *https://www.slideshare.net/clkbro/how-does-a-hammer-mill-workslsh*
2. *pharmapproach.com/hammer-mill/*
3. *https://www.saintytec.com/working-principle-hammer-mills/*

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 5: Use Ball mill to find average particle size by fixed the residence time of material. (Part - I)

I Practical Significance

Big size particle are available as raw material for many process industry. Size reduction of this particle in necessary for processing. Ball mill available in many process industries for size reduction, which reduced big size particle to different particle size. By performing this practical, students will able to find average size of particle obtained from ball mill.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use basic principles of electrical engineering in different applications'***:

1. Identify ball mill for required size reduction.
2. Interpret given ball mill. .

IV Relevant Course Outcome(s)

Use size reduction equipment in chemical process industry.

V Practical Outcome

- Calculate average particle size obtained from ball mill.

VI Minimum Theoretical Background

A ball mill is a type of grinder used to grind and blend materials for use in mineral dressing processes, paints, pyrotechnics, ceramics and selective laser sintering. It works on the principle of impact and attrition: size reduction is done by impact as the balls drop from near the top of the shell.

A ball mill consists of a hollow cylindrical shell rotating about its axis. The axis of the shell may be either horizontal or at a small angle to the horizontal. It is partially filled with balls. The grinding media is the balls, which may be made of steel (chrome steel), stainless steel, ceramic, or rubber. The inner surface of the cylindrical shell is usually lined with an abrasion-resistant material such as manganese steel or rubber. Less wear takes place in rubber lined mills. The length of the mill is approximately equal to its diameter.

The general idea behind the ball mill is an ancient one, but it was not until the industrial revolution and the invention of steam power that an effective ball milling machine could be built. It is reported to have been used for grinding flint for pottery in 1870.

The ball mill is used for grinding materials such as coal, pigments, and feldspar for pottery. Grinding can be carried out either wet or dry but the former is performed at low speed. Blending of explosives is an example of an application for rubber balls. For systems with multiple components, ball milling has been shown to be effective in

increasing solid-statechemical reactivity. Additionally, ball milling has been shown effective for production of amorphous materials.

VII Diagram:

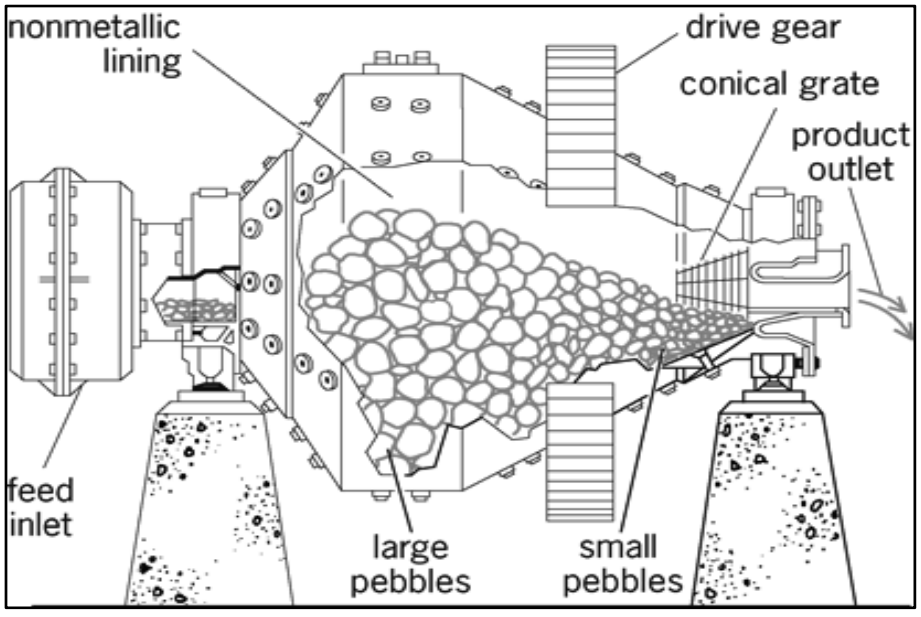

Fig: Ball Mill

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ball Mill		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that mill will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Weigh the known amount of sample for milling.
2. Find the diameter of ball mill and balls used in mill.
3. After weighing the given sample, it is fed into the ball mill by opening lid of the mill and then pack the lid.
4. Run the mill for 10 min.
5. After 10 mins stop the mill and remove the materials from ball mill.
6. Material is screened in screening equipment.
7. Note down the weight of material which retains on each screen.
8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Radius of Mill (R) = ……cm

b. Radius of Ball (E) =……cm

ObservationTable

Sr No:	Mesh No:	Screen opening in microns/mm	Avg Particle size (D_{piavg})	Mean residence time – 10minutes			
				Weight retained	Weight fraction (x_i)	$\frac{x_i}{D_{p\,avg}}$	$\overline{D_s}$
				$\sum \frac{x_i}{D_{p\,avg}} =$			

Sample calculation

1. Average particle size ($D_{pi\ avg}$) =

2. Weight fraction (x_i) = weight retained on the screen = Total weight of the mixture

3. $\frac{x_i}{Dp_{i,avg}} =$

4. $\overline{D_s}$ for 10 minutes = Volume surface mean diameter(This represents the average diameter of particle in the given sample)

$$= \frac{1}{\Sigma\left(\frac{x_i}{Dp_{i\ avg}}\right)}$$

XV Results

a. Average particle size after 10 min grinding = …….gms
b. Critical speed of ball mill (N_c) = r.p.s.

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term centrifuging and critical speed.
2. When the feed rate of material increases then what is the effect on grinding operation?
3. State the forces acting on the ball in ball mill.
4. Sate the advantages of ball mill.
5. Write application of ball mill in industry.

(Space for Answer)

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XIX References / Suggestions for Further Reading

1. *www.fab3r.com/ball-mill*
2. *pharmapproach.com/ball-mill/*
3. *https://www.youtube.com/watch?v=tL21JCLG9s8*
4. *https://www.youtube.com/watch?v=LHygXfdsPqU*

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.6: Use Ball mill to find average particle size by changing the residence time of material. (Part – II)

I Practical Significance

Big size particle are available as raw material for many process industry. Size reduction of this particle in necessary for processing. Ball mill available in many process industries for size reduction, which reduced big size particle to different particle size. By performing this practical, students will able to find average size of particle obtained from ball mill.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use basic principles of electrical engineering in different applications'***:

1. Identify ball mill for required size reduction.
2. Interpret given ball mill. .

IV Relevant Course Outcome(s)

Use size reduction equipment in chemical process industry.

V Practical Outcome

- Calculate average particle size obtained from ball mill.

VI Minimum Theoretical Background

A ball mill is a type of grinder used to grind and blend materials for use in mineral dressing processes, paints, pyrotechnics, ceramics and selective laser sintering. It works on the principle of impact and attrition: size reduction is done by impact as the balls drop from near the top of the shell.

A ball mill consists of a hollow cylindrical shell rotating about its axis. The axis of the shell may be either horizontal or at a small angle to the horizontal. It is partially filled with balls. The grinding media is the balls, which may be made of steel (chrome steel), stainless steel, ceramic, or rubber. The inner surface of the cylindrical shell is usually lined with an abrasion-resistant material such as manganese steel or rubber. Less wear takes place in rubber lined mills. The length of the mill is approximately equal to its diameter.

The general idea behind the ball mill is an ancient one, but it was not until the industrial revolution and the invention of steam power that an effective ball milling machine could be built. It is reported to have been used for grinding flint for pottery in 1870.

The ball mill is used for grinding materials such as coal, pigments, and feldspar for pottery. Grinding can be carried out either wet or dry but the former is performed at low speed. Blending of explosives is an example of an application for rubber balls. For systems with multiple components, ball milling has been shown to be effective in

increasing solid-statechemical reactivity. Additionally, ball milling has been shown effective for production of amorphous materials.

VII Diagram:

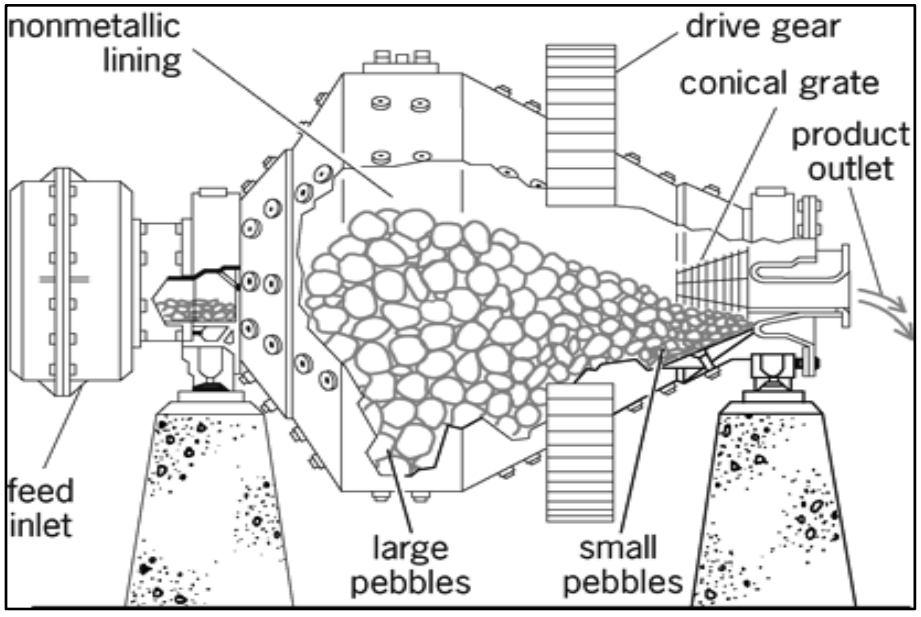

Fig: Ball Mill

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ball Mill		1 No.
2	Weighing balance		1 No.
3	A set of standard screen		1 No.
4	Lime stone, phosphate rock, bauxite etc.		

IX Precautions to be Followed

1. Feed rate is adjusted so that mill will not get blocked or choked.
2. Don't put hand or finger in to the hopper. Feed material can be dropped by using suitable container.

X Procedure

1. Weigh the known amount of sample for milling.
2. Find the diameter of ball mill and balls used in mill.
3. After weighing the given sample, it is fed into the ball mill by opening lid of the mill and then pack the lid.
4. Run the mill for 10 min.
5. After 15 mins stop the mill and remove the materials from ball mill.
6. Material is screened in screening equipment.
7. Note down the weight of material which retains on each screen.
8. From the weight fraction, calculate cumulative oversize weight fraction and cumulative undersize weight fraction.
9. After screening, collect the screened material and again feed it in to the ball mill. Grind it again for 10 min. and then screen it.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Radius of Mill (R) = ……cm
b. Radius of Ball (E) =……cm

Observation Table:

Sl No :	Mesh No:	Screen opening in microns /mm	Avg Particle size (D_{piavg})	Mean residence time – 10minutes				Mean residence time –20minutes			
				Weight retained	Weight fraction (x_i)	$\frac{x_i}{\overline{D_{p\,avg}}}$	$\overline{D_s}$	Weight retained	Weight fraction (x_i)	$\frac{x_i}{\overline{D_{p\,avg}}}$	$\overline{D_s}$
=						$\sum \frac{x_i}{D_{p\,avg}}$				$\sum \frac{x_i}{D_{p\,avg}}$ =	

Sample calculation

1. Average particle size (D_{piavg}) =

2. Weight fraction (x_i) = $\frac{\text{weight retained on the screen}}{\text{Total weight of the mixture}}$ =

3. $\frac{x_i}{Dp_{i,avg}} =$

4. $\overline{D_s}$ for 10 minutes = Volume surface mean diameter(This represents the average diameter of particle in the given sample)

$$= \frac{1}{\Sigma\left(\frac{x_i}{Dp_{i\,avg}}\right)}$$

4. $\overline{D_s}$ for 20 minutes = Volume surface mean diameter(This represents the average diameter of particle in the given sample)

XV Results

a. Average particle size after 10 min grinding = …….gms
b. Average particle size after 20 min grinding = …….gms
c. Critical speed of ball mill (N_c) = r.p.s.

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the meaning of the term centrifuging and critical speed.
2. When the feed rate of material increases then what is the effect on grinding operation?
3. State the forces acting on the ball in ball mill.
4. Sate the advantages of ball mill.
5. Write application of ball mill in industry

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *www.fab3r.com/ball-mill*
2. *pharmapproach.com/ball-mill/*
3. *https://www.youtube.com/watch?v=tL21JCLG9s8*
4. *https://www.youtube.com/watch?v=LHygXfdsPqU*

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 7: Use screen for calculation of effectiveness of screen no 3/4/5 using different size of particles. Part - I

I Practical Significance

Proper size of the particle required for processing in Chemical industry. Required size of the particle will not be obtained from crushing operations. Screening is operation in which different micron size particle obtained, necessary for given operation. By performing this experiment students will able to perform screening operation.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify screening operation for effectiveness of screen.
2. Interpret screening operation. .

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

- Calculate screen effectiveness for given materials.

VI Minimum Theoretical Background

A sieve analysis (or gradation test) is a practice or procedure used to assess the particle size distribution (also called gradation) of a granular material.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

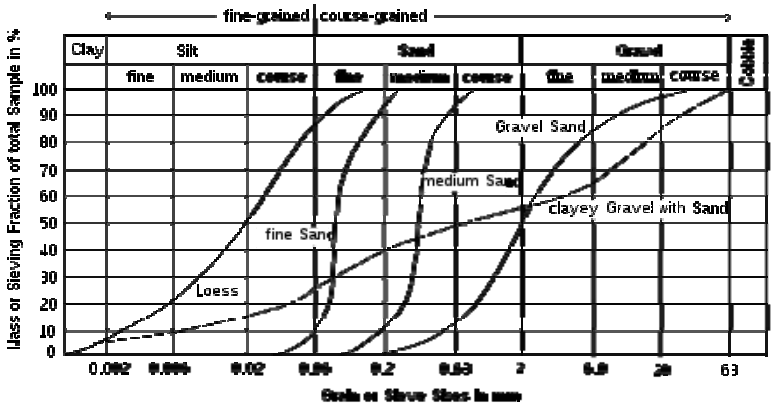
A gradation test is performed on a sample of aggregate in a laboratory. A typical sieve analysis involves a nested column of sieves with wire mesh cloth (screen). See the separate Mesh (scale) page for details of sieve sizing.

A representative weighed sample is poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan, called the receiver.

The column is typically placed in a mechanical shaker. The shaker shakes the column, usually for some fixed amount of time. After the shaking is complete the

material on each sieve is weighed. The weight of the sample of each sieve is then divided by the total weight to give a percentage retained on each sieve. The size of the average particle on each sieve is then analysed to get a cut-off point or specific size range, which is then captured on a screen.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	A set of standard screen		1 No.
2	Weighing balance		1 No.
3	Lime stone, phosphate rock, bauxite, Sand etc.		1 No.
4	Stop Watch		

IX Precautions to be Followed

1. Feed rate is adjusted so that screen will not get blocked or choked.

X Procedure

1. Take a sample feed of crushed material.
2. Then charge it to the top of set of screens.
3. Carry out screening operation for 15 min.
4. Weigh the material retained on each screen.
5. Calculate weight fraction, cumulative over size weight fraction and cumulative undersize weight fraction.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Differential Analysis

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight of sample in gms retained on screen	Weight fraction of retained material
1				
2				
3				
4				
5				
6				
7				

Cumulative Analysis:

Sr. No.	Mesh No.	Screen opening in mm/micron	Weight of sample in gms retained on screen	Weight Fraction (X_F)	Cumulative Weight Fraction oversize (X_D)	Cumulative Weight Fraction undersize (X_B)
1						
2						
3						
4						
5						
6						
7						

Calculations:

Effectiveness of screen

Screen Effectiveness based on material A = $E_A = \frac{D.\ X_D}{F.\ X_F}$

Similarly,

The screen effectiveness based on the undersize material is given B = $E_B = \frac{B.\ (1-X_B)}{F.\ (1-X_F)}$

The overall efficiency of screen $E = E_A . E_B$

Where, E is the overall efficiency of screen.

Putting the values of E_A & E_B from above equation

$$E = \frac{D.\ B.\ X_D\ (1-X_B)}{F^2.\ X_F\ (1-X_F)} =$$

From material balance the values of

$$D/F = \frac{X_F - X_B}{X_D - X_B} \qquad B/F = \frac{X_D - X_F}{X_D - X_B}$$

$$E = \frac{(X_F - X_B)\ .\ (X_D - X_F)\ .\ X_D\ \ (1 - X_B)}{(X_D - X_B)^2\ \ (1 - X_F)\ .X_F} =$$

XV Results

a. Overall effectiveness of the screen = ……..%

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XVI Interpretation of Results

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XVII Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define screen aperture, mesh number.
2. State the meaning of the term differential analysis and cumulative analysis.
3. List the factors for screening.

