* Mineral processing *

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:- Unit-01 :-

- **Comminution :-**

Comminution in the mineral processing industry is a physical pre-treatment method that involves ore milling, grinding and breaking. these Mechanical methods increase the accessible surface area of the ore and its precious metals / materials through particle size reduction and size distribution.

- **Defination :-**

The process of comminution is the crushing and grinding of a material / ore to reduce it to smaller or finer particles. the comminution process reduces particle sizes by breaking, crushing, or grinding of ore, rock, coal, or other materials.

- **Scope and Economic Justification :-**

the scope of mineral processing is limited to liberation of individual mineral phases and their separation from each other without altering the identity of any mineral constituents. Mineral processing is the field of study that starts after mining and ends before extraction of metals for metallic ores.

Economic justification of mineral are used in a wide range of applications related to construction, manufacturing, agriculture & energy supply.

Economic minerals include:-

① Energy minerals used to produce
   ⓐ Electricity
   ⓑ fuel for transportation
   ⓒ Heating for homes and offices

② In the manufacture of plastics.

• Main Step in ore Mineral dressing operation:-

:- Ore Dressing & Mineral dressing:-

The first process most ores undergo after they leave the mine is mineral dressing (processing), also called ore preparation, milling, and ore dressing or ore beneficiation.

* Ore Dressing:- it is a process of mechanically separating the grains of ore minerals from gangue minerals, to produce a concentrate containing most of the ore mineral and a tailing (discard) containing the bulk of the gangue minerals.

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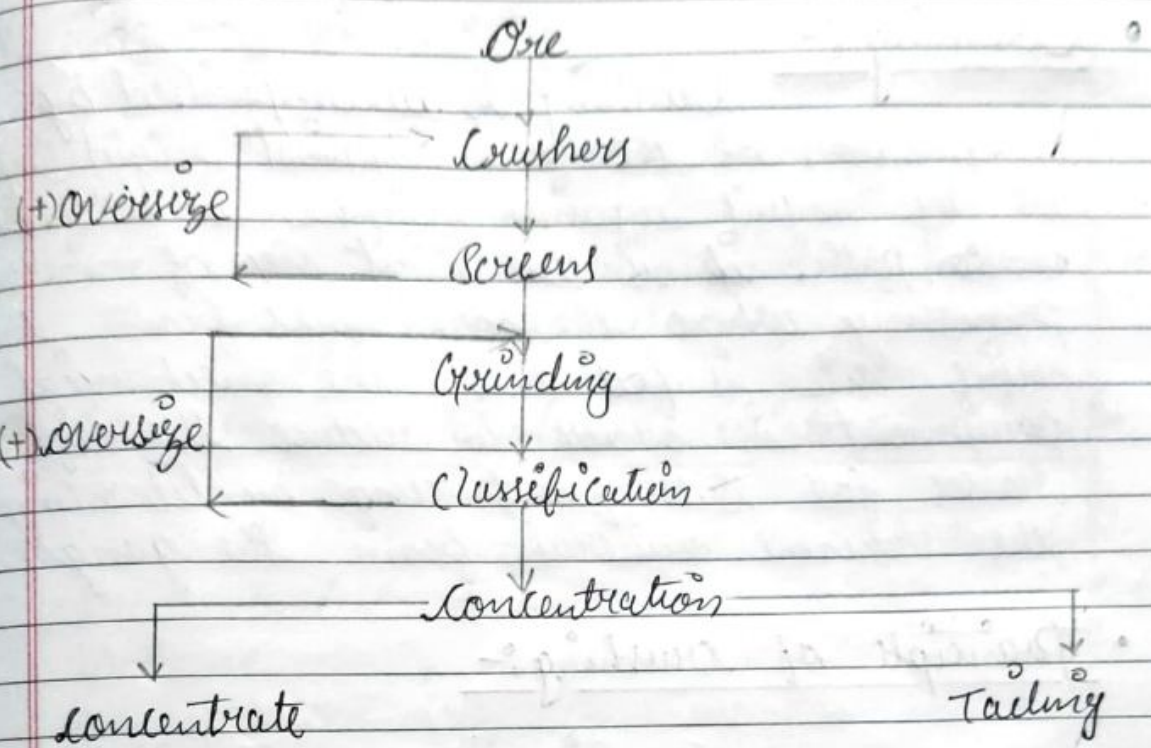
∴ A Simple flowsheet of a Mineral processing plant :-



