LEARNING MATERIAL

SEMESTER : **6TH SEMESTER**

BRANCH : **MINING ENGINEERING**

THEORY SUBJECT : **MINERAL DRESSING (TH – 4)**

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classmate
Date
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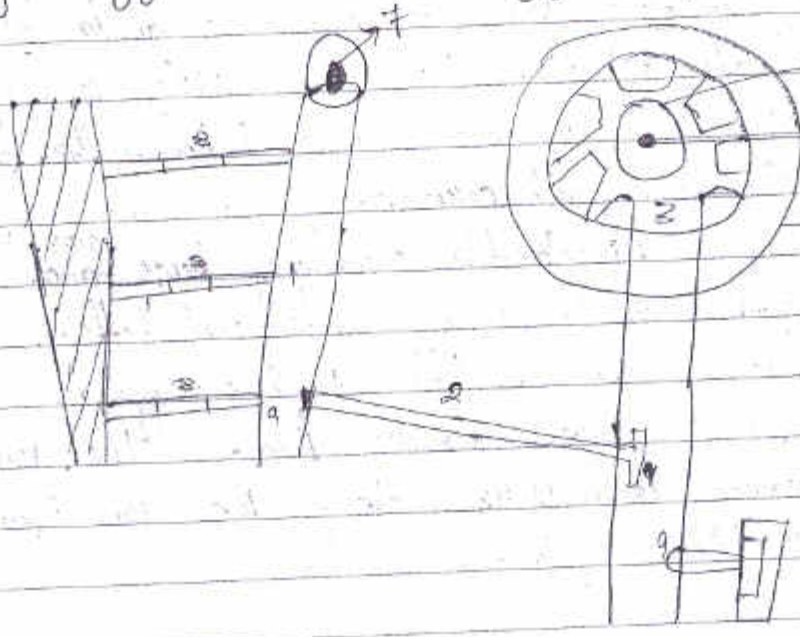
« Mineral Dressing »

1) Describe the working of blake jaw crusher with neat sketch?

Ans ⇒ It is the most popular and widely used primary crusher. It has a moving jaw pivoted at the top. Thorough the working principles of blake and dodge crushers are different, constructionally both look alike excepting few notable differences between them.

The blake crusher may be classified as single toggle or double toggle type.



1) Jaw plates
2) Toggles
3) Pitman
4) main shaft
5) Eccentric
6) Fly wheel
7) Top hinge (pivot)
8) check plate
9) Bearing

"Constructional Features"

→ As the name suggest a jaw crusher has two jaws set to form a v-shape at the top through which feed is admitted into the jaws space. One of the jaws is fixed to the main structure of the crusher almost vertically while the other is movable. The swinging jaw is driven by an eccentric that reciprocates in a horizontal plane making an angle of 20-30 degrees with the stationary jaw. Then the angle between the two jaw is known as angle of bite or angle of nip. The jaws apply a huge compressive force on the ore caught between them and ultimately the ore get crushed.

Replacable crushing ~~bars and bolts~~ fixed into the jaws by bars and bolts. The crushing jaws are of hard field manganese steels for enhanced service life. The jaw width varies from 8-48 inches. The jaw speed is between 100-400 cycles per minute.

Working of Blake crusher :

→ Initially a large lump are cut and broken at the top. The broken parts fragments drop to the narrow bottom space and are crushed again when the jaws close for the next cycle. This action continues until the feeds come out.

In this machine, an eccentric drives the pitman. The circular to up and down moti

is connected to and fro motion with the help of toggles. One of the toggles is fixed to the main frame and pivoted with the other one is fixed to the moving jaws and pivoted.

At the swinging jaw pivoted at the top the amplitude movement is largest at the bottom.

The maximum distance the moving jaw travels is called throughs of the crusher the throw is between 1-7 cm. The distance between the jaw plates at the feed opening end is known as gap.

The distance between the jaw is the discharge. size is known as sets (s) An important part of jaw crusher is the fly wheel mounted on the main shaft the use of fly wheel is important because as crushing takes place a heavy work load on the machine to reduce the load and balance the machine the fly wheel is fitted.