Space for Answers:

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.8: Use screen for calculation of effectiveness of screen no 3/4/5 using different size of particles. Part - II

I Practical Significance

Proper size of the particle required for processing in Chemical industry. Required size of the particle will not be obtained from crushing operations. Screening is operation in which different micron size particle obtained, necessary for given operation. By performing this experiment students will able to perform screening operation.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.

PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry.'**:

1. Identify screening operation for effectiveness of screen.
2. Interpret screening operation. .

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

- Calculate screen effectiveness for given materials.

VI Minimum Theoretical Background

A sieve analysis (or gradation test) is a practice or procedure used to assess the particle size distribution (also called gradation) of a granular material.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

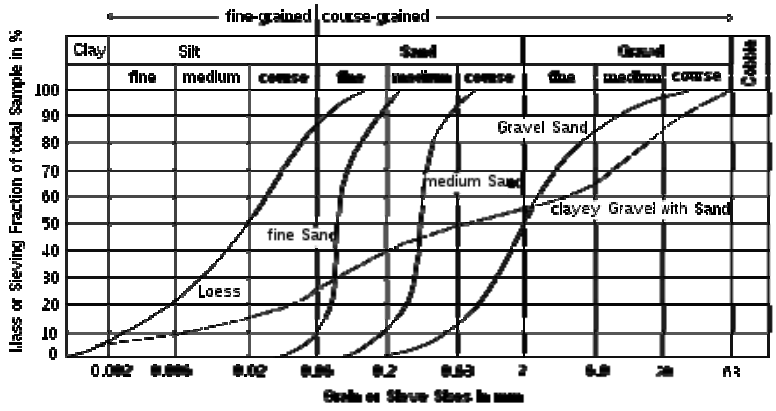
A gradation test is performed on a sample of aggregate in a laboratory. A typical sieve analysis involves a nested column of sieves with wire mesh cloth (screen). See the separate Mesh (scale) page for details of sieve sizing.

A representative weighed sample is poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan, called the receiver.

The column is typically placed in a mechanical shaker. The shaker shakes the column, usually for some fixed amount of time. After the shaking is complete the material on each sieve is weighed. The weight of the sample of each sieve is then

divided by the total weight to give a percentage retained on each sieve. The size of the average particle on each sieve is then analysed to get a cut-off point or specific size range, which is then captured on a screen.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	A set of standard screen		1 No.
2	Weighing balance		1 No.
3	Lime stone, phosphate rock, bauxite, Sand etc.		1 No.
4	Stop Watch		

IX Precautions to be Followed

1. Feed rate is adjusted so that screen will not get blocked or choked.

X Procedure

1. Weigh about 1 kg of feed.
2. Arrange the screens in the increasing order of mesh
3. Identify the screen whose efficiency is to be determined and note down its cut diameter.
4. Introduce the feed into the topmost screen and shake well for 10 minutes in the sieve shaker.
5. Weigh the particles retained on each screen.
6. Separate the cumulative overflow and cumulative underflow for the selected screen and find its weight.
7. Perform screen analysis for the overflow by using the same set of sieves .
8. Note down the weight retained on each screen.
9. Repeat steps 7 and 8 for underflow.
10. Plot the graph of screen opening in microns(mm)Vs cumulative weight fraction for feed, overflow and underflow.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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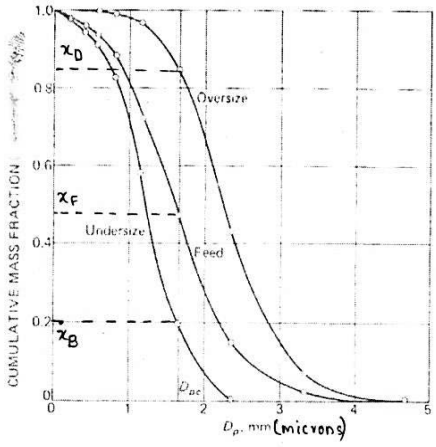
XIV Observations table

Sl No:	Mesh No:	Size of the opening in microns	Feed			Overflow			Underflow		
			Weight retained	Weight fraction	Cumulative weight fraction (oversize)	Weight retained	Weight fraction	Cumulative weight fraction (oversize)	Weight retained	Weight fraction	Cumulative weight fraction (oversize)
1											
2											
3											
4											
5											
6											
7											
8											



Sample calculation

Mesh no:

Size of the opening in microns =

Total weight of feed(F) =

Total weight of overflow(D) =

Total weight of underflow(B) =

From graph

X_D =

X_F =

X_B=

Effectiveness ofscreen = $\frac{DB\ X_D(1-X_B)}{F^2X_F(1-X_F)}$

Results

a. Overall effectiveness of the screen = ……..%

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XV Interpretation of Results

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XVI Conclusions

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Plot graph:

1. Mesh no V/s Cumulative weight fraction oversize
2. Mesh no V/s Cumulative weight fraction undersize

XVII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the significance of screening.
2. Differentiate ideal and actual screen.

Space for Answer:

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XVIII References / Suggestions for Further Reading

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 09: Determine the efficiency of Flotation cell for separation of solid in a given solid mixture. at the end of 15 minutes. (Part – I)

I Practical Significance

Separation of small size particle is necessary in chemical process industry. Special types of liquids are used for particle separation. Froth flotation is operation which is used for such separation. By performing this student's will able understand to find efficiency of Froth flotation cell.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify Froth flotation cell for separation of solid materials.
2. Interpret froth flotation cell. .

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

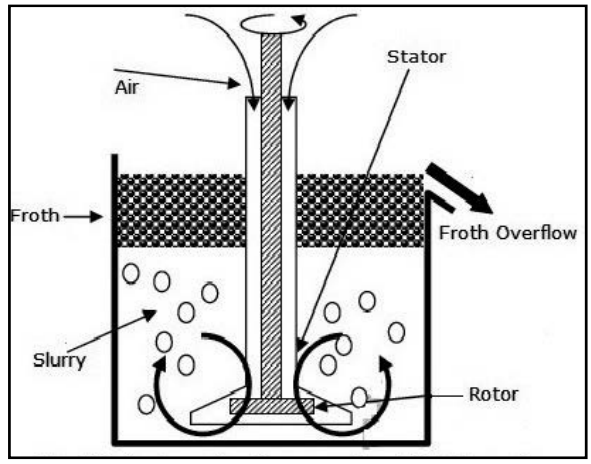
V Practical Outcome

- Calculate efficiency of froth flotation cell for given solid-solid separation.

VI Minimum Theoretical Background

Froth flotation is a process for selectively separating hydrophobic materials from hydrophilic. This is used in mineral processing, paper recycling and waste-water treatment industries. Historically this was first used in the mining industry, where it was one of the great enabling technologies of the 20th century. It has been described as "the single most important operation used for the recovery and upgrading of sulfide ores". The development of froth flotation has improved the recovery of valuable minerals, such as copper- and lead-bearing minerals. Along with mechanized mining, it has allowed the economic recovery of valuable metals from much lower grade ore than previously.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Froth Floatation Cell		1 No.
2	Compressor		1 No.
3	Frothing agent		1 No.
4	Charcoal powder		
5	Water		

IX Precautions to be Followed

1. Take precaution during handling chemicals used for flotation.
2. Collect and measure carefully solid collected in flotation.

X Procedure

1. Weigh charcoal powder.
2. Charge the floatation cell with Charcoal powder, water and frothing agent.
3. Start the compressor.
4. Agitate the liquid by bubbling air through the fed.
5. Air bubble attaches with itself light particles due to reduction in their effective density and rise to the surface liquid. These particles are collected in the overflow i.e hydrophobic particles (solids).
6. Hydrophilic particles (solids) will collect at the bottom of floatation cell as underflow.
7. Particles collected in overflow and underflow are dried and weighed.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of charcoal powder = ……..gm
b. Water taken = ……..lit
c. Pine oil = ……..drops. as a frothing agent

After floatation is completed

a. Particles (solids) collected in overflow (top) = …….gm
b. Particles (solids) collected in underflow (bottom) =……..gm

Calculations:

$$\text{Efficiency of Froth Floatation Cell} = \frac{\text{Weight of solid particles in the overflow}}{\text{Weight of solid particles charges with the feed}} \times 100$$

XV Results

Efficiency of Froth Floatation cell = ……..%

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XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define froth floatation.
2. State the operation principle of floatation cell.
3. List the factors for floatation to occur.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. https://en.wikipedia.org/wiki/Froth_flotation
2. https://www.911metallurgist.com/blog/explain-froth-flotation-process
3. www.chem.mtu.edu/chem_eng/faculty/kawatra/Flotation_Fundamentals.pdf

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 10: Determine the efficiency of Flotation cell for separation of solid in a given solid mixture at the end of 20 minutes. (Part – II)

I Practical Significance

Separation of small size particle is necessary in chemical process industry. Special types of liquids are used for particle separation. Froth flotation is operation which is used for such separation. By performing this student's will able understand to find efficiency of Froth flotation cell.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify Froth flotation cell for separation of solid materials.
2. Interpret froth flotation cell. .

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

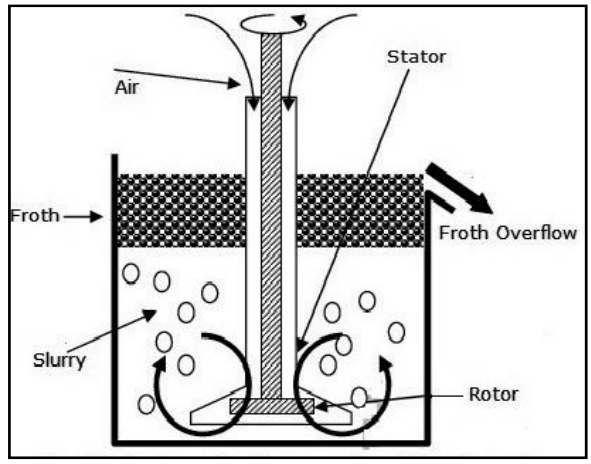
V Practical Outcome

- Calculate efficiency of froth flotation cell for given solid-solid separation.

VI Minimum Theoretical Background

Froth flotation is a process for selectively separating hydrophobic materials from hydrophilic. This is used in mineral processing, paper recycling and waste-water treatment industries. Historically this was first used in the mining industry, where it was one of the great enabling technologies of the 20th century. It has been described as "the single most important operation used for the recovery and upgrading of sulfide ores". The development of froth flotation has improved the recovery of valuable minerals, such as copper- and lead-bearing minerals. Along with mechanized mining, it has allowed the economic recovery of valuable metals from much lower grade ore than previously.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Froth Floatation Cell		1 No.
2	Compressor		1 No.
3	Frothing agent		1 No.
4	Charcoal powder		
5	Water		

IX Precautions to be Followed

1. Take precaution during handling chemicals used for flotation.
2. Collect and measure carefully solid collected in flotation.

X Procedure

1. Weigh charcoal powder.
2. Charge the floatation cell with Charcoal powder, water and frothing agent.
3. Start the compressor.
4. Agitate the liquid by bubbling air through the fed.
5. Air bubble attaches with itself light particles due to reduction in their effective density and rise to the surface liquid. These particles are collected in the overflow i.e hydrophobic particles (solids).
6. Hydrophilic particles (solids) will collect at the bottom of floatation cell as underflow.
7. Particles collected in overflow and underflow are dried and weighed.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of charcoal powder = ……..gm
b. Water taken = ……..lit
c. Pine oil = ……..drops. as a frothing agent

After floatation is completed
a. Particles (solids) collected in overflow (top) = …….gm
b. Particles (solids) collected in underflow (bottom) =……..gm

Calculations:

$$\text{Efficiency of Froth Floatation Cell} = \frac{\text{Weight of solid particles in the overflow}}{\text{Weight of solid particles charges with the feed}} \times 100$$

XV Results

Efficiency of Froth Floatation cell = ……..%
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……
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XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Name the industries in which floatation machine is used.
2. Differentiate hydrophobic and hydrophilic solids.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. https://en.wikipedia.org/wiki/Froth_flotation
2. https://www.911metallurgist.com/blog/explain-froth-flotation-process
3. www.chem.mtu.edu/chem_eng/faculty/kawatra/Flotation_Fundamentals.pdf

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the Jaw crusher and Sieve shaker	20%
2	Determination of weight fraction	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.11: Perform electromagnetic separation applying magnetic Drum separator. [Saw Dust: Iron filling = 50:50]
Part - I

I Practical Significance

Separation of solid from solid is important operation in chemical process industry. Electromagnetic separation is another process for separation of solid from solid. Efficiency of magnetic separation is more as compare to other process. By performing this operation students will able to understand process of separation by drum separator.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify given magnetic separation process for solid-solid separation.
2. Interpret magnetic drum separator..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

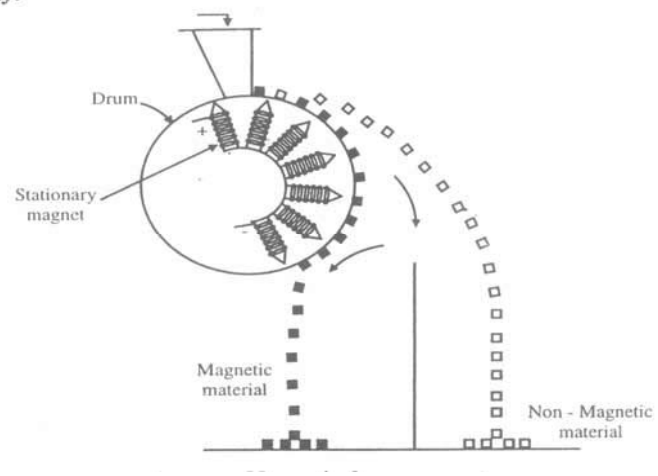
- Calculate separation efficiency of given magnetic drum separator.

VI Minimum Theoretical Background

Magnetic separation is one ways to separate heterogeneous solid mixture this is done by use of bar magnet .a bar magnet attracts object made of iron , the easiest way to separate magnetic substance from nonmagnetic substance.

Magnetic impurities are removed from their ores by magnetic separation , ex. Magnetite from quartz or magnetic contaminants or other valuable minerals from nonmagnetic values All magnetic are affected in some way when placed in magnetic field , although with most substances the effect is too slight to be detected , materials can be classified in two groups whether they are attracted or repelled diamagnetic along the lines of magnetic force to a point where the field intensity is smaller , the forces involved here are small and diamagnetic substances cannot be concentrated magnetically , paramagnetic are attracted along the lines of magnetic force to points of greater field intensity .

VII Diagram: magnetic Drum Separator



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Magnetic bar		01
2	Iron fillings		100 gm
3	Saw dust		100gm
4	Petri dish		
5	Eye goggles , nose mask		
6	Hand gloves		

IX Precautions to be Followed

1. Keep safe distance from moving parts of magnetic drum separator.
2. Carefully handle raw materials used for given separation.

X Procedure

1. Take 100 gms of saw dust and 100 gms of iron fillings
2. Mix it thoroughly so that proper mixing done
3. Feed the mixture through the hopper/inlet.
4. Allow the mixture to fall on rotary drum.
5. Collect the fractions of magnetic (Iron filling) and non magnetic (Saw Dust) in the respective bins.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Actual Procedure Followed

1. Take 100 gms of saw dust and 100 gms of iron fillings
2. Mix it thoroughly so that proper mixing done
3. Feed the mixture through the hopper/inlet.
4. Allow the mixture to fall on rotary drum.
5. Collect the fractions of magnetic (Iron filling) and non magnetic (Saw Dust) in the respective bins.

XII Precautions Followed

a. Do not drink or chew while during experiment
b. Avoid Breathening in dust particles
c. Clean area immediately after experiment

XIII Results

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XIV Interpretation of Results

Giving meaning to the results

XV Conclusions

Actions to be taken based on the interpretations.

XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. what do you mean by magnetic separation ?
2.what are different types of magnets ?
3.what is meant by paramagnetism and ferromagnetism ?