* Mineral Dressing :-

Since most ore mineral are usually finely disseminated and intimately associated with gangue mineral, the various minerals must be broken apart (freed) or liberated before they can be collected in separate products.

therefore, the first part in any ore dressing process will involve the crushing & grinding (which is also known by a common name called Comminution) of the ore to a point where each mineral grain is practically free.

- **Crushing :-** Crushing is accomplished by compression of the ore against rigid surface, or by impact against surfaces in a constrained motion path. It is the first step of mineral processing where the ore/rocks from the mine site is fed into the mechanical equipment in order to reduce the size of masses for subsequent usage by liberating the valuable mineral from the gangue.

- **Principle of Crushing :-**

Crushing is a mechanical process where large solid particles of brittle materials are subjected to sufficiently high forces and energy with the consequence that the material of the particles fails and fragments are generated. this process happens predominantly in crushers.

- **Stages of Crushing :-**

Crushing are usually carried out in a sequence of operation by which the lump size is reduced step by step. there are 3 stages of crushing

1. Primary Crushing
2. Secondary Crushing
3. Tertiary crushing

i) Primary Crushing (coarse crushing):-

In primary crushing, ore or run-of-mine ore (up to 1 m in size) is crushed down to about 10cm and it is done in a jaw or gyratory crusher.

ii) Secondary Crushing (Intermediate crushing):-

In this case, ore is crushed from 10cm to less than 1-2 cm size; for this purpose jaw, cone or roll crusher are used. these secondary crushers consume more power than primary crushers.

iii) Tertiary Crushing (Fine Crushing):-

By tertiary crushers ore is crushed from 1-2cm to less than 0.5 cm. Short head cone crushers, roll crushers, hammer mills can be used for this purpose.

- **Jaw Crushers:-**

A Jaw crusher is a large piece of equipment thats used in mine and ore processing plants to crush rocks. the equiment was first introduced back in 1858 by inventor Eli whitey Black who primarily developed machinery used for crushing stone.

- **Gyratory Crushers:-**

A gyratory crusher includes a solid cone set on a revolving shaft and placed within a hollow body, which has conical or vertical sloping sides. material is crushed when the crushing surface approach each other and the crushed products fall through the discharging opening.

- **Cone Crushers:-**

A cone crusher is a compression type of machine that reduces material by squeezing or compressing the feed material between a moving pieces of steel and a stationary piece of steel.

the basic principle is straight forward the material to be crushed, drops into the crushing chamber. the mantle is a moving part that gyrates in an eccentric motion.

- **Roll Crushers:-**

Roll crushers are designed to handle the primary, secondary and tertiary stage crushing of friable material such as coal, salt, clay, bauxite, limestone & other minerals of similar characteristics in the mining, power generation and numerous other industries.

• Gravity Stamps their Classification & application:-

Gravity methods use the difference in the density of minerals as the concentrating agent.

In heavy-media separations (also called sink-and-float separation), the medium used is a suspension in water of a finely ground heavy mineral or technical product. Such a suspension can simulate a fluid with a higher density than water. When ground ores are fed into the suspension, the gangue particles, having a lower density, tend to float and are removed as tailings, whereas the particles of valuable minerals, having higher density, sink and are also removed.

In the process called jigging, a water stream is pulsed, or moved by pistons upward & downward, through the material bed. Important to this process is a thorough classification of the feed. Since particles less than one millimetre in size cannot be separated by jigging.