Differentiate between jaw crusher and gyratory crusher.

Jaw Crushers	Gyratory Crushers
i) The load on the machine members is intermittent.	→ The load on the machine members is uniform.
ii) crushing action is intermittent	→ crushing action is continues.
iii) It has an lower cost of installation	→ It has a higher cost of installation.

iv)	It is suitable for lower rate of production	→ It is suitable for higher rate of production.
v)	The wear on the jaw plates is not uniforms.	→ The wear on crushing head is quite uniforms.
vi)	Power consumption is higher for jaw.	→ For same reduction ratio and capacity.

crusher for a particular the operating ~~capacity~~ reduction ratio and crushers requires capacity less power.

vii)	Irregular powers draft	Regular powers draft.

3) Describe the operation of ball mill. Operation of ball mill.

Ball mill may be continuous or batch type, in which grinding media and the ore to be ground are rotated around the axis of ball mill. Due to the friction between the liners - ball and liners - ore, lump both the ore lump and ball are carried up along the inner wall of the shell nearly the top point where the media fall down on the ore particle. This is usually happens at the toe zone of the ball mill.

The energy used in the lifting of the grinding media is thus utilized in reducing the size of the ore lumps. The entire grinding

process is carried out by three stages:

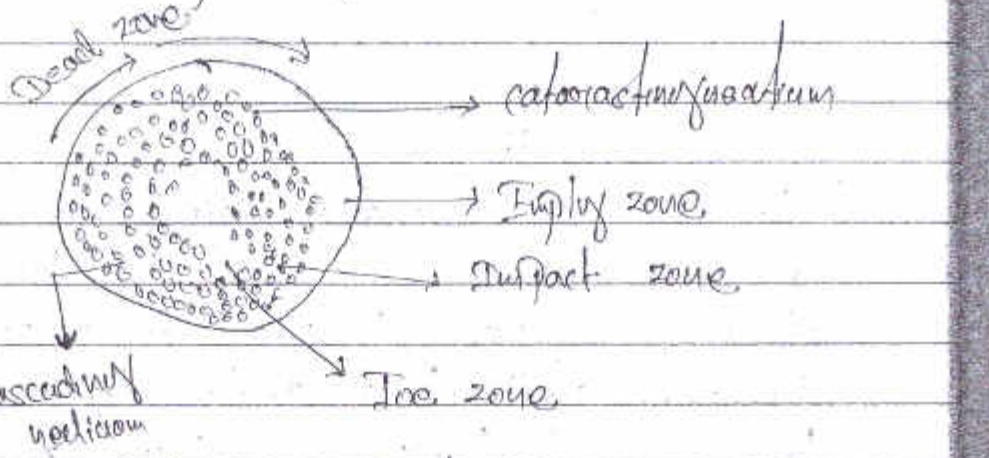
i). Cascading
ii). Cataracting
iii) Centrifuging.

→ The effective grinding depends on the rotational speed of the ball mill. If the ball mill operates at a low speed balls will be carried up along the inner wall to a certain higher but not large enough to provide sufficient large impact force. In this case the grinding is takes place by the balls in the way of slip. So this type of operational condition is known as cascading.

ii)→ After cascading if the speed of the ball mill is raised. The ball starts moving up further along the inner wall and suddenly fall from a greater height and imparts sufficiently large impact force of the top of the mill. The impact is largely responsible for most of the grinding in the ball mill. This condition is known as cataracting.

iii)→ If the rotation becomes too high the balls are carried over and over again along the inner liner. This operational condition barely causes any grinding. The condition is known as centrifuging of the ball mill. As no grinding is occurs when the mill centrifuse the speed at which the mill starts centrifusing is termed is called.

critical speed of the ball will.



→ Tyler series and ASTM standard screens

Tyler mathematical series is most widely used to regulate the aperture size of the screen while manufacturing ASTM standard screens. The screen are made from bronze brass or stainless steel wire woven into a screen cloth having square opening size of the screen varies with a factor $\sqrt{2}$. The lowest screen opening available under this series is 37 cm. in the As the standardization. mesh on ranges from 3 to 400.