Space for Answers:

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XVII References / Suggestions for Further Reading

1. http://www.open.edu/openlearncreate
2. Htttp://eprints.nmlindia.org/59071/189-102pdf

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the apparatus	20%
2	Correct assembly of apparatus	10%
3	Choose correct material for separation	10%
4	Observation of reading	10%
5	Proper measurement	10%
6	Calculation of parameters concerned	10%
Product Related (15 Marks)		**(60%)**
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.12: Perform electromagnetic separation applying magnetic Drum separator. [Saw Dust: Iron filling = 60:40] Part – II

I Practical Significance

Separation of solid from solid is important operation in chemical process industry. Electromagnetic separation is another process for separation of solid from solid. Efficiency of magnetic separation is more as compare to other process. By performing this operation students will able to understand process of separation by drum separator.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify given magnetic separation process for solid-solid separation.
2. Interpret magnetic drum separator..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

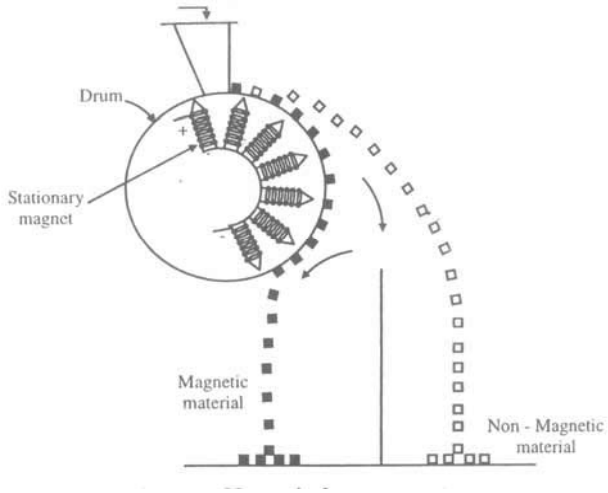
V Practical Outcome

- Calculate separation efficiency of given magnetic drum separator.

VI Minimum Theoretical Background

Magnetic separation is one ways to separate heterogeneous solid mixture this is done by use of bar magnet .a bar magnet attracts object made of iron , the easiest way to separate magnetic substance from nonmagnetic substance
Magnetic impurities are removed from their ores by magnetic separation , ex. Magnetite from quartz or magnetic contaminants or other valuable minerals from nonmagnetic values
All magnetic are affected in some way when placed in magnetic field , although with most substances the effect is too slight to be detected , materials can be classified in two groups whether they are attracted or repelled diamagnetic along the lines of magnetic force to a point wherethe field intensity is smaller , the forces involved here are small and diamagnetic substances cannot be concentrated magnetically , paramagnetic are attracted along the lines of magnetic force to points of greater field intensity .

VII Diagram: Magnetic Drum Separator



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Magnetic bar		01
2	Iron fillings		100 gm
3	Saw dust		100gm
4	Petri dish		01
5	Plastic bag wrapper		03
6	Eye goggles , nose mask		
7	Hand gloves		

IX Precautions to be Followed

1. Keep safe distance from moving parts of magnetic drum separator.
2. Carefully handle raw materials used for given separation.

X Procedure

1. Take 120 gms of saw dust and 80 gms of iron fillings
2. Mix it thoroughly so that proper mixing done
3. Feed the mixture through the hopper/inlet.
4. Allow the mixture to fall on rotary drum.
5. Collect the fractions of magnetic (Iron filling) and non magnetic (Saw Dust) in the respective bins.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XII Precautions Followed

a. Do not drink or chew while during experiment
b. Avoid Breathening in dust particles
c. Clean area immediately after experiment

XIII Results

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XIV Interpretation of Results

Giving meaning to the results

XV Conclusions

Actions to be taken based on the interpretations.

XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Enlist application of Magnetic Separation.
2. Draw neat sketch of drum Magnetic Separation.

Space for Answers:

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XVII References / Suggestions for Further Reading

1. http://www.open.edu/openlearncreate
2. Htttp://eprints.nmlindia.org/59071/189-102pdf

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the apparatus	20%
2	Correct assembly of apparatus	10%
3	Choose correct material for separation	10%
4	Observation of reading	10%
5	Proper measurement	10%
6	Calculation of parameters concerned	10%
Product Related (15 Marks)		**(60%)**
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.13: Use Grizzlies/Trommels / Vibrating Screen/Sieve Shaker for separation of given solid mixture. Part - I

I Practical Significance

Screening operation is important to handle solid mixture in process industry. After size reduction, particle size distribution requires different types of equipments. Separation efficiency calculation requires separation of different size particle. By performing this practical, students will able to understands the different types of equipments.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry.'**:

1. Identify different types separation equipments for solid separation.
2. Interpret different types of screen..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

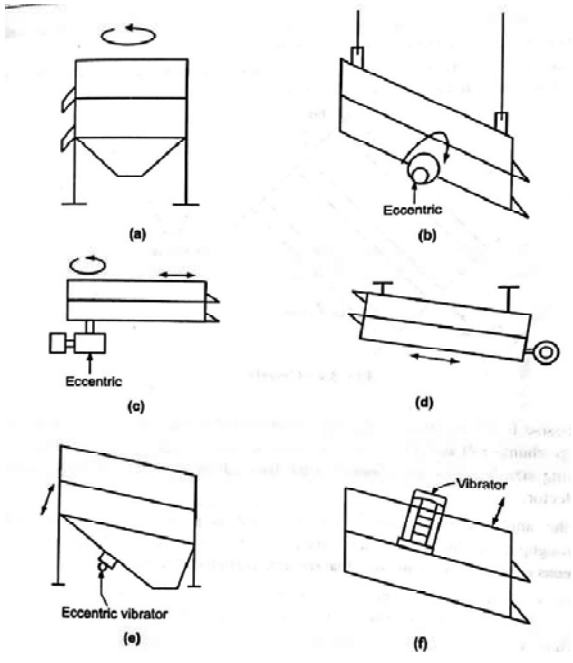
Use of Grizzlies, Trommels, Vibrating Screen for separation of solids from mixture

VI Minimum Theoretical Background

Screening Equipments can be classified on the basis of size of material as the screens may be required to pass grains ranging from several mm in diameter down to 200 mesh.

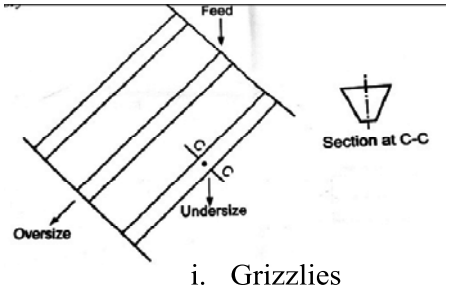
a. Grizzlies are used for the coarse screening of large lumps.
b. Trommels are generally used for fairly large particles.
c. Shaking and Vibrating screens are used in a coarse range and also for fine sizing

In screening Operation, coarse particles pass esily through the large openings ina stationary surface but

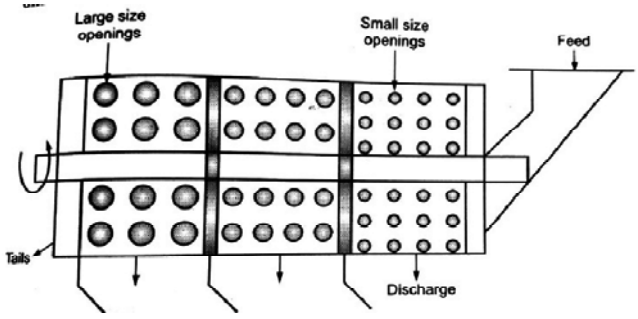


for fine particles the screen must be agitated by shaking gyrating or vibrating it mechanically or electrically. Fig, shows typical screen motions.
(a) Gyrations in horizontal plane (b) Gyrations in vertical plane (c) gyrations at one end and shaking to other (d) Shaking € Mechanically vibrated (f) Electrically vibrated.

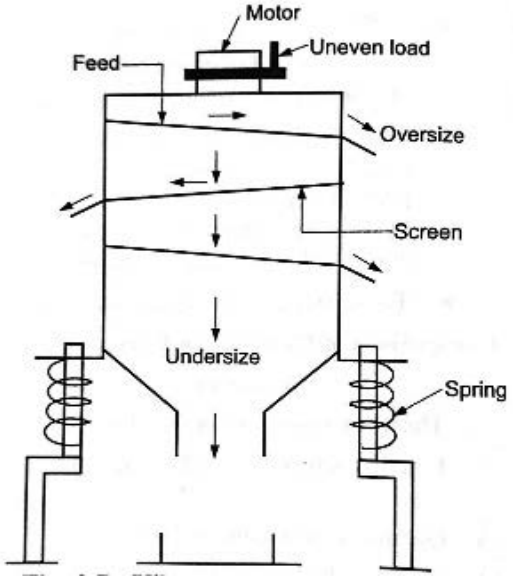
VII Circuit diagram / Setup



i. Grizzlies



(b) Trommels



(b) Vibrating Sceens

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Grizzlie		
2	Trommel		
3	Vibrating screen		
4	Sieve Shaker		

IX Precautions to be Followed

1. Keep safe distance from moving parts of screening equipment's.
2. Carefully do all electrical connections.

X Working

1. **Grizzlies:**

A coarse feed is fed at the upper end of the grizzly. Large chunks roll and slide to the lower end, whereas small lumps having size less than the opening in the bars fall through the grid into a separate collector.

If the angle of Inclination to the horizontal is greater, greater is the output but the lower is the screen efficiency. Stationary inclined woven-metal screens operate in the same way that separate particles 12 to 100mm in size.

2. **Trommels:**

The material to be screened is fed at the upper end and gradually moves down the screening surface towards the lower end. The material passes over the apertures of gradually increasing size.

If the single cylinder is provided with the screen having three different size perforations then get four fractions. The finest material is collected as the underflow in the compartment near the feed end and the oversize material is withdrawn from the discharge end. Such type of arrangement is usually used for smaller capacities. With this type of trammel, there is tendency of blockage of the apertures by the large material and the screen with the finest opening being the weakest it is subjected to the largest wear.

The opening speed of a trammel is 30 to 50% of the critical speed.

3. **Vibrating screens:**

In case of single screen, the vibrations are given to the screen to effect the separation of solid particles into two size fractions.

In case of vibrating screens, the material to be separated is fed to the top screen and simultaneously the screens are vibrated either electrically or mechanically at a frequency of 1000 to 3500 per minute. Due to vibrations the particles on the screen are kept moving and due to inclination given to the screens, the oversize material travels along the screen and is collected separately. The undersize material passes through the screen and is collected separately. The undersize material passes through the screen and is collected. Four fractions are obtained with a three deck screen.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Observation:

1) Material Used: ……

2) Weight of Sample: …….. gms.

Table:

Sr. No.	Mesh no.	Screen Opening in mm/ micron	Average particle size	Weight retained on the Screen	Weight Fraction

XV Results:

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XVI Interpretation of Results

Giving meaning to the results

XVII Conclusions

Actions to be taken based on the interpretations.

XVIII Practical Related Questions

a. Define Screening

b. Define the terms : Differential analysis & Cumulative analysis

Space for Answers:

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the screening equipments	40%
Product Related (15 Marks)		**(60%)**
2	Interpretation of result	20%
3	Conclusions	20%
4	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.14:Use Grizzlies/Trommels / Vibrating Screen/Sieve Shaker for separation of given solid mixture. (Part – II)

I Practical Significance

Screening operation is important to handle solid mixture in process industry. After size reduction, particle size distribution requires different types of equipments. Separation efficiency calculation requires separation of different size particle. By performing this practical, students will able to understands the different types of equipments.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based
Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry.'**:

1. Identify different types separation equipments for solid separation.
2. Interpret different types of screen..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

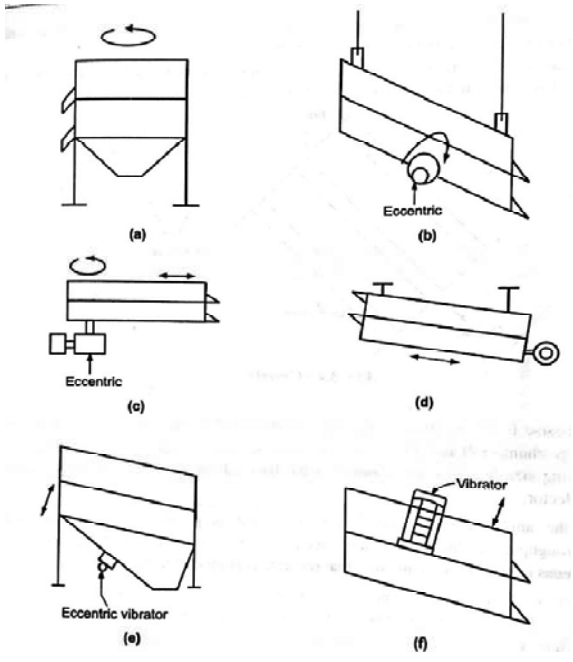
Use of Grizzlies, Trommels, Vibrating Screen for separation of solids from mixture

VI Minimum Theoretical Background

Screening Equipments can be classified on the basis of size of material as the screens may be required to pass grains ranging from several mm in diameter down to 200 mesh.

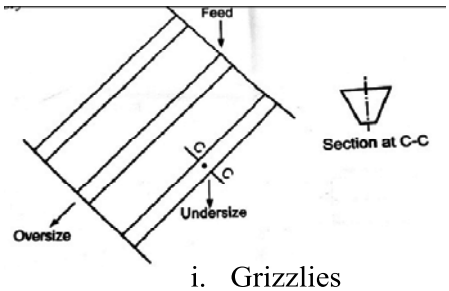
a. Grizzlies are used for the coarse screening of large lumps.
b. Trommels are generally used for fairly large particles.
c. Shaking and Vibrating screens are used in a coarse range and also for fine sizing

In screening Operation, coarse particles pass esily through the large openings ina stationary surface but

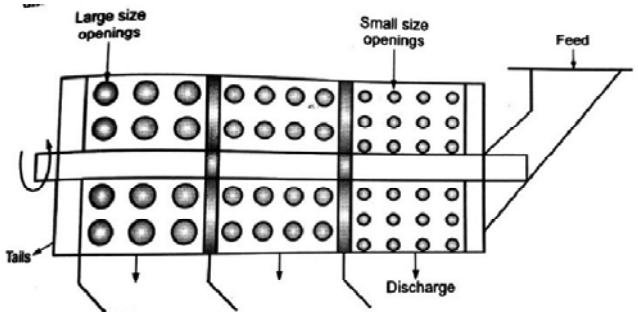


for fine particles the screen must be agitated by shaking gyrating or vibrating it mechanically or electrically. Fig, shows typical screen motions.
(a) Gyrations in horizontal plane (b) Gyrations in vertical plane (c) gyrations at one end and shaking to other (d) Shaking € Mechanically vibrated (f) Electrically vibrated.

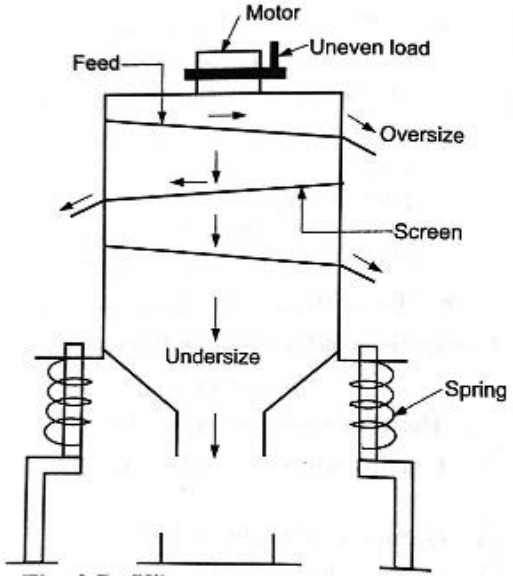
VII Circuit diagram / Setup



i. Grizzlies



(b) Trommels



(b) Vibrating Sceens

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Grizzlie		
2	Trommel		
3	Vibrating screen		
4	Sieve Shaker		

IX Precautions to be Followed

1. Keep safe distance from moving parts of screening equipment's.
2. Carefully do all electrical connections.

X Working

1. **Grizzlies:**

A coarse feed is fed at the upper end of the grizzly. Large chunks roll and slide to the lower end, whereas small lumps having size less than the opening in the bars fall through the grid into a separate collector.

If the angle of Inclination to the horizontal is greater, greater is the output but the lower is the screen efficiency. Stationary inclined woven-metal screens operate in the same way that separate particles 12 to 100mm in size.

2. **Trommels:**

The material to be screened is fed at the upper end and gradually moves down the screening surface towards the lower end. The material passes over the apertures of gradually increasing size.

If the single cylinder is provided with the screen having three different size perforations then get four fractions. The finest material is collected as the underflow in the compartment near the feed end and the oversize material is withdrawn from the discharge end. Such type of arrangement is usually used for smaller capacities. With this type of trammel, there is tendency of blockage of the apertures by the large material and the screen with the finest opening being the weakest it is subjected to the largest wear.