- **Grinding :-**

Grinding is a powdering or pulverizing process using the rock mechanical forces of impaction and attrition. the two main objectives for a grinding process are :-

① To liberate individual minerals trapped in rock crystals (ores) and thereby open up for a subsequent enrichment in the form of separation.

② To produce fines (or filler) from mineral fractions by increasing the specific surface.

- there is two stages of grinding are :-

i.) **Coarse Grinding :-** Rod mills are generally used as coarse grinding machines. they are capable of taking feed as large as 50mm and making a product as fine as 300 microns.

ii.) **Fine Grinding :-** Fine grinding, which is the final stage of comminution, is performed in ball mill. after feeding 0.5mm material may give a product that is less than 100 microns Grinding is usually done wet.

- **Ball mills:-**

A ball mill is a type of grinder used to grind or 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 drops from near the top of the shell.

Applications:-

a. The ball mill is used for grinding materials such as coal, pigments, and feldspar for pottery.

b. Grinding can be carried out either wet or dry but the former is performed at low speed.

c. Blending of explosives is an example of an application for rubber balls.

d. For system with multiple components, ball milling has been shown to be effective in increasing solid-state chemical reactivity.

e. Ball milling has been shown effective for production of amorphous materials.

- **Rod mills:-**

A mill that produces rods of steel or other metal and a pulverizing machine that uses loose iron rods as the grinding media. It works on the principle of inside filled grinding media. in this case steel Rods. these rods run the length of the machine, which is mostly common between eight sixteen feet in length.

The diameter of these rods will range from, when new, between 2 or 4 inches. the rods are free inside the mill.

Application:-

Rod mills are used in an open circuit between crushing and the ball mill. they often operate in wet and where the pulp contains up to 50% solid by mass. this machine is equally very applicable to dry where it could take a feed that has achived 6% moisture.

generally rod mills operate between 280 feet per minute & 480 feet per minute the periphery of the mill.

- **Pebble mills :-**

A rotating cylinder in which usually hard rounded stones or flint pebbles grind ceramic materials to extreme fineness. it works on the principle of vessel rotates and the media is lifted and cascades down, the particles are milled between the grinding media by continuous impacts.

:- Unit :-02 :-

- **Sizing :-**

Sizing is the general term for separating minerals according to their size. the separation methods are based on the variations among the physical properties of different minerals, such as shape, susceptibility to size reduction, specific gravity, surface chemical property, and electromagnetic exposure.

- **Objects or Purposes of Sizing :-**

① **Sizing or classifying :-** to separate particles by size, usually to provide a downstream unit process with the particle size range suited to that unit operation.

② **Scalping:-** to remove the coarsest size fractions in the feed material, usually so that they can be crushed or removed from the process.

③ **Grading:-** to prepare a number of products within specified size ranges. This is important in quarrying and iron ore, where the final product size is an important part of the specification.

④ **Media Recovery:-** for washing magnetic media from ore in dense medium circuits.

⑤ **Dewatering:-** to drain free moisture from a wet sand slurry.

⑥ **De-slimming or De-dusting:-** to remove fine material, generally below 0.5 mm from a wet or dry feed.

⑦ **Trash Removal:-** usually to remove wood fibers from a fine slurry stream.

⑧ To cut off the fine end from either feeds and thus save power and overgrinding

• Laboratory Sizing :-

- Material for size analysis is collected from the crushing section, the grinding section or closed circuit return / discharge.
- Material from the crushing section - to assess the work done by the crusher and the work to be done by the subsequent grinder.
- Material from the mill discharge of grinding section - to assess the size distribution of discharged particles.
- Material from closed circuit return - to assess sizes of material returned for further grinding.
- Material from closed circuit discharge - to assess whether the valuables are properly liberated for further concentration.

- **Need**

Lab sizing tests are done to check.

① progress of the material at various stages of treatments.
② the efficiency of power &
③ the effect of grinding on the recovery of values from the ore.

lab. Screening is normally done upto 40 microns (making sieves with accuracy below this is difficult)

- The apertures (meshes) of sieve - they are reference point telling whether particles will pass through them or not. this depends on the cross sectional area of the particles.