Mesh NO.	Aperture (In mm)
3	6.680
4	6.699
6	3.362
8	2.362
10	1.651
14	1.168
20	0.833

28	0.589
35	0.417
48	0.295
65	0.208
100	0.147
150	0.104
200	0.0474
270	0.052
400	0.037

5/. Open circuit and close circuit grinding and what is dry wet grinding.

Open circuit grinding:

In open circuit grinding the will received feed and grinds to the desired product size in one pass.

Open circuit grinding is employed in the following cases:-

i)→ For coarse grinding.

ii)→ To grind the wet cement raw mix

iii)→ When drying operation and extreme.

The can be followed

Run of mine (ROM)

↓

Jaw crushers

↓

crushing Rolls

Ball mill

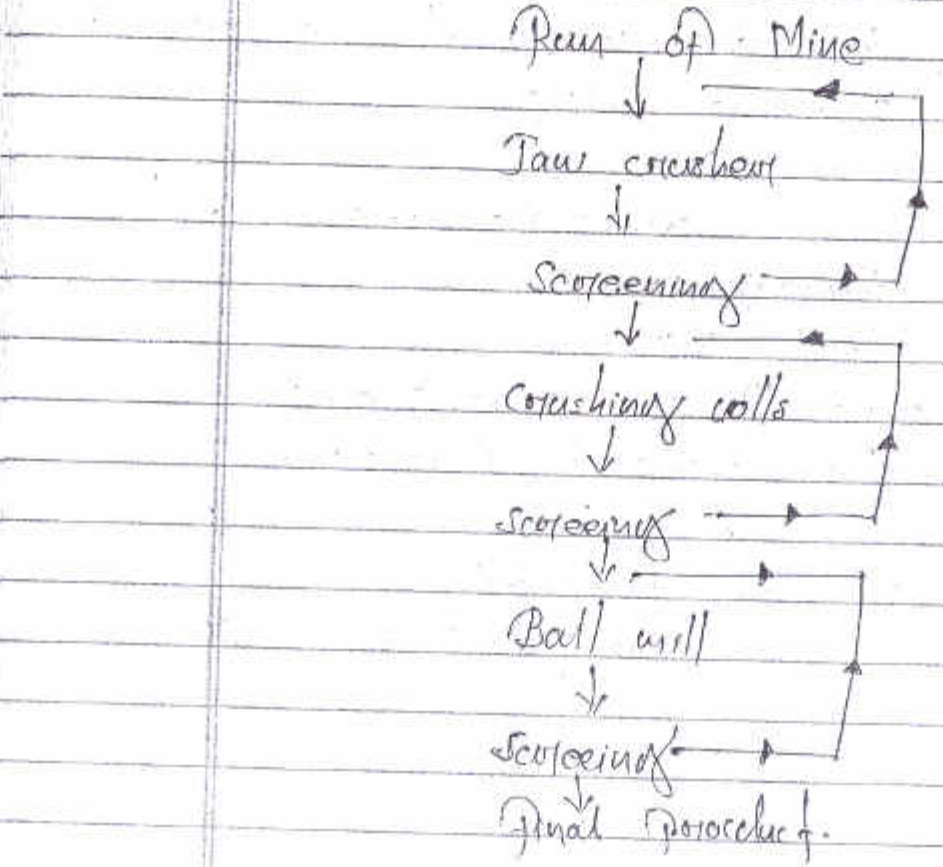
↓

Fine Product.

closed circuit grinding

→ In closed circuit grinding the mill discharge is fed to a sizing device to separate out the oversize material which is recycled to the grinding mill close circuit grinding requires less skilled operators to give a constant product size analysis.

closed circuit grinding is used in most mineral processing industries.



Dry and wet grinding

→ The materials should be ground when either wet enough to form a slurry (wet ground) completely dry (dry grinding). since the grinding in the most and sticky state is difficult and requires extremely high energy.

→ Dry grinding is preferred where the subsequent concentration process is done on in the are where water is scarce: Dry grinding is employed in cement industry due to the nature of the material. Dry grinding requires the consideration following point.