The opening speed of a trammel is 30 to 50% of the critical speed.

3. **Vibrating screens:**

In case of single screen, the vibrations are given to the screen to effect the separation of solid particles into two size fractions.

In case of vibrating screens, the material to be separated is fed to the top screen and simultaneously the screens are vibrated either electrically or mechanically at a frequency of 1000 to 3500 per minute. Due to vibrations the particles on the screen are kept moving and due to inclination given to the screens, the oversize material travels along the screen and is collected separately. The undersize material passes through the screen and is collected separately. The undersize material passes through the screen and is collected. Four fractions are obtained with a three deck screen.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations:

Observation:

1) Material Used: ……
2) Weight of Sample: …….. gms.

Table:

Sr. No.	Mesh no.	Screen Opening in mm/ micron	Average particle size	Weight retained on the Screen	Weight Fraction

XV Results

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XVI Interpretation of Results

Giving meaning to the results

XVII Conclusions

Actions to be taken based on the interpretations.

XVIII Practical Related Questions

a. Differentiate actual & Ideal screen

b. Compare Grizzlies with trommels

Space for Answers:

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the screening equipments	40%
Product Related (15 Marks)		**(60%)**
2	Interpretation of result	20%
3	Conclusions	20%
4	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 15: Use Plate and Frame filter press for solid liquid separation at constant Pressure to draw rate of filtration curve using slurry of 5% concentration of $CaCO_3$. (Part – I)

I Practical Significance

Separation of liquid from solid has given lot of importance in many process industries. Many processes required separation of liquid from solid at the last step of operation. Liquid or sometime solid required as a product. Drum filter, plate and frame filters are used for such operations. By performing this operations, students will able to understand filtration operation and capable to find the filtration rate curve.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types filtration equipment's used in chemical industry.
2. Interpret plate and frame filter press. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

V Practical Outcome

- Draw the filtration rate curve for given operation.

VI Minimum Theoretical Background

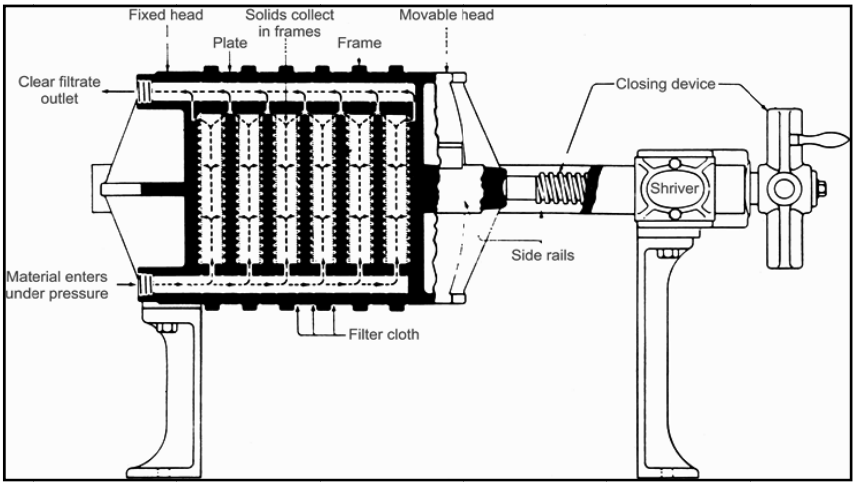
An industrial filter press is a tool used in separation processes, specifically to separate solids and liquids. The process uses the principle of pressure drive as provided by a slurry pump. Among other uses, filter presses are utilized in marble factories in order to separate water from mud in order to reuse the water during the marble cutting process.

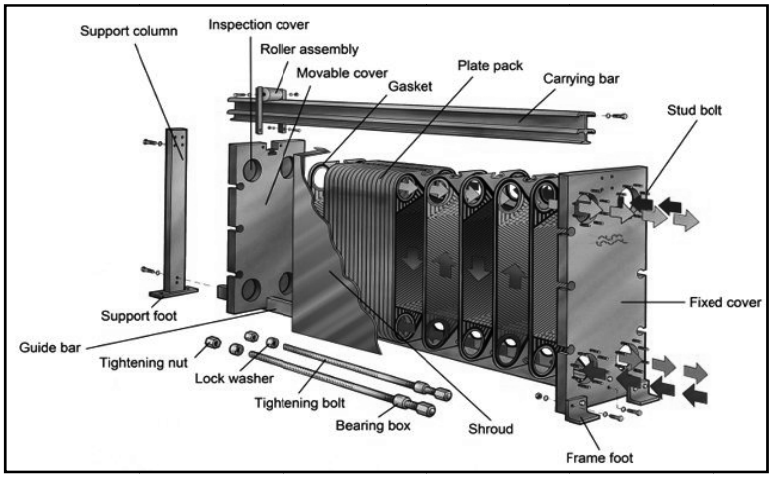
Generally, the slurry that will be separated is injected into the center of the press and each chamber of the press is filled. Optimal filling time will ensure the last chamber of the press is loaded before the mud in the first chamber begins to cake. As the chambers fill, pressure inside the system will increase due to the formation of thick sludge.[2] Then, the liquid is strained through filter cloths by force using pressurized air, but the use of water could be more cost-efficient in certain cases, such as if water was re-used from a previous process.

A plate and frame filter press is the most fundamental design, and many now refer it as a "membrane filter plate". This type of filter press consists of many plates and frames assembled alternately with the supports of a pair of rails. The presence of a centrifuge pump ensures the remaining suspended solids do not settle in the system, and its main function is to deliver the suspension into each of the separating chambers in the plate

and frame filter. For each of the individual separating chambers, there is one hollow filter frame separated from two filter plates by filter cloths. The introduced slurry flows through a port in each individual frame, and the filter cakes are accumulated in each hollow frame. As the filter cake becomes thicker, the filter resistance increases as well. So when the separating chamber is full, the filtration process is stopped as the optimum pressure difference is reached. The filtrate that passes through filter cloth is collected through collection pipes and stored in the filter tank. Filter cake (suspended solid) accumulation occurs at the hollow plate frame, then being separated at the filter plates by pulling the plate and frame filter press apart. The cakes then fall off from those plates and are discharged to the final collection point
Cake discharge can be done in many ways. For example: Shaking the plates while they are being opened or shaking the cloths. A scraper can also be used, by moving from one chamber to another and scraping the cake off the cloth. At the end of each run, the cloths are cleaned using wash liquid and are ready to start the next cycle.

VII Diagram





VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Compressor		1 No.
2	Pressure Pump		1 No.
3	Plate & Frame Filter Press		1 No.
4	Filtration cloth		
5	Weight Balance		1 No.
6	$CaCo_3$ and Water		

IX Precautions to be Followed

1. Keep safe distance from machine parts.
2. Properly handle the heavy plate and frame.
3. Carefully handle the liquids, always use hand gloves.

X Procedure

1. Prepare a slurry of 1 liter ,50 gms of $CaCo_3$ in a beaker .
2. Add the slurry in the feed tank.
3. Start the compressor and agitation.
4. Collect the filtrate from the outlet of filter press.
5. Note down the time required to collect the required volume (for example 01 liter)
6. Similarly note down the pressure during the filtration from pressure gauge ;
7. Repeat the procedure for 5 another reading.
8. Plot a graph for volume of filtrate Vs time.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of solid (CaCO3) = …….gms.
b. Volume of water = ……..liters
c. Weight of wet cake = ……gms.
d. Volume of filtrate collected = ……ltrs

Observation Table:

Sr. No.	Volume of filtrate collected Vcm3	Time, t sec	Rate of Filtration (V/t)

Graph of Rate Filtration (cm^3/sec) v/s Time (Sec)

XV Results

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XV Interpretation of Results

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XVI Conclusions

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XVII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define filtration.
2. Describe process of preparing slurry of different concentration.
3. List advantages and disadvantages of plate and frame filter press.
4. List methods of filtration.

Space for Answers:

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XVIII References / Suggestions for Further Reading

1. www.filter-press.cn/Filter_Press/Plate_&_Frame
2. https://en.wikipedia.org/wiki/Filter_press
3. https://www.youtube.com/watch?v=xOPVJ33g1BQ

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 16: Use Plate and Frame filter press for solid liquid separation at constant Pressure to draw rate of filtration curve using slurry of 10 % concentration of $CaCO_3$. Part – II

I Practical Significance

Separation of liquid from solid has given lot of importance in many process industries. Many processes required separation of liquid from solid at the last step of operation. Liquid or sometime solid required as a product. Drum filter, plate and frame filters are used for such operations. By performing this operations, students will able to understand filtration operation and capable to find the filtration rate curve.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types filtration equipment's used in chemical industry.
2. Interpret plate and frame filter press. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

V Practical Outcome

- Draw the filtration rate curve for given operation.

VI Minimum Theoretical Background

An industrial filter press is a tool used in separation processes, specifically to separate solids and liquids. The process uses the principle of pressure drive as provided by a slurry pump. Among other uses, filter presses are utilized in marble factories in order to separate water from mud in order to reuse the water during the marble cutting process.

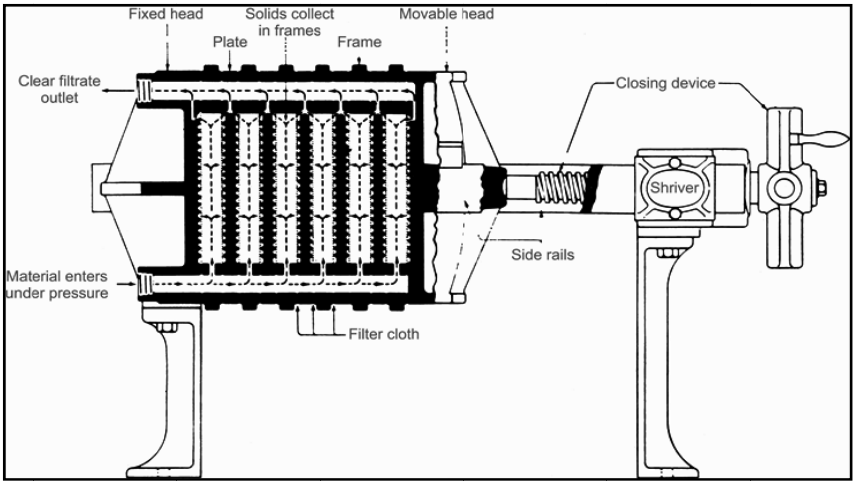
Generally, the slurry that will be separated is injected into the center of the press and each chamber of the press is filled. Optimal filling time will ensure the last chamber of the press is loaded before the mud in the first chamber begins to cake. As the chambers fill, pressure inside the system will increase due to the formation of thick sludge.[2] Then, the liquid is strained through filter cloths by force using pressurized air, but the use of water could be more cost-efficient in certain cases, such as if water was re-used from a previous process.

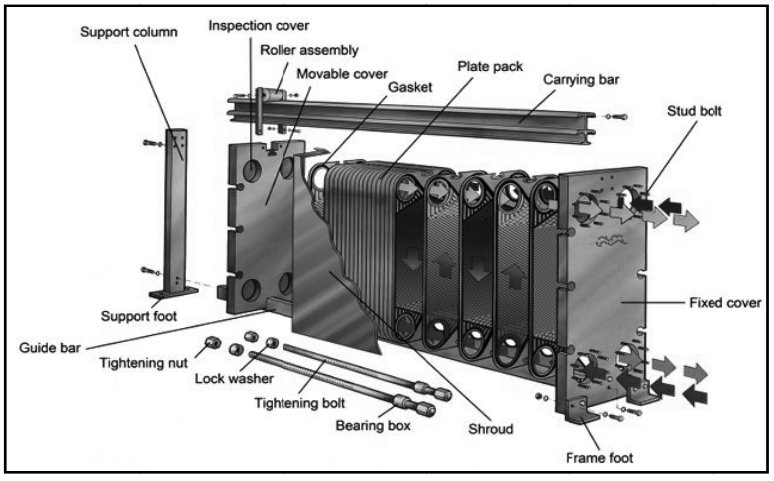
A plate and frame filter press is the most fundamental design, and many now refer it as a "membrane filter plate". This type of filter press consists of many plates and frames assembled alternately with the supports of a pair of rails. The presence of a centrifuge pump ensures the remaining suspended solids do not settle in the system, and its main function is to deliver the suspension into each of the separating chambers in the plate

and frame filter. For each of the individual separating chambers, there is one hollow filter frame separated from two filter plates by filter cloths. The introduced slurry flows through a port in each individual frame, and the filter cakes are accumulated in each hollow frame. As the filter cake becomes thicker, the filter resistance increases as well. So when the separating chamber is full, the filtration process is stopped as the optimum pressure difference is reached. The filtrate that passes through filter cloth is collected through collection pipes and stored in the filter tank. Filter cake (suspended solid) accumulation occurs at the hollow plate frame, then being separated at the filter plates by pulling the plate and frame filter press apart. The cakes then fall off from those plates and are discharged to the final collection point

Cake discharge can be done in many ways. For example: Shaking the plates while they are being opened or shaking the cloths. A scraper can also be used, by moving from one chamber to another and scraping the cake off the cloth. At the end of each run, the cloths are cleaned using wash liquid and are ready to start the next cycle.

VII Diagram





VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Compressor		1 No.
2	Pressure Pump		1 No.
3	Plate & Frame Filter Press		1 No.
4	Filtration cloth		
5	Weight Balance		
6	$CaCO_3$ and Water		

IX Precautions to be Followed

1. Keep safe distance from machine parts.
2. Properly handle the heavy plate and frame.
3. Carefully handle the liquids, always use hand gloves.

X Procedure

1. Prepare a slurry of 1 liter ,50 gms of $CaCO_3$ in a beaker .
2. Add the slurry in the feed tank.
3. Start the compressor and agitation.
4. Collect the filtrate from the outlet of filter press.
5. Note down the time required to collect the required volume (for example 01 liter).
6. Similarly note down the pressure during the filtration from pressure gauge .
7. Repeat the procedure for 5 another reading.
8. Plot a graph for volume of filtrate Vs time.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of solid ($CaCO_3$) = …….gms
b. Volume of water = ……..liters
c. Weight of wet cake = ……gms
d. Volume of filtrate collected = ……ltrs

XV Observation Table:

Sr. No.	Volume of filtrate collected V cm^3	Time, t sec	Rate of Filtration (V/t)

Graph of Rate Filtration (cm^3/sec) v/s Time (Sec)

XV Results

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XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State principle of filtration.
2. State the factors affecting the rate of filtration.
3. List the characteristics of the filter medium.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. www.filter-press.cn/Filter_Press/Plate_&_Frame
2. https://en.wikipedia.org/wiki/Filter_press
3. https://www.youtube.com/watch?v=xOPVJ33g1BQ

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.17: Use Centrifuge for calculation of percentage of solids recovered from given slurry (10%concentration) using basket centrifuge. (Part – I)

I Practical Significance

Recovery of solids plays an important role in separation processes. It needs to be removed from the process. It increase the cost of operation also has adverse effect on the equipment's. In some process, small water content also not tolerable. Centrifugal action, gives better separation. By performing this experiment, students will able to conduct the sedimentation by centrifuge and calculate the percentage solid recovery.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-liquid separation.
2. Interpret centrifuge for sedimentation test..

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

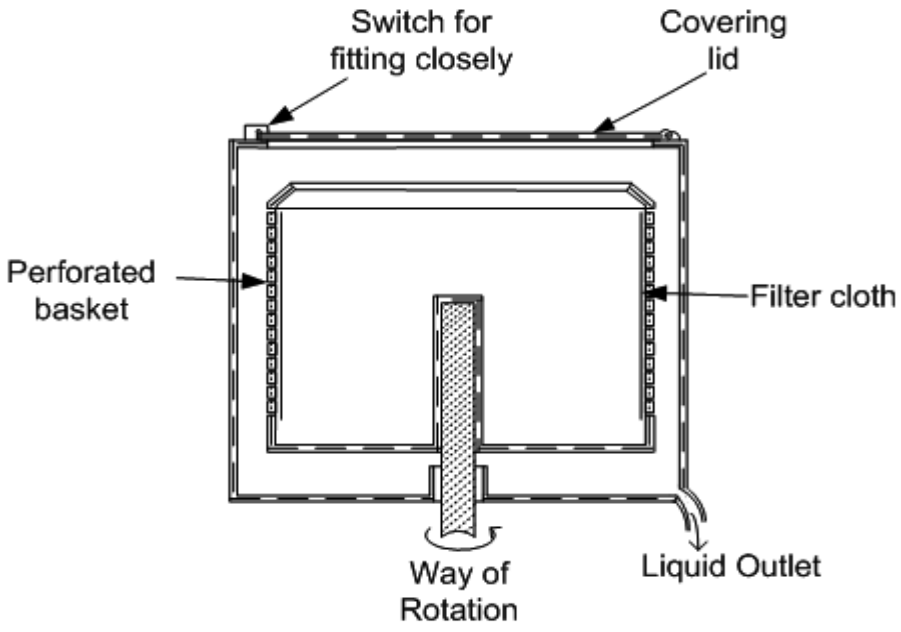
V Practical Outcome

- Calculate percentage recovery of solids by centrifuge.