- A screen - an assembly of various apertures to test many particles at the same time.

- Screening :-

The crushed particles are separated using a rigid metallic screen with a perforated surface of fixed dimensions & uniform aperture. Crushed fragments of urban-mined material are dropped onto the screen surface. particles finer than the opening pass through the screen, while oversized particles are conveyed to the discharge end for re-crushing. Factors affecting screen performance are particle size, shape, orientation, feed rate, angle of discharge, percent % open area, type of vibration, moisture content, & feed material. Its efficiency is measured by recovery of the desired size & the misplaced materials in each product.

- Different types of industrial screen are available, each suited to handling a particular type of material. the screen may be of non-vibrating (such as grizzly) or the more frequently used vibrating type (such as trommel screens, vibratory & gyratory types)

1. Grizzly Screening. (Non-Vibrating)
2. Trommel Screening. } Vibrating
3. Vibratory Screening. }
4. Gyratory Screening.

- **Grizzly Screening :-**

The grizzly is used for primary screening of very coarse materials & is most often found in crushing circuits. it generally installed to size the feed to the primary crusher it is formed of a parallel set of horizontal or inclined heavy wear-resistant manganese steel rails or bars set a fixed distance apart. finer materials fall through the spacing of the bars. oversized materials slide onto the surface of the bars and are reduced on site by manual hammering. screens are static for very coarse materials a grizzly can incorporate a mechanism for shaking or vibrating the screen to improve performance.

- **Trommel Screening:-** is a horizontal or slightly inclined rotating cylindrical screen. The feed material enters at one end of the cylinder, undersized particles fall through the screening surface, oversized particles move by a rotating motion to the discharge end.

A trommel can separate several different-sized fractions by using a series of screens with apertures ranging from coarsest to finest. It can handle both dry and wet feed material. although trommels are relatively cheap, they have lower capacities and are susceptible to rapid wear. hence they have been largely replaced by vibratory or shaking screens.

- **Vibratory Screening:-**

The vibratory screen is the most common screening device found in mineral processing applications for the various types of material and particle sizes encountered. the shaking motion of the surface imparts on the material being screened. it can be arranged as multiple decks so that different particle-size products can be obtained from a single feed.

• Gyratory Screening :-

Gyratory screen separators consist of multiple, circular, removable and replaceable decks or trays for different-sized products. they work through both gyratory and slightly vertical motion operated by a specially designed motor mounted vertically at the centre of the baseplate of the screen.

gyratory separators are ideal for large and fine solid particles & solid/liquid applications.

• Classification :-

classification is a operation in which a mass of grain of mixed sized and specific gravity is allowed or caused to settle through a fluid medium which may be either in motion or stationary state. it's separation of particles according to their settling rate in a fluid.

classification used to classify particles of 2-3 mm sizes to 0.02 to 0.03 mm. normally used to size fine than 35 mesh screens.

- **Application:-**

1). Separation into relatively coarse and relatively fine size fraction, typically for separation too fines to be economically screened.

2). To effect concentration of smaller heavier particles from large lighter particles.

3). To split in long range size distribution in to fraction.

4). To restrict the property distribution of particles entering in concentration process.

5). To control close circuit grinding.

- **Principles of Classification:-**

1). When a solid particle falls freely in a vacuum, it is subject to constant acceleration and its velocity increase indefinitely, being independent of size and density. thus a lump of lead & a feather fall at exactly the same rate.

2). In a viscous medium, such as air or water, there is resistance to this movement and the value increase with velocity. when equilibrium is attained between the gravitational and fluid resistance forces, the body reaches its terminal velocity & thereafter falls at a uniform rate.

3). Effectively all resistance to motion is due to the shear forces or viscosity of the fluid & its hence called viscous resistance.

4). At high velocities the main resistance is due to the displacement of fluid by