(i) Feed material should be low in moisture water.
ii) It requires dust control system
iii) costly filtering and drying equipments are not required.
iv) A single storage system is required.
v) Power consumption is lowered by 10-30% over dry grinding portion of product.

→ Wet grinding is used is mineral processing industry since most is subsequent processes such as flotation. magnetic separation leaching etc. are done wet.

wet grinding requires the consideration of following points:

a) It requires less power per tonne of material than dry grinding.
b) It requires less space than dry grinding
c) It does not required dust control equipment
d) It requires large quantity of water.
e) Purity circumference is high.

6) Mechanism of screening

When the crushed product is fed to the screen, a portion of the product passes through and the rest is returned on the screen. The fraction of the material passing through the screen is known as under flow while the portion is known as over flow. So the basic fact attached to screening is the passage of undersized material through the screen. The factors which affects screening are listed below.

i) The relative size of the particle to that of screen aperture.
ii) The absolute size of the screen opening or aperture.
iii) The percentage of open area available for screening with respect to the total surface area of the screen.
iv) The angle at which the particle strikes the screen surfaces.

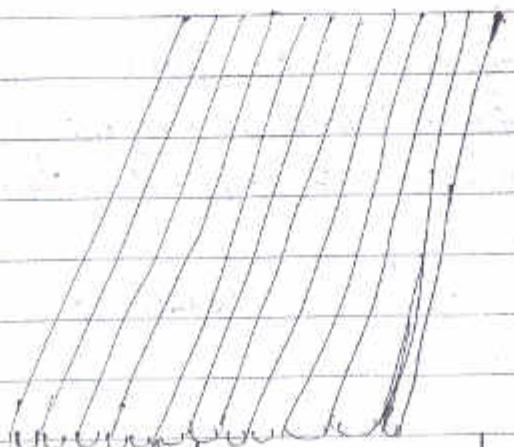
v) The speed with which the particles strikes the screening surface.

7/. classification of screens

1) stationary.
2) Moving.

stationary screens →

These screen are of limited use but are not to tally absolete. These screens are grizlies. They consist of parallel bricks bars or woven wire mesh set at an angle to the ground. The bars are held together at right angles to their length. Space at the desired distance using sleeves and baths. A slope is generally provided so that the materials feed on to the surface would roll down automatically due to force of gravity. The disadvantage of this type of screen is clogging.



stationary grizzly.

2/ Moving screens are -

i) moving grizzless
ii) Trommels or Revolving screens.
iii) Shaking screens
iv) Vibrating screens.

Moving Grizzlies :-

→ This grizzlies is made up of rods and to stationary grizzly. In moving grizzlies alternate bare or rode rise and subside alternatively. The feed material move forward gently with sufficient training over there are different grizzlies such as :

i) Moving bar grizzly
ii) chain grizzly
iii) Travelling grizzly
iv) Disc or Roller type grizzly
(v) vibrating grizzly.
(vi) Shaking grizzly.

Advantage of Grizzlies :-

i) lower floor space is required for instation Work.
ii) They act as feeders to intermediate crushers.
(iii) They results in better screening than stationary screens.

Trommels or Revolving screens :-

→ Revolving screens or trommels are used more widely than any other moving screen However they are being replaced by Vibrating screens. It consists of rotating cylindrical, prismatic, conical or pyramidal shells made up of punched plates or thick woven wires. When the trommel has only one shell it is known as single trommel commonly the trommel has a diameter of 3-4 feet and a length 5-10 feet. It is driven by a central shaft attached to it by 4 or 6 armed spiders.

Advantage :-

→ Require smaller floor space.
→ larger capacity per unit screening are.
→ cheap to operate both on dry and wet feed.
→ Several fraction are obtained in one go.
→ screening operation is quite efficient.

Shaking Screens :-

It is essentially a shallow rectangular box where length is at least 24 times the width. It is open above end and is filled with a screen bottom. It is shaked by means of a suitable mechanism. Speed slope and length of the stroke should be adjusted to produce rapid stratification of the feed with a forward motion so that minimum blocking of screen surfaces to take places it is mostly used for screening coal. It looks very similar to the

Vibrating screen:

(Vibratory screens)

→ Vibratory screens are recently developed and have replaced most of the other screening apparatus obsolete. It is essentially a flat screen surface which made from punched plates or woven wire secured rigidly on a steel frame. The frame is attached to certain mechanical device to impart a reciprocating and down motion in a direction either normal or at a high angle to the screen surface. These screens can be driven electrically or mechanically. The undersize and overflow continously get discharged at the other end of the screen.