VI Minimum Theoretical Background

Basket centrifuges are often called centrifugal filters or clarifiers. They have a perforated wall and cylindrical tubular rotor. In many cases the outer wall of a basket centrifuge consists of a fine mesh screen or a series of screens with the finer mesh screens supported by the heavier coarse screen, which in turn is supported by the bowl. The liquid passes through the screen, and the particles too large to pass through the screen are deposited. The basket centrifuge is employed in the manufacture of cane sugar, in the home and in laundries for the rapid drying of clothes, and in the washing and drying of many kinds of crystals and fibrous materials, etc.

VII Diagram of basket centrifuge



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Basket centrifuge		1
2	Three phase supply		1
3	Chemicals : water and lime		5 l & 2 kg respectively

IX Precautions to be Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

X Procedure

1. Prepare the slurry of calcium carbonate in water of 10 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for known time
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

1. Prepare the slurry of calcium carbonate in water of 10 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for known time
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. off the supply.

Precautions Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

XII Observations and Calculations

S.N.	Weight of calcium carbonate (gm)	Water taken	Cake deposited on filter medium	Filtrate collected
1				

percentage of solids recovered = (weight of solids deposited on filter medium /weight of solids initially in feed) x 100

XIII Results

Percentage of solids recovered**:…… %**

XIV Interpretation of Results

percentage of solids recovered **:**
as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium
Conclusions as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is meant by centrifugal filtration
2. List out various factors on which centrifugal action depend
3. In industry which type of equipment is used for centrifugal action
4. When concentration of slurry change then what is effect on rate of filtration

Space for Answers:

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XVI References / Suggestions for Further Reading

XVII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.18: Use Centrifuge for calculation of percentage of solids recovered from given slurry (15 %concentration) using basket centrifuge. (Part – II)

I Practical Significance

Recovery of solids plays an important role in separation processes. It needs to be removed from the process. It increase the cost of operation also has adverse effect on the equipment's. In some process, small water content also not tolerable. Centrifugal action, gives better separation. By performing this experiment, students will able to conduct the sedimentation by centrifuge and calculate the percentage solid recovery.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-liquid separation.
2. Interpret centrifuge for sedimentation test..

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

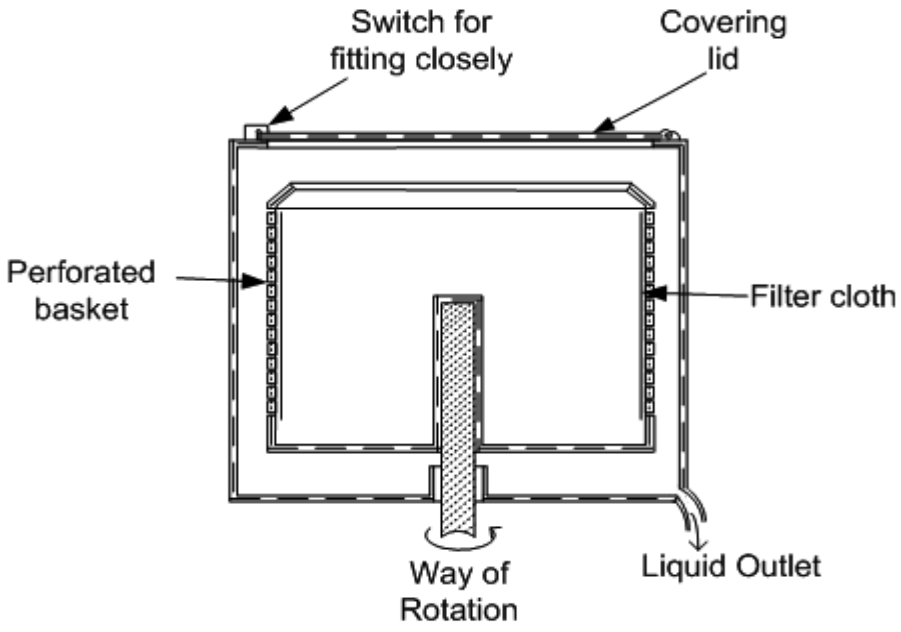
V Practical Outcome

- Calculate percentage recovery of solids by centrifuge.

VI Minimum Theoretical Background

Basket centrifuges are often called centrifugal filters or clarifiers. They have a perforated wall and cylindrical tubular rotor. In many cases the outer wall of a basket centrifuge consists of a fine mesh screen or a series of screens with the finer mesh screens supported by the heavier coarse screen, which in turn is supported by the bowl. The liquid passes through the screen, and the particles too large to pass through the screen are deposited. The basket centrifuge is employed in the manufacture of cane sugar, in the home and in laundries for the rapid drying of clothes, and in the washing and drying of many kinds of crystals and fibrous materials, etc.

VII Diagram of basket centrifuge



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Basket centrifuge		1
2	Three phase supply		1
3	Chemicals : water and lime		5 l & 2 kg respectively

IX Precautions to be Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

X Procedure

1. Prepare the slurry of calcium carbonate in water of 15 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for known time
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

1. Prepare the slurry of calcium carbonate in water of 15 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run th basket centrifuge for known time
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. Off the supply.

Precautions Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

XII Observations and Calculations

S.N.	Weight of calcium carbonate (gm)	Water taken	Cake deposited on filter medium	Filtrate collected
1				

percentage of solids recovered = (weight of solids deposited on filter medium /weight of solids initially in feed) x 100

XIII Results

percentage of solids recovered **:…… %**

XIV Interpretation of Results

percentage of solids recovered **:**
as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

Conclusions as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. How to wash the cake in centrifuge
2. What is the material of construction of centrifuge
3. Write classification of centrifuge

Space for Answers:

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XVI References / Suggestions for Further Reading

XVII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 19: Use vacuum filter for determination of the rate of filtration for solid liquid mixture for 5 % Concentration slurry. Part - I

I Practical Significance

Vacuum filtration plays an important role in filtration. Rate of filtration was higher for vacuum filtration. Many chemical industries go for vacuum filtration instead of pressure filtration. By performing this experiment students will able to find rate of filtration for vacuum.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types of filtration equipments using vacuum.
2. Interpret vacuum filtration. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

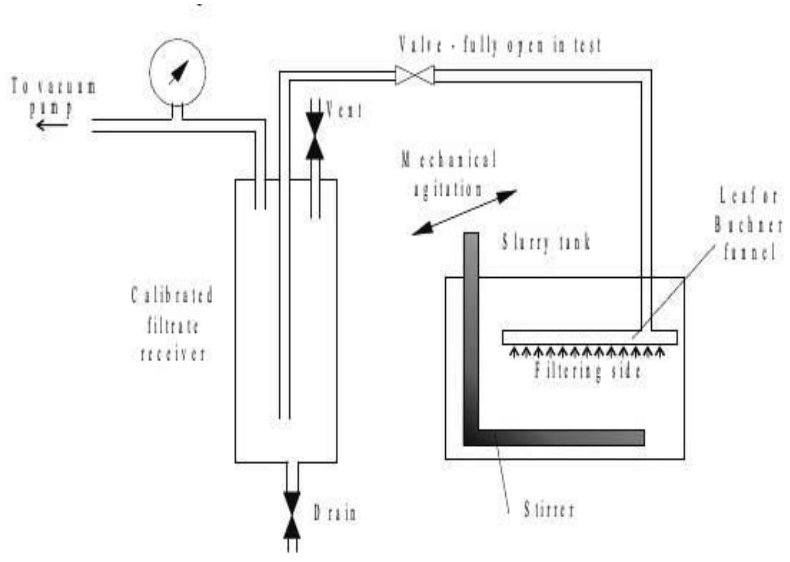
V Practical Outcome

- Calculate rate of filtration for vacuum filtration.

VI Minimum Theoretical Background

Vacuum filtration is a chemistry laboratory technique which allows for a greater rate of **filtration**. Whereas in normal **filtration** gravity provides the force which draws the liquid through the **filter** paper, in **Vacuum filtration** a pressure gradient performs this function.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Vacuum Filtration Unit		1 No.
2	Stop Watch		1 No.
3	CaCO3 slurry		1 No.
4	Measuring Cylinder		
5	Weighing Balance		
6	Oven		

IX Precautions to be Followed

1. Keep safe distance from vacuum creating equipment's.
2. Always use hand gloves.

Procedure

1. Prepare $CaCO_3$/dolomite slurry of known concentration 5 % by weight in a given tank. The volume of slurry should be such that the leaf assembly must be immersed in the slurry.
2. Keep valve V_1 and V_2 closed as shown in the diagram. Keep valve V_3 closed throughout the experiment. Apply vacuum at a definite pressure.
3. Open valve V_4 and adjust the vacuum by operating the valve V_2.
4. Note the time for rise in level of filtrate (through level gauge).
5. Note the readings in the observation table below.
6. Plot the graph of rate of filtration v/s time for the given concentration.
7. Repeat the procedure for different concentration of slurry.

OR

1. Clamp the flask securely to a ring stand.
2. Add the Buchner funnel with a rubber funnel adaptor.
3. Take a piece of filter paper in the funnel.
4. Connect the side arm of flask to a vacuum pump.
5. Wet the paper with the small amount of solution.
6. Turn on the vacuum pump.
7. Pour continuously the mixture which is to be filtered onto the filter paper.
8. Measure the height of filtrate in the flask after a specific time interval.

X Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XI Actual Procedure Followed

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XII Precautions Followed

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Observations and Calculations

a. Feed concentration = ---------- gm/lit

Sr. No.	Time t sec	Filtrate collected,V ml	dV = V_2-V_1	dt= t_2-t_1	Rate of Filtration, dV/dt
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

XIII Results

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XIV Interpretation of Results

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XV Conclusions

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XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What are the factors effecting the rate of filtration?
2. Explain principle of filtration.
3. What is meant by filter aid?

Space for Answers:

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XVII References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 20: Use vacuum filter for determination of the rate of filtration for solid liquid mixture for 10 % Concentration slurry. Part - II

I Practical Significance

Vacuum filtration plays an important role in filtration. Rate of filtration was higher for vacuum filtration. Many chemical industries go for vacuum filtration instead of pressure filtration. By performing this experiment students will able to find rate of filtration for vacuum.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types of filtration equipments using vacuum.
2. Interpret vacuum filtration. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

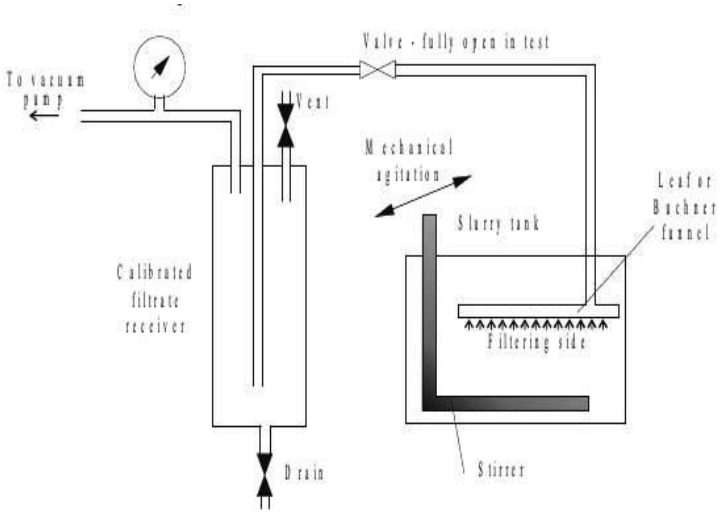
V Practical Outcome

- Calculate rate of filtration for vacuum filtration.

VI Minimum Theoretical Background

Vacuum filtration is a chemistry laboratory technique which allows for a greater rate of **filtration**. Whereas in normal **filtration** gravity provides the force which draws the liquid through the **filter** paper, in **Vacuum filtration** a pressure gradient performs this function**.**

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Vacuum Filtration Unit		1 No.
2	Stop Watch		1 No.
3	CaCO3 slurry		1 No.
4	Measuring Cylinder		
5	Weighing Balance		
6	Oven		

IX Precautions to be Followed

1. Keep safe distance from vacuum creating equipment's.
2. Always use hand gloves.

X Procedure

1. Prepare $CaCO_3$/dolomite slurry of known concentration (5 or 10 %) by weight in a given tank. The volume of slurry should be such that the leaf assembly must be immersed in the slurry.
2. Keep valve V_1 and V_2 closed as shown in the diagram.Keep valve V_3 closed throughout the experiment. Apply vacuum at a definite pressure.
3. Open valve V_4 and adjust the vacuum by operating the valve V_2.
4. Note the time for rise in level of filtrate (through level gauge).
5. Note the readings in the observation table below.
6. Plot the graph of rate of filtration v/s time for the given concentration.
7. Repeat the procedure for different concentration of slurry.

OR

1. Clamp the flask securely to a ring stand.
2. Add the Buchner funnel with a rubber funnel adaptor.
3. Take a piece of filter paper in the funnel.
4. Connect the side arm of flask to a vacuum pump.
5. Wet the paper with the small amount of solution.
6. Turn on the vacuum pump.
7. Pour continuously the mixture which is to be filtered onto the filter paper.
8. Measure the height of filtrate in the flask after a specific time interval.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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Observations and Calculations

a. Feed concentration = ---------- gm/lit

Sr. No.	Time t sec	Filtrate collected,V ml	dV = V_2-V_1	dt= t_2-t_1	Rate of Filtration, dV/dt
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

XIV Results

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XV Interpretation of Results

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XVI Conclusions

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XVII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw neat diagram of Washing Press.

2. How washing of cake is done ?

Space for Answers:

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XVIII References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the filter press	20%
2	Handling of the compressor for air	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 21: Determine terminal settling velocity for different concentration [5 %] of calcium carbonate slurry using batch sedimentation test. Part - I

I Practical Significance

Separation of solids from slurry has significant importance in chemical process industries. Many small and big industries have its technology for separation in Chemical process industries. For finding the rate of solid separation. Calculation of terminal settling velocity gives important information about the sedimentation process. By performing this experiment, students will able to calculate the terminal settling velocity, by performing the sedimentation test.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use basic principles of electrical engineering in different applications'***:

1. Identify different types sedimentation operations.
2. Interpret sedimentation test. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations

V Practical Outcome

- Calculate terminal settling velocity for sedimentation test.

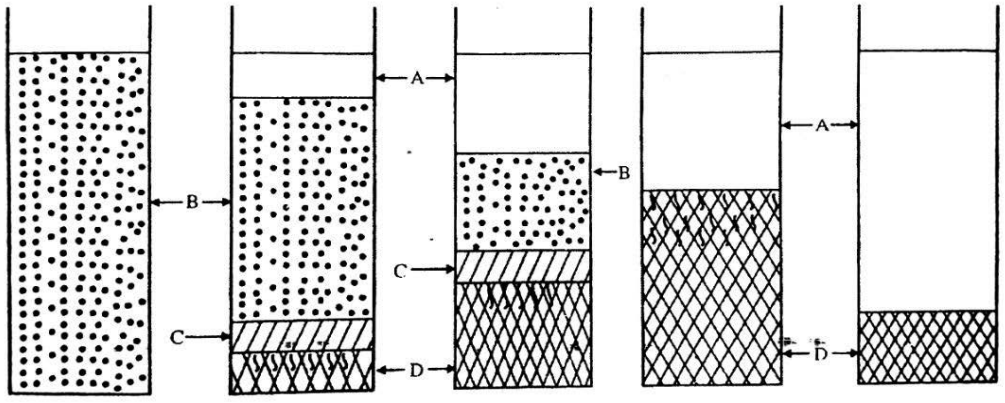
VI Minimum Theoretical Background

Sedimentation is the tendency for particles in suspension to settle out of the fluid in which they are entrained and come to rest against a barrier. This is due to their motion through the fluid in response to the forces acting on them: these forces can be due to gravity, centrifugal acceleration, or electromagnetism. Settling is the falling of suspended particles through the liquid, whereas sedimentation is the termination of the settling process.

Sedimentation may pertain to objects of various sizes, ranging from large rocks in flowing water to suspensions of dust and pollen particles to cellular suspensions to solutions of single molecules such as proteins and peptides. Even small molecules supply a sufficiently strong force to produce significant sedimentation.