8). Factors which affecting classification

→ Specific gravity:-

Particle having the higher specific gravity will settle faster than other particles of same size and lower specific gravities.

→ Size:-

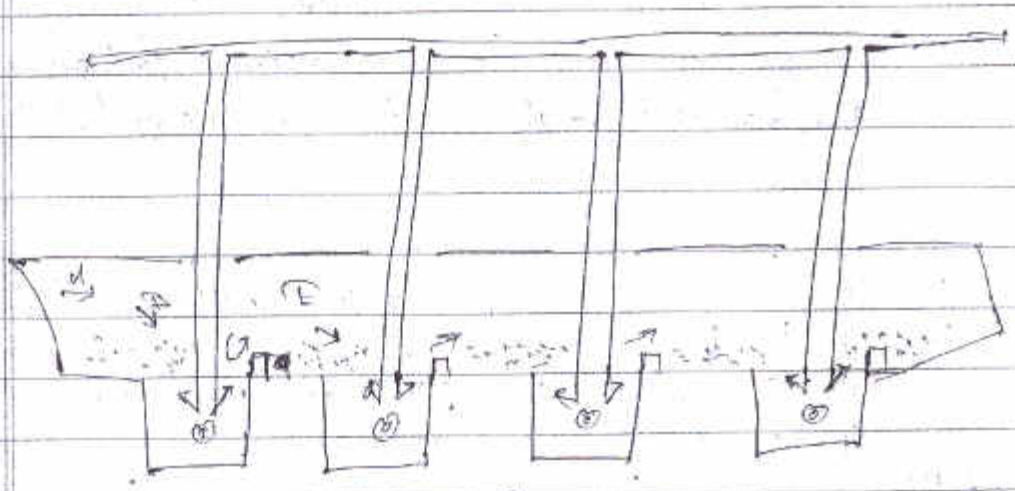
Among the particles of same specific gravity the largest particle will settle fastest.

→ Specific gravity of the fluid:-

For fluids of different specific gravities the partical will settle fastest in the lighter fluid.

→ Air bubble :
Advance of air bubbles to the solid particles would lower the settling speed.

Q. Evan's classifier :
→ A schematic Evan's classifier is shown in figure below. It is a sloping launder. At openings to this launder several rectangular boxes. BC are attached. To these rectangular spigots. D are fitted which discharge out the sorted particles. Pipes are suspended from a main pipeline into the rectangular boxes. Water is introduced into the boxes through the suspended pipe and it flow is controlled by valve V.



"Evan classifier"

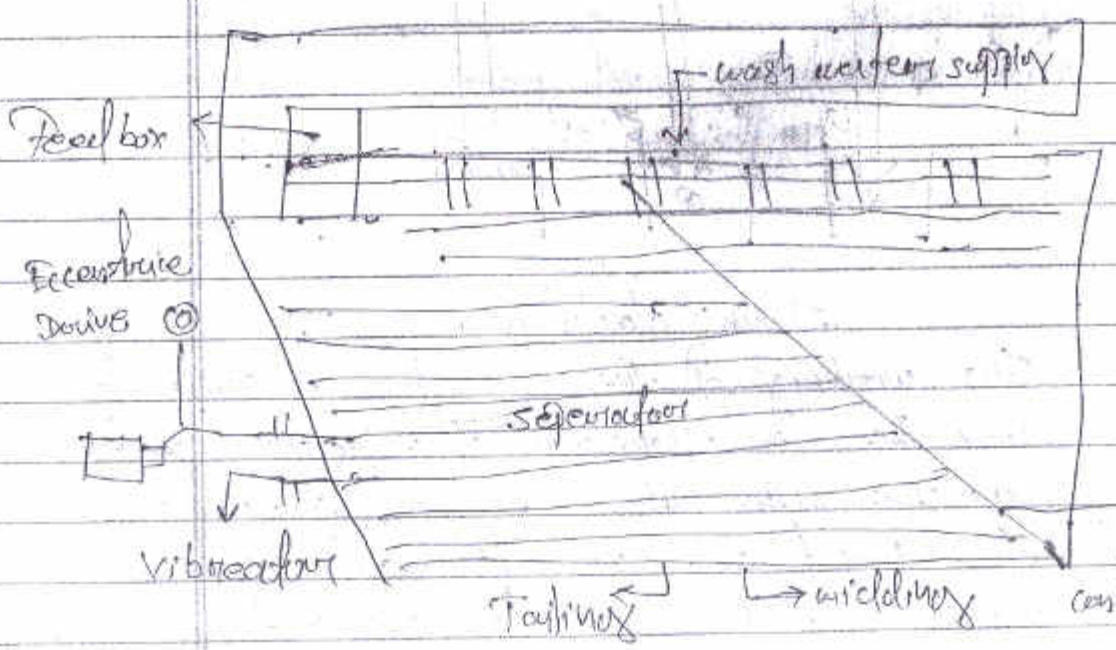
The working of the classifier a simple. As water the is introduced the faster settling particales selle into the boxes starting with the finest one from left and the slower settling over flow at E. to the next box in the

launder. The settled particles are discharged out through the spigots fitted to the boxes.

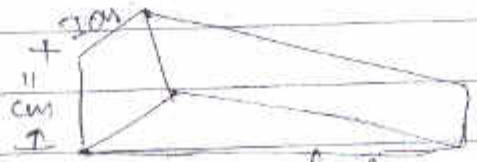
Baffles plates fixed to the launder to restrict the return of particles to the same box from the overflow. Depending on the number of rectangular boxes attached to the launder several product are obtained water flow rate in each successive pipe is reduced as the size of particles settling get reduced successively.

10) Construction of wifley table

The table is made up of wood or similar such materials. The table surface is treated. specific discussion on deals on riffles is required as they undergoes frequent replacement during the working of the wifley table



The cleats are usually made from wood with a maximum height and width of one centimeter each. The cleat highest tapers downstream left to right.



→ They are place longitudinally parallel to each other so as to form channels of less width and depth at the extreme left side end which tappers down to zero depth at the right side opposite end. All the cleats ends along the imaginary diagonal line on the riffley table which divides the total surface are of the table in a ratio of 2:1 approximately.

→ This means 2/3rd of the total surface area of the table is cleated (ruffled) and rest 1/3rd position is unruffled the inclination provided increases the ore handling capacity of the table. The inclination is limited to maximum of 3° as further increase will hamper the efficiency of classification for majority ores a slope of 0.75 - 1.25° is used

Important uses of riffley table →

i) To concentrate cassiterite tin ore.
ii) To concentrate free milled gold ores.
iii) To beneficiate of nonmetallics like glass and sand
iv) To beneficiate chromite and tungsten ores.

v). To recover a part of galena and sphalerite in coarse aggregate of lead-Zinc ores.
vi). To clean Zinc coal.
vii). To beneficiate particular types of iron ores
viii). Adopted as a pilot plant to guide flotation plants.

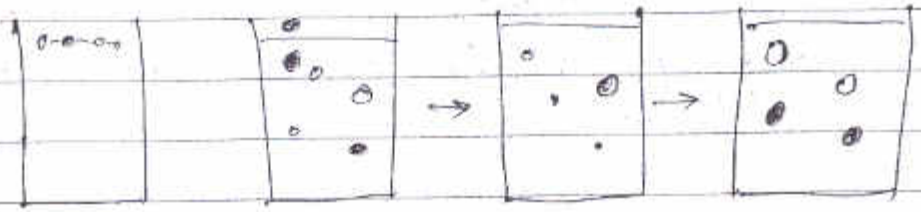
ix). What is jigging Describe the principle of jigging.

Jigging :- Jigging is one of the most ancient method to concentrate ores. It is a special form of hindered setting which promotes stratification of particles into layers of different specific gravities followed by removal of stratified layers.