During batch sedimentation, a suspension of particles is allowed to stand in a settling tank (or column). Usually, the tank is vertical to correspond to the traditional vertical settling tanks used in much many industrial applications.

VII Diagram



A – Clear Liquid ; B – Uniform Concentration C – Non uniform Concentration
D – Heavier Faster Settling Particles

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Measuring Cylinder		1 No.
2	Weighing balance		1 No.
3	$CaCO_3$ & $KmNO_4$		1 No.
4	Water, stirrer		

IX Precautions to be Followed

1. Carefully stir the solid in liquid.
2. Take reading carefully, as particle settle quickly.

X Procedure

1. Fill the jar with water and calcium carbonate/ dolomite.
2. Stir for about 15 min with the help of agitator.
3. Start the stop watch after stirring is stopped. (No vortex formation should take place).
4. Note the height of inter-phase as initial height of slurry.
5. For each unit cm drop in height of slurry. Note the time required.
6. Repeat the procedure till there is no change in height of the slurry.
7. Plot the graph of interface height v/s time.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of calcium carbonate ----------gm.
b. Volume of water ----------lit.

Sr. No.	Height of Interface,cm	Time,sec	Settling velocity, (cm/sec)
1			
2			
3			
4			
5			
6			
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XV Results

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XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Interpret interface height v/s time graph related to sedimentation.
2. How various zones are formed during sedimentation?
3. State the principles used while performing this experiment.

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 22: Determine terminal settling velocity for different concentration[6 %] of calcium carbonate slurry using batch sedimentation test. Part - II

I Practical Significance

Separation of solids from slurry has significant importance in chemical process industries. Many small and big industries have its technology for separation in Chemical process industries. For finding the rate of solid separation. Calculation of terminal settling velocity gives important information about the sedimentation process. By performing this experiment, students will able to calculate the terminal settling velocity, by performing the sedimentation test.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use basic principles of electrical engineering in different applications'***:

1. Identify different types sedimentation operations.
2. Interpret sedimentation test. .

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations

V Practical Outcome

- Calculate terminal settling velocity for sedimentation test.

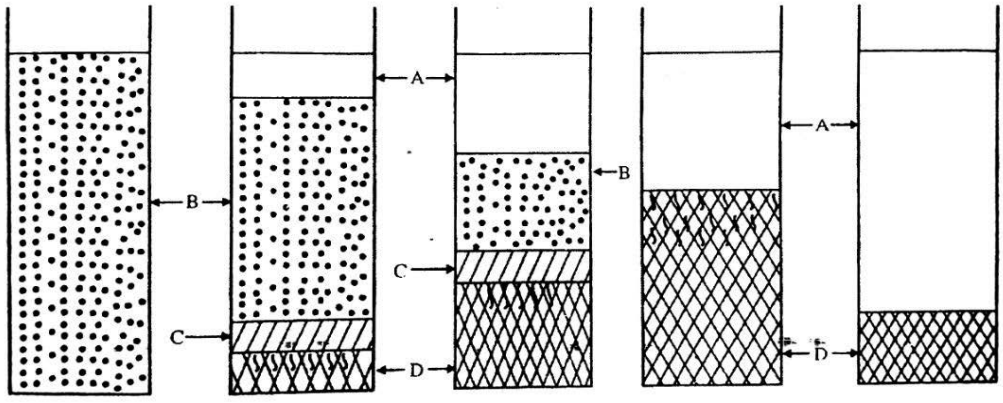
VI Minimum Theoretical Background

Sedimentation is the tendency for particles in suspension to settle out of the fluid in which they are entrained and come to rest against a barrier. This is due to their motion through the fluid in response to the forces acting on them: these forces can be due to gravity, centrifugal acceleration, or electromagnetism. Settling is the falling of suspended particles through the liquid, whereas sedimentation is the termination of the settling process.

Sedimentation may pertain to objects of various sizes, ranging from large rocks in flowing water to suspensions of dust and pollen particles to cellular suspensions to solutions of single molecules such as proteins and peptides. Even small molecules supply a sufficiently strong force to produce significant sedimentation.

During batch sedimentation, a suspension of particles is allowed to stand in a settling tank (or column). Usually, the tank is vertical to correspond to the traditional vertical settling tanks used in much many industrial applications.

VII Diagram



A – Clear Liquid ; B – Uniform Concentration C – Non uniform Concentration
D – Heavier Faster Settling Particles

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Measuring Cylinder		1 No.
2	Weighing balance		1 No.
3	$CaCO_3$ & $KmNO_4$		1 No.
4	Water, stirrer		

IX Precautions to be Followed

1. Carefully stir the solid in liquid.
2. Take reading carefully, as particle settle quickly.

X Procedure

1. Fill the jar with water and calcium carbonate/ dolomite.
2. Stir for about 15 min with the help of agitator.
3. Start the stop watch after stirring is stopped. (No vortex formation should take place).
4. Note the height of inter-phase as initial height of slurry.
5. For each unit cm drop in height of slurry. Note the time required.
6. Repeat the procedure till there is no change in height of the slurry.
7. Plot the graph of interface height v/s time.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

a. Weight of calcium carbonate ----------gm.
b. Volume of water ----------lit.

Sr. No.	Height of Interface,cm	Time,sec	Settling velocity, (cm/sec)
1			
2			
3			
4			
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XV Results

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XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the Principal of operation in sedimentation.
2. Explain the concepts of Free settling and Hindered settling
3. Differentiate between sedimentation and Filtration

Space for Answers:

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XIX References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.23: Use Centrifuge for calculation of percentage of solids recovered from given slurry using basket centrifuge. Part - I

I Practical Significance

Recovery of solids plays an important role in separation processes. It needs to be removed from the process. It increase the cost of operation also has adverse effect on the equipment's. In some process, small water content also not tolerable. Centrifugal action, gives better separation. By performing this experiment, students will able to conduct the sedimentation by centrifuge and calculate the percentage solid recovery.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-liquid separation.
2. Interpret centrifuge for sedimentation test..

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

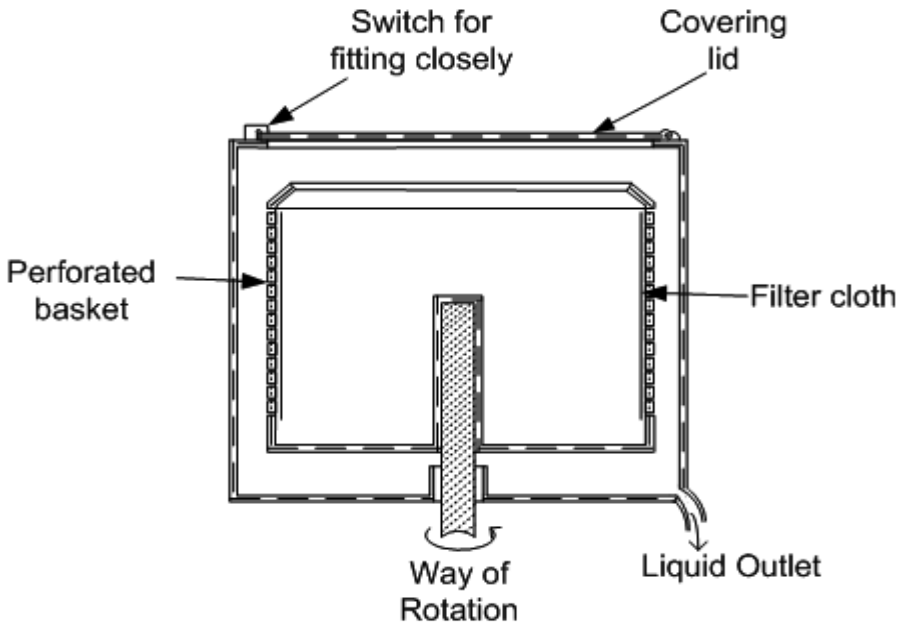
V Practical Outcome

- Calculate percentage recovery of solids by centrifuge.

VI Minimum Theoretical Background

Basket centrifuges are often called centrifugal filters or clarifiers. They have a perforated wall and cylindrical tubular rotor. In many cases the outer wall of a basket centrifuge consists of a fine mesh screen or a series of screens with the finer mesh screens supported by the heavier coarse screen, which in turn is supported by the bowl. The liquid passes through the screen, and the particles too large to pass through the screen are deposited. The basket centrifuge is employed in the manufacture of cane sugar, in the home and in laundries for the rapid drying of clothes, and in the washing and drying of many kinds of crystals and fibrous materials, etc.

VII Diagram of basket centrifuge



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Basket centrifuge		1
2	Three phase supply		1
3	Chemicals : water and lime		1 & 2 kg respectively

IX Precautions to be Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

X Procedure

1. Prepare the slurry of calcium carbonate in water of 10 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for 07 min.
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

1. Prepare the slurry of calcium carbonate in water of 10 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for 07 min.
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. off the supply.

Precautions Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

XII Observations and Calculations

S.N.	Weight of calcium carbonate (gm)	Water taken	Cake deposited on filter medium	Filtrate collected
1				
2				
3				
4				

Percentage of solids recovered = (weight of solids deposited on filter medium /weight of Solids initially in feed) x 100 .

XIII Results

Percentage of solids recovered**:**

XIV Interpretation of Results

percentage of solids recovered **:**
as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

Conclusions as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw the neat sketch of Basket Centrifuge.

Space for Answers:

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XVI References / Suggestions for Further Reading

XVII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.23: Use Centrifuge for calculation of percentage of solids recovered from given slurry using basket centrifuge. Part - I

I Practical Significance

Recovery of solids plays an important role in separation processes. It needs to be removed from the process. It increase the cost of operation also has adverse effect on the equipment's. In some process, small water content also not tolerable. Centrifugal action, gives better separation. By performing this experiment, students will able to conduct the sedimentation by centrifuge and calculate the percentage solid recovery.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-liquid separation.
2. Interpret centrifuge for sedimentation test..

IV Relevant Course Outcome(s)

Select the method for solid-liquid separations.

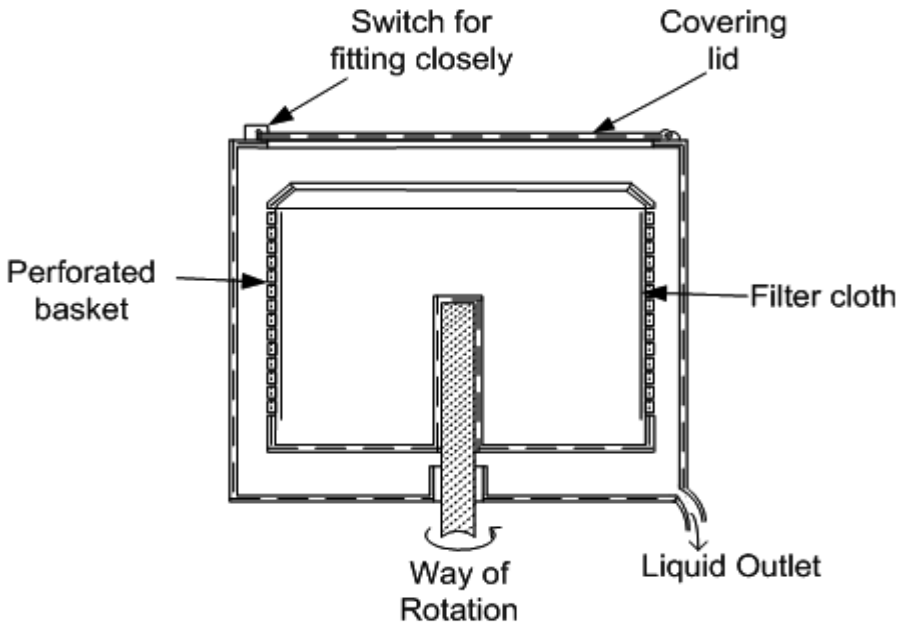
V Practical Outcome

- Calculate percentage recovery of solids by centrifuge.

VI Minimum Theoretical Background

Basket centrifuges are often called centrifugal filters or clarifiers. They have a perforated wall and cylindrical tubular rotor. In many cases the outer wall of a basket centrifuge consists of a fine mesh screen or a series of screens with the finer mesh screens supported by the heavier coarse screen, which in turn is supported by the bowl. The liquid passes through the screen, and the particles too large to pass through the screen are deposited. The basket centrifuge is employed in the manufacture of cane sugar, in the home and in laundries for the rapid drying of clothes, and in the washing and drying of many kinds of crystals and fibrous materials, etc.

VII Diagram of basket centrifuge



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Basket centrifuge		1
2	Three phase supply		1
3	Chemicals : water and lime		

IX Precautions to be Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

X Procedure

1. Prepare the slurry of calcium carbonate in water of 15 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for 15 min.
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it.
7. Measure the filtrate collected
8. Switch off the supply.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

1. Prepare the slurry of calcium carbonate in water of 15 % conc.
2. Put the filler medium, properly charge this slurry in basket centrifuge
3. Close the basket and open outlet valve for filtrate collection
4. Run the basket centrifuge for 15 min
5. Then stop the basket centrifuge and open the centrifuge
6. Collect the cake deposited on filter medium and weigh it .
7. Measure the filtrate collected
8. off the supply.

Precautions Followed

1. Keep safe distance from moving parts of centrifuge.
2. Properly set up the equipment, to get maximum separation.

XII Observations and Calculations

S.N.	Weight of calcium carbonate (gm)	Water taken	Cake deposited on filter medium	Filtrate collected
1				
2				
3				
4				

Percentage of solids recovered = (weight of solids deposited on filter medium /weight of solids initially in feed) x 100

XIII Results

Percentage of solids recovered**:**

XIV Interpretation of Results

percentage of solids recovered **:**
as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

Conclusions as the cake thickness increases or decreases the rate of filtration increases or decreases for a given differential across the filter medium

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write down the applications of Centrifuge .

Space for Answers:

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XVI References / Suggestions for Further Reading

XVII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.25: Determine efficiency of Cyclone Separator for the given solid gas mixture for Fine Dust. Part - I

I Practical Significance

Environmental protection, a prime importance in all types of industries. Removal of small size particle like in cement industry done by cyclone separation. Cyclone separator used in many industries for better dust separation. In cyclone separator, separation done by centrifugal force. By performing this experiment students will able to find the efficiency of cyclone separator.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-solid separation.
2. Interpret working of cyclone separator..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

- Calculate the efficiency of cyclone separator for dust collection.

VI Minimum Theoretical Background

Most centrifugal separators for removing particles from gas streams contain no moving parts. They are typified by the Cyclone separator. It consists of vertical cylinder with a conical bottom, a Tangential inlet at the top, and an outlet for dust at the bottom of the cone. The inlet is usually rectangular. The outlet pipe is extended into the cylinder to prevent short circuiting of air from inlet to outlet.

The incoming dust-laden air travels in a spiral path around and down the cylindrical body of the cyclone. The centrifugal force develop in the vortex to move the particles radially towards the wall, and the particles that reach the wall side down into the cone and are collected.

The cyclone basically a settling device in which a strong centrifugal force, acting radially, used in place of a relatively weak gravitational force acting vertically.

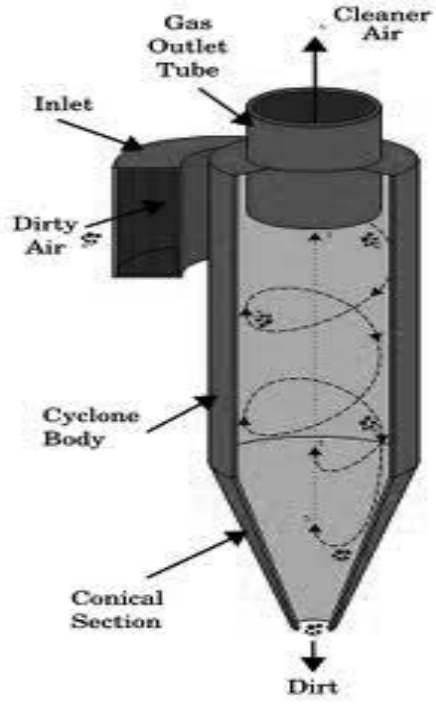
The centrifugal force Fc at a radius r is equal to mu^2tanr, where m is the mass of the particle and u tan is the tangential Velocity. The ratio of the centrifugal force to the force of gravity is then

$Fc/Fg=(mu^2tanr) / (mg)= u^2tanr/g$

The ratio is Fc/Fg is called as the separation factor.

The collection efficiency of the cyclone increases with particle density and decreases as the gas temperature is increased because of the increase in gas viscosity. The efficiency is quite dependent on the flow rate because of the u2 tan term in the above equation. The cyclone separator is one of the few separation devises that work better at full load than a partial load. Sometimes two identical cyclones are used in a series to get more complete solid removal, but the efficiency of the second unit is less than the first.