Principles of jigging :
There are three physical factors responsible for stratification of particles during jigging are :-
i). Hindered setting classification.
ii). Differential acceleration at the beginning of the fall
iii). consolidation toughening at the end of fall
step
i). Hindered setting classification :-
→ The essential difference in hindered setting in jigs and classifiers that in jigging the

Fluid mixture is very thick and it approximates with industrial fluid.

→ The thick solid-fluid suspension under jigs can be maintain for a long length of time and also does not allow sufficient play between the particles for their complete rearrangement.



* Differential acceleration.

→ In jigs particles are allowed to move and get rearranged only when they are accelerating.

→ The heavy particles have a greater inertia and speed than the lighter particles.

iii) Consolidation tracking,

→ In this principle with little vibration to the stratified bed. The finer particles runs down through the interstitial space available in the bed of coarse particles under influence of gravity. This phenomenon is known as consolidation tracking.

→ During pulsion stage when the bed is open is essentially controlled by induced settling and initial of differential acceleration.

→ During the suction stage: when the load is brought to the stratification is controlled by consolidation drainage.

12/. Flotation Reagents:-

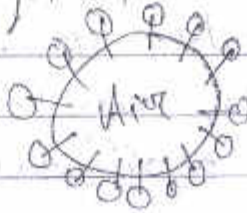
→ Froth Flotation being a physico-chemical process requires a no of chemical reagents for its success. Broadly the flotation reagents can be classified under following categories:-

i). Frothers.
ii). collectors.
iii). modifiers.

Frothers:-

→ Frothers are heteropolar surface active organic reagents capable of being on the air water interface. The adsorption of frothers at the bubble-water interface reduces the surface tension and stabilizeses the air bubble.

→ In the froth bubble the polar group is oriented towards the water phase providing the necessary water repellency to the bubble. A typical froth bubble is shown below



ii) Collectores,

The collector is the most important reagent in flotation. Each molecule of the collector contains a polar and a non-polar group. It get absorbed on the mineral surface and forms a continuous heteropolar surface film all around the particle.

→ The heteropolar film is so formed that the polar part is attached to the mineral surface and non-polar group is projected outwardly providing hydrophobicity to the mineral surface.

These of two types:-

i). Anionic collectors.
ii). Cationic collectors.

iii) Modifiers,

→ Sometimes it may be necessary to use a modifier before the collector can be a modifier before the collector can be made to function effectively. It is possible to accomplish the following by the use of a modifier.

→ Utilize, collectores under optimum condition.
→ Prevent or control mutual injured interaction.
→ Prevent our control action of atmospheric air and the aquatic impredients on the mineral surfaces.

→ modify favourably or achieve by the ability of some mineral to become floatable.

According to their function the modifying agents may be classified to the following categories.

i) PH regulators
ii) Activators
iii) Depressants or Des pressure
iv) Dispersants.

13) Heavy media separation process

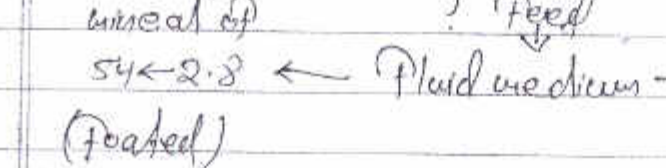
→ If a fluid is available with specific gravity intermediate between two solids. which are to be separated from each other then the simplest process will be to suspend the mixed mass in the fluid under consideration.

Principle of heavy media separation

→ The basic principle is involved in the gravity concentration process is the float and sink. This is carried out by using a fluid whose specific gravity lies two mineral particles in the ore.

→ As the most of the mineral heavier than the water it is used a suitable medium to carry out heavy media separation.

→ For the process to be effective fluids heavier than water are required. In the following figure the basic principle of scheme involved in heavy media separation.



Heavy media separation circuit

→ A simple heavy media separation circuit essentially consist of the following:-

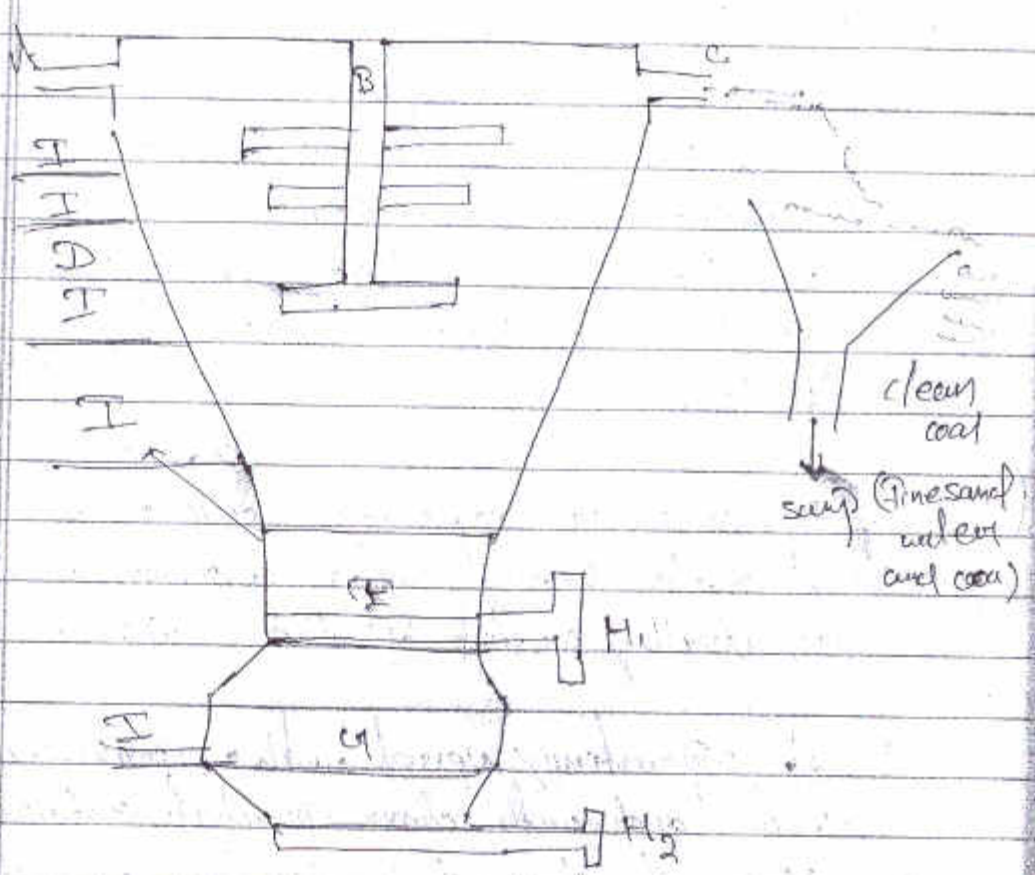
i). A separating vessel with a provision to collect float and with drawn product continuously.

ii). Means to clean the separated product remove the media and recirculate the same to the vessel for further utilization.

Chance process.

→ Chance process is in the use for last 150 yrs. for cleaning coal:-

→ where the parting fluid is suspension of 200 Quartz or sand particles in water in the size range of 40 to 180.



where, A = feed chute (Raw coal)
B = mechanical stirrer
C = Discharge (clean coal)
D = water line
E = seperating cone
F = classifying column
G = Refuse chamber
H_1 and H_2 = two pervated sidewalls

I = Dewatering screen

→ It consist of a separating tank or a cone shape separator in which the sand suspension moves up gently.

→ An agitator is used to stir the suspension to prevent its packing.

→ The overflow of clean coal and sand passes over to the cleaning screens which desands and dewaters the coal.

→ spray water is used for dewatering the specific gravity of fluid is adjusted by varying the proportion of sand in the suspension.

→ Anthracite coal required heavier fluid compared to bituminus coal.

* Liberation,

classification :-

→ classification is a process by which particles of various size, shapes and specific gravities are separated into different groups by allowing them to settle in a fluid medium. The coarse heavier grains settle faster than the finer and light grains - usually. air water or suspension may be regarded primarily as a mineral beneficiation process based stoke's or newton's laws of sedimentation or settling.