VII Circuit diagram / Setup



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Cyclone Separator		
2	Weighing Pan		
3	Saw Dust		
4			

IX Precautions to be Followed

1) Introduce the solids in inlet of cyclone separator carefully so as to prevent chocking of inlet.
2) Collect and weigh the bottom product.

X Procedure

1. Note down weight of Fine dust.
2. Start cyclone separator and adjust one particular air flow rate.
3. Add dust particles in space provided, for introducing solids. Note down time required for which dust is passed from Cyclone separator.
4. Collect bottom product of Cyclone separator and note down weight.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

1. Initial weight of the sample : ……gm.
2. Final weight of the sample : …….gm

CALCULATIONS:

$$\% \text{ Efficiency} = \frac{finalweight}{Initialweight} * 100$$

= ……..

=……..

XV Results

Efficiency of Cyclone separator =

XVI Interpretation of Results (Giving meaning to the results)

XVII Conclusions (Actions to be taken based on the interpretations)

XVIII Practical Related Questions

1. What is the working principle of cyclone separator?
2. Give applications of cyclone separator.
3. What are the different types of Gas-Solid Separation Equipments?

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.26: Determine efficiency of Cyclone Separator for the given solid gas mixture (heavy dust). Part - II

I Practical Significance

Environmental protection, a prime importance in all types of industries. Removal of small size particle like in cement industry done by cyclone separation. Cyclone separator used in many industries for better dust separation. In cyclone separator, separation done by centrifugal force. By performing this experiment students will able to find the efficiency of cyclone separator.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different methods for solid-solid separation.
2. Interpret working of cyclone separator..

IV Relevant Course Outcome(s)

Use the relevant separation methods for solid-solid separation.

V Practical Outcome

- Calculate the efficiency of cyclone separator for dust collection.

VI Minimum Theoretical Background

Most centrifugal separators for removing particles from gas streams contain no moving parts. They are typified by the Cyclone separator. It consists of vertical cylinder with a conical bottom, a Tangential inlet at the top, and an outlet for dust at the bottom of the cone. The inlet is usually rectangular. The outlet pipe is extended into the cylinder to prevent short circuiting of air from inlet to outlet.

The incoming dust-laden air travels in a spiral path around and down the cylindrical body of the cyclone. The centrifugal force develop in the vortex to move the particles radially towards the wall, and the particles that reach the wall side down into the cone and are collected.

The cyclone basically a settling device in which a strong centrifugal force, acting radially, used in place of a relatively weak gravitational force acting vertically.

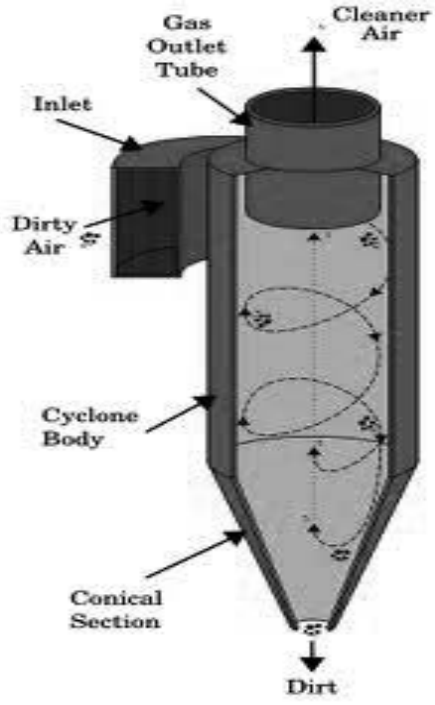
The centrifugal force Fc at a radius r is equal to mu^2tanr, where m is the mass of the particle and u tan is the tangential Velocity. The ratio of the centrifugal force to the force of gravity is then

$Fc/Fg=(mu^2tanr) / (mg)= u^2tanr/g$

The ratio is Fc/Fg is called as the separation factor.

The collection efficiency of the cyclone increases with particle density and decreases as the gas temperature is increased because of the increase in gas viscosity. The efficiency is quite dependent on the flow rate because of the u2 tan term in the above equation. The cyclone separator is one of the few separation devises that work better at full load than a partial load. Sometimes two identical cyclones are used in a series to get more complete solid removal, but the efficiency of the second unit is less than the first.

VII Circuit diagram / Setup



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Cyclone Separator		
2	Weighing Pan		
3	Saw Dust		

IX Precautions to be Followed

1) Introduce the solids in inlet of cyclone separator carefully so as to Prevent chocking of inlet.
2) Collect and weigh the bottom product.

X Procedure

1. Note down weight of heavy dust Particles .
2. Start cyclone separator and adjust one particular air flow rate.
3. Add dust particles in space provided, for introducing solids. Note down time required for which dust is passed from Cyclone separator.
4. Collect bottom product of Cyclone separator and note down weight.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

1. Initial weight of the sample : ……gm.
2. Final weight of the sample : …….gm

CALCULATIONS:

$$\% \text{ Efficiency} = \frac{finalweight}{Initialweight} * 100$$

= ……..

=……..

XV Results

Efficiency of Cyclone separator =

XVI Interpretation of Results (Giving meaning to the results)

XVII Conclusions (Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

1. What is the formula to find the smallest particle size?
2. How to calculate the efficiency of cyclone separator?

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.27: Use conveyor for transport of given solids [For Heavy Material]. Part - I

I Practical Significance

Transportation of solids from one place to another done by many methods. Different types of conveyors are available for such work in industry. Specially in cement industry, sugar industry, fertilizer industry, metal industry etc. By performing this experiment, students will able to understand the working of different types of conveyors for transportations.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types conveying equipment for transportation.
2. Interpret different transportation equipment's..

IV Relevant Course Outcome(s)

Use the relevant method for transportation of solid in industry

V Practical Outcome

- Calculate the capacity of conveyor.

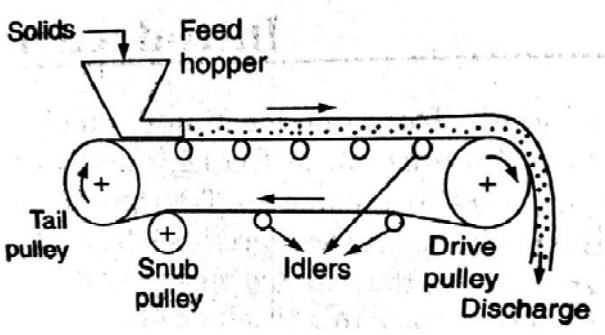
VI Minimum Theoretical Background

Conveyors either carry the solids on them or drag them through a channel or trough and are used both for short and long distance transport, operated either intermittently or continuously. Conveyors that lift the solids vertically are called elevators.
The selection of equipment depends upon

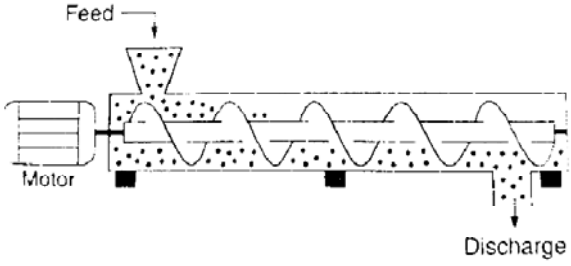
(i) Capacity Requirement
(ii) Distance of travel
(iii) Shape & Size of material
(iv) Material characteristics such as chemical and physical
(v) Whether the solids are to be transported horizontally or vertically or inclined.

VII Diagram

i. Belt conveyor



(b) Screw Conveyor



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Belt Conveyor		01
2	Screw Conveyor		01

IX Precautions to be Followed

1. Keep safe distance from moving parts of conveyor.
2. Use suitable material for conveyor.

X Procedure

a. Start the power supply of the motor for the conveyor
b. Weigh the material.
c. Place the material on conveyor belt or trough of screw conveyor
d. Collect the material which is to be transported though the conveyor
e. Weight material again
f. Calculate the time
g. Calculate the capacity of conveyor

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Sr. No.	Parameter	Belt Conveyor
01	Cross Sectional Area of load in m2	
02	Linear speed of the belt m/s	
03	Bulk density of solid materials kg/m3	

Calculations

Maximum Capacity of the conveyor

$$Q_b = A_b \, V \, \rho_b$$

Where –

Q_b = maximum capacity of the belt conveyor kg/s

A_b= cross sectional area of load on the conveyor belt m2

V= Linear speed of the belt m/s

ρ_b = Bulk density of the solid materials kg/m3

XV Results

XVI Interpretation of Results

Giving meaning to the results

XVII Conclusions

Actions to be taken based on the interpretations.

XVIII Practical Related Questions

1. *Give the common materials used for conveyor belt*
2. *Give the materials used for belts to handle hot and moist materials*

Space for answers:

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.28: Use conveyor for transport of given solids [for Fine Powder]. Part - II

I Practical Significance

Transportation of solids from one place to another done by many methods. Different types of conveyors are available for such work in industry. Specially in cement industry, sugar industry, fertilizer industry, metal industry etc. By performing this experiment, students will able to understand the working of different types of conveyors for transportations.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry**:

1. Identify different types conveying equipment for transportation.
2. Interpret different transportation equipment's..

IV Relevant Course Outcome(s)

Use the relevant method for transportation of solid in industry

V Practical Outcome

- Calculate the capacity of conveyor.

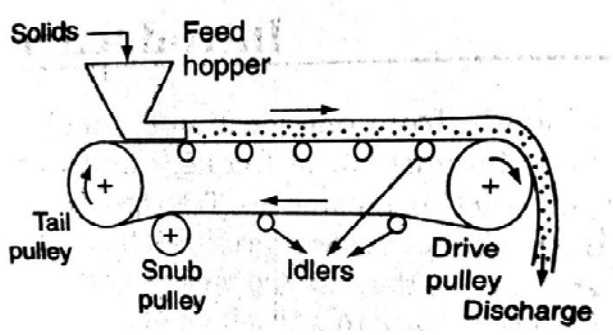
VI Minimum Theoretical Background

Conveyors either carry the solids on them or drag them through a channel or trough and are used both for short and long distance transport, operated either intermittently or continuously. Conveyors that lift the solids vertically are called elevators.
The selection of equipment depends upon

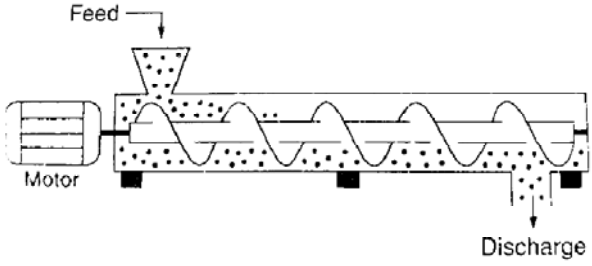
(i) Capacity Requirement
(ii) Distance of travel
(iii) Shape & Size of material
(iv) Material characteristics such as chemical and physical
(v) Whether the solids are to be transported horizontally or vertically or inclined.

VII Diagram

i. Belt conveyor



(b) Screw Conveyor



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Belt Conveyor		01
2	Screw Conveyor		01
3			
4			

IX Precautions to be Followed

1. Keep safe distance from moving parts of conveyor.
2. Use suitable material for conveyor.

X Procedure

a. Start the power supply of the motor for the conveyor
b. Weigh the material.
c. Place the material on conveyor belt or trough of screw conveyor
d. Collect the material which is to be transported though the conveyor
e. Weight material again
f. Calculate the time
g. Calculate the capacity of conveyor

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations

Sr. No.	Parameter	Belt Conveyor
01	Cross Sectional Area of load in m2	
02	Linear speed of the belt m/s	
03	Bulk density of solid materials kg/m3	

Calculations:

Maximum Capacity of the conveyor

$$Q_b = A_b \, V \, \rho_b$$

Where –

Q_b = maximum capacity of the belt conveyor kg/s

A_b= cross sectional area of load on the conveyor belt m2

V = Linear speed of the belt m/s

ρ_b = Bulk density of the solid materials kg/m3

XV Results

XVI Interpretation of Results (Giving meaning to the results)

XVII Conclusions (Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

1. *Give the advantages of belt conveyor*
2. *Give the applications of belt conveyor in chemical industry*

Space for Answers:

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XIX References / Suggestions for Further Reading

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 29: Use Ribbon Blender to determine solid-solid mixing index [for composition of 50: 50] Part - I

I Practical Significance

Mixing of solid-solid particle improves the efficiency of operation. Different types of mixing equipment's are available in industry. Ribbon blender is used for higher efficiency in mixing operation. By performing this experiment, students will able to find the mixing index of given solids.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :**Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different mixing equipment for finding mixing index.
2. Interpret Ribbon blender for mixing operation. .

IV Relevant Course Outcome(s)

Select the relevant equipment for agitation and mixing.

V Practical Outcome

- Calculate mixing index for Ribbon blender.

VI Minimum Theoretical Background

In a Ribbon Blender, a long complicated single paddle is mounted axially and used to disperse the ingredients of the mixture. The ribbon is usually so constructed that the powder near the outside of the container is moved in one direction, whereas in the middle it is moved in the opposite direction. Ribbon mixer are available from several manufacturers and they all have their own type of ribbon.

There are a number of different types of mixers used in the feed industry with the most widely used being:

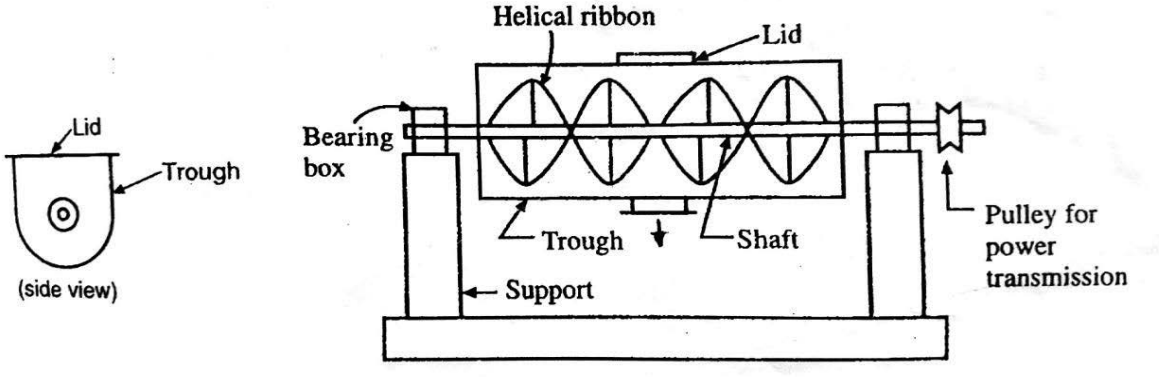
Vertical Ribbon Blenders – Used in small farms, they consist of a vertical screw which takes material to the top where it falls back down again, and repeats that process to mix materials

Horizontal Ribbon Mixers – Consisting of paddles or blades attached to a horizontal rotor, these mixers are normally mixer and can usually have a higher consistent homogeneity and short mixing times.

Ribbon mixers are a basic industrial mixing tool. They consist, basically, of a trough-shaped casing (usually 2 to 3 times longer than it is wide) with a semicircular bottom,

fitted with a horizontal longitudinal shaft on which are mounted arms supporting a combination of ribbon blades, paddles or helical screws set at a fairly close clearance to the semicircular mixer body so that no layer of material remains on the bottom of the mixer. The most effective design of ribbon layout is the double spiral in which the outer ribbon moves the product in one direction and the inner ribbon moves it in the opposite direction. This creates axial flow and prevents any buildup of material moved by the blades as they rotate is relatively small so that mixing times can be long. The capacity of the mixer should not be exceeded otherwise the ribbon and/or blades are not effective and the surface layers of the powder do not get adequately mixed.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ribbon Bender Set Up		1 No.
2	Jawar and Sand		
3	Weigh balance		1 No.

IX Precautions to be Followed

1. Keep safe distance from equipment.
2. Use hand gloves during experiment.

X Procedure

1. Weigh known quantity of jawar /bajra and sand sample.
2. Feed the samples to the blender and mix for definite period of time.
3. Stop the blender.
4. Remove samples from various location of blender.
5. Screen the samples with set of sieves.
6. Note the weight of jawar/bajra and sand retained on each screen and tabulate.
7. Prepare the table as given below.

Observation table:

Sl no:	Total weight of sample	Weight of ----retained	weight fraction(X_i)	$\bar{X}$	X_i^2
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
			$\sum X_i =$		$\sum X_i^2$

Weight of …… =……..g

Weight of flour = ……g

Weight fraction of …… in feed(μ) = =

No: of samples (N) = 10

Sample calculation for set no:

Weight fraction of bajra retained in sample --- = weight of …….. retained on the screen

Total weight of the mixture

$\bar{X}$ = $\frac{\sum X_i}{N}$

S^2 = variance of the fractional sample composition from the mean composition

= $\frac{1[(\sum x_i^2)]}{n}$ -$(\overline{x})^2$

S_0^2 = initial value of S = 0.2(1-0.2) = 0.16

$S_r^2 = S_{15}$ = random value of S = S_0^2 / N where N is the no: of particles in the sample analyzed.

For very small particles, N is very large and N→∞, thus $S_r^2 = 0$

Mixing index (I_s) = $\frac{S_0^2 - S^2}{S_0^2 - S_r^2}$ =

Result

Mixing index of the given solid-solid mixture is

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Results

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XV Interpretation of Results

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XVI Conclusions

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XVII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is mixing index?
2. What are the precautions to be taken during operation of blender?

Space for Answers:

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XVIII References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XIX Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 30: Use Ribbon Blender to determine solid-solid mixing index. [For composition of 60: 40] Part - II

I Practical Significance

Mixing of solid-solid particle improves the efficiency of operation. Different types of mixing equipment's are available in industry. Ribbon blender is used for higher efficiency in mixing operation. By performing this experiment, students will able to find the mixing index of given solids.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different mixing equipment for finding mixing index.
2. Interpret Ribbon blender for mixing operation. .

IV Relevant Course Outcome(s)

Select the relevant equipment for agitation and mixing.

V Practical Outcome

- Calculate mixing index for Ribbon blender.

VI Minimum Theoretical Background

In a Ribbon Blender, a long complicated single paddle is mounted axially and used to disperse the ingredients of the mixture. The ribbon is usually so constructed that the powder near the outside of the container is moved in one direction, whereas in the middle it is moved in the opposite direction. Ribbon mixer are available from several manufacturers and they all have their own type of ribbon.

There are a number of different types of mixers used in the feed industry with the most widely used being:

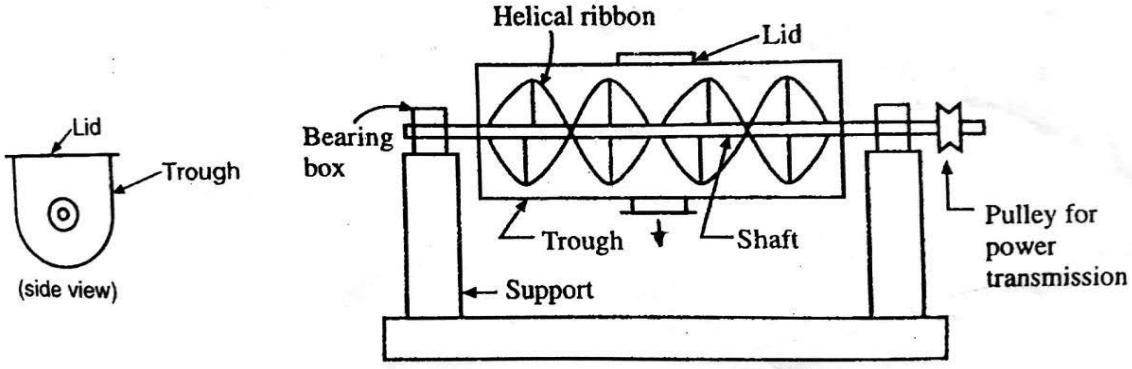
Vertical Ribbon Blenders – Used in small farms, they consist of a vertical screw which takes material to the top where it falls back down again, and repeats that process to mix materials

Horizontal Ribbon Mixers – Consisting of paddles or blades attached to a horizontal rotor, these mixers are normally mixer and can usually have a higher consistent homogeneity and short mixing times.

Ribbon mixers are a basic industrial mixing tool. They consist, basically, of a trough-shaped casing (usually 2 to 3 times longer than it is wide) with a semicircular bottom, fitted with a horizontal longitudinal shaft on which are mounted arms supporting a

combination of ribbon blades, paddles or helical screws set at a fairly close clearance to the semicircular mixer body so that no layer of material remains on the bottom of the mixer. The most effective design of ribbon layout is the double spiral in which the outer ribbon moves the product in one direction and the inner ribbon moves it in the opposite direction. This creates axial flow and prevents any buildup of material moved by the blades as they rotate is relatively small so that mixing times can be long. The capacity of the mixer should not be exceeded otherwise the ribbon and/or blades are not effective and the surface layers of the powder do not get adequately mixed.

VII Diagram



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ribbon Bender Set Up		1 No.
2	Jawar and Sand		
3	Weigh balance		1 No.

IX Precautions to be Followed

1. Keep safe distance from equipment.
2. Use hand gloves during experiment.

X Procedure

1. Weigh known quantity of jawar/bajra and sand sample.
2. Feed the samples to the blender and mix for definite period of time.
3. Stop the blender.
4. Remove samples from various location of blender.
5. Screen the samples with set of sieves.
6. Note the weight of jawar and sand retained on each screen and tabulate.
7. Prepare the table as given below.
8. Weigh known quantity of jawar /bajra and sand sample.
9. Feed the samples to the blender and mix for definite period of time.
10. Stop the blender.
11. Remove samples from various location of blender.
12. Screen the samples with set of sieves.
13. Note the weight of jawar/bajra and sand retained on each screen and tabulate.
14. Prepare the table as given below.

Observation table:

Sl no:	Total weight of sample	Weight of ------retained	weight fraction(X_i)	$\bar{X}$	X_i^2
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
			$\sum X_i$ =		$\sum X_i^2$

Weight of …… =……..g

Weight of flour = ……g

Weight fraction of …… in feed(μ) = =

No: of samples (N) = 10

Sample calculation for set no:

Weight fraction of bajra retained in sample --- = weight of …….. retained on the screen

Total weight of the mixture

$\bar{X}$ = $\frac{\sum X_i}{N}$

S^2 = variance of the fractional sample composition from the mean composition

= $\frac{1[(\sum x_i^2)]}{n}$ -$(\overline{x})^2$

S_0^2 = initial value of S = 0.2(1-0.2) = 0.16

$S_r^2 = S_{15}$ = random value of S = S_0^2 / N where N is the no: of particles in the sample analyzed.

For very small particles, N is very large and N→∞, thus $S_r^2 = 0$

Mixing index (I_s) = $\frac{S_0^2 - S^2}{S_0^2 - S_r^2}$ =

X Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XI Actual Procedure Followed

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XII Precautions Followed

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XIII Results

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XIV Interpretation of Results

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XV Conclusions

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XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the specifications of the blender used in the experiment.
2. What procedure are adopted for disposal of the feed mixture?

Space for Answers:

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XVII References / Suggestions for Further Reading

1. *www.mine-engineer.com/mining/jaw_crusher.htm*
2. *https://www.youtube.com/watch?v=1Wf1q5FHdk0*
3. www.electricaltechnology.org

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 31: Use Sigma mixer for determination of solid -solid mixing index. [for composition of 50: 50] Part – I

I Practical Significance

Sigma mixer is equipment used for better mixing in chemical industry. Mixing efficiency can be improved by changing the design of the blade used in mixer. Sigma mixer gives better mixing as compare to other mixer. By performing this experiment, students will able to calculate mixing index for given solids.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different types mixing equipment's for desired mixing index.
2. Interpret sigma mixer. .

IV Relevant Course Outcome(s)

Select the relevant equipment for agitation and mixing.

V Practical Outcome

- Calculate mixing index for sigma mixer.

VI Minimum Theoretical Background

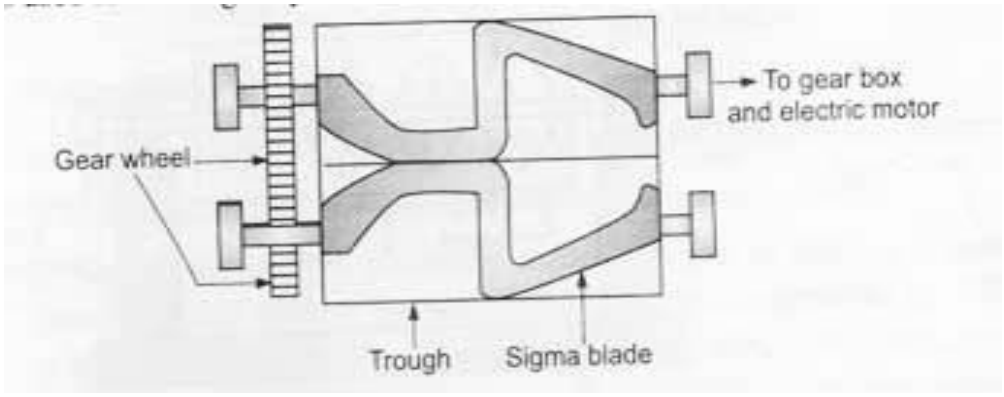
1. Phase: a substance which is uniform throughout in physical state and chemical composition is called a homogeneous substance or a phase. phase may be liquid solid or gaseous
2 . Mixing implies taking at least two separate phases and causing them to distribute randomly through one another.
3. Mixing may involve gases liquids solids combination of two or more components

a) Two different liquids
b) Liquid and gas
c) Liquid and powdered gas
d) Two different or same solid

4. Mixing is necessary to promote a chemical reaction as contactbetween reacting phases / substances are necessary for a reaction to proceed properly
5. **Type of impellers:**
   There are two types of impellers
   1. Axial flow impeller: this generates flow currents parallel to axis of shaft
   2 .Radial flow impeller are those which generates flow currents in tangential or radial direction

VII Resources Required: ribbon blender / sigma mixer jawar , sand or any other combination of material , weighing balance , set of screens , sieve shaker

Diagram: Sigma Mixer



VIII Precautions to be Followed

1. Keep safe distance from equipment.
2. Use hand gloves during experiment.

IX Procedure

1. Weigh known quantity of jawar and sand sample
2. Feed the samples to blender and mix for definite period of time.
3. Stop the blender.
4. Remove samples from various location of blender.
5. Screen the samples with set of sieves.
6. Note the weight of jawar and sand retained on each screen and tabulate.
7. Prepare the table as given below.

Observation table:

Sl no:	Total weight of sample	Weight of ------retained	weight fraction(X_i)	$\bar{X}$	X_i^2
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
			$\sum X_i =$		$\sum X_i^2$

Weight of …… =……..g

Weight of flour = ……g

Weight fraction of …… in feed(μ) = =

No: of samples (N) = 10

Sample calculation for set no:

Weight fraction of bajra retained in sample --- = weight of …….. retained on the screen

Total weight of the mixture

$\bar{X}$ = $\frac{\sum X_i}{N}$

S^2 = variance of the fractional sample composition from the mean composition

= $\frac{1[(\sum x_i^2)]}{n}$ -$(\overline{x})^2$

S_0^2 = initial value of S = 0.2(1-0.2) = 0.16

$S_r^2 = S_{15}$ = random value of S = S_0^2 / N where N is the no: of particles in the sample analyzed.

For very small particles, N is very large and N→∞, thus $S_r^2 = 0$

Mixing index (I_s) = $\frac{S_0^2 - S^2}{S_0^2 - S_r^2}$ =

X Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Sigma Mixer Set Up		1 No.
2	Jawar and Sand		
3	Weigh balance		1 No.
4			

XI Actual Procedure Followed

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XII Precautions Followed

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XIII Observations and Calculations

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X Results

a. MIXING INDEX of Ip of given sample :

XIV Interpretation of Results

Giving meaning to the results

XV Conclusions

The effectiveness of given type of mixer depends on the nature and consistency of mixed materials and quantity of feed

XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define mixing index
2. State principles of mixers
3. List out various mixers used in industrial scale
4. What is purpose of mixing' list various agitators ?

Space for Answers:

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XVII References / Suggestions for Further Reading

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Preparation of Slurry of given Concentration	20%
2	Measurement of Height at interface	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 32: Use Sigma mixer for determination of solid -solid mixing index. [for composition of 60: 40] Part – II

I Practical Significance

Sigma mixer is equipment used for better mixing in chemical industry. Mixing efficiency can be improved by changing the design of the blade used in mixer. Sigma mixer gives better mixing as compare to other mixer. By performing this experiment, students will able to calculate mixing index for given solids.

II Relevant Program Outcomes (POs)

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.
PO 2. **Discipline knowledge:** Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.
PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use various mechanical engineering equipment in chemical process industry'**:

1. Identify different types mixing equipment's for desired mixing index.
2. Interpret sigma mixer. .

IV Relevant Course Outcome(s)

Select the relevant equipment for agitation and mixing.

V Practical Outcome

- Calculate mixing index for sigma mixer.

XIX Minimum Theoretical Background

1. Phase: a substance which is uniform throughout in physical state and chemical composition is called a homogeneous substance or a phase. Phase may be liquid solid or gaseous

2 .Mixing implies taking at least two separate phases and causing them to distribute randomly through one another.

3. Mixing may involve gases liquids solids combination of two or more components
a)Two different liquids
b) Liquid and gas
c) Liquid and powdered gas
d) Two different or same solid

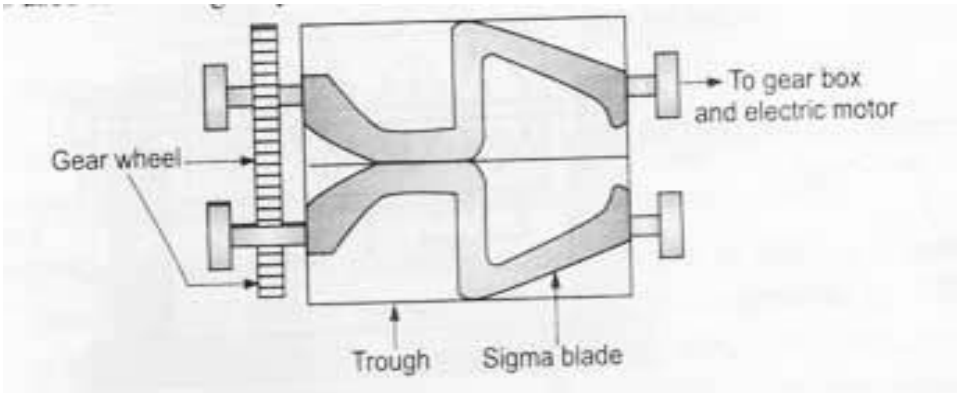
4. Mixing is necessary to promote a chemical reaction as contact between reacting phases / substances are necessary for a reaction to proceed properly

5. **Type of impellers:**

There are two types of impellers
1. Axial flow impeller: this generates flow currents parallel to axis of shaft
2 .Radial flow impeller are those which generates flow currents in tangential or radial direction

XX Resources Required: ribbon blender / sigma mixer jawar , sand or any other combination of material , weighing balance , set of screens , sieve shaker

Diagram: Sigma Mixer



VII Precautions to be followed

1. Keep safe distance from equipment.
2. Use hand gloves during experiment.

VIII Procedure

1. Weigh known quantity of jawar and sand sample
2. Feed the samples to blender and mix for definite period of time.
3. Stop the blender.
4. Remove samples from various location of blender.
5. Screen the samples with set of sieves.
6. Note the weight of jawar and sand retained on each screen and tabulate.
7. Prepare the table as given below.

IX Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Sigma Mixer Set Up		1 No.
2	Jawar and Sand		
3	Weight balance		1 No.

X Actual Procedure Followed

……
……
……

XI Precautions Followed

……
……
……

XII Observations and Calculations

1. weight of jawar in……. gm
2. weight of sand in …….. gm

S. No.	Wt of jawar gm	Wt of sand gm	Weight of fraction of jawar X
1			
2			
3			
4			

Sample Calculations

1. $X = \frac{\sum x_i}{N} = \frac{\text{sum weight fraction of jawar}}{\text{No of observations}}$

2. $\mu = \frac{\text{Total weight of jawar}}{\text{Weight of jawar + weight of sand}}$

3. Mixing Index (Ip) $= \frac{(N-1)\,\mu\,(1-\mu)}{\sum x_i^2 -}$

Abbreviations
N = No of observations.
μ = overall average fraction of tracer in the mixture.
xi = weight fraction of jawar.
x = average value of the measured concentration.

XIII Results

a. Mixing Index of Ip of given sample :

XIV Interpretation of Results (Giving meaning to the results)

XV Conclusions :

The effectiveness of given type of mixer depends on the nature and consistency of mixed materials and quantity of feed

XVI Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State blending operation used in chemical industries
2. Explain the meaning of term sigma as applicable to mixer blade
3. What is the difference between mixing blending and kneading .

Space for Answers:

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XVII References / Suggestions for Further Reading

XVIII Assessment Scheme

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List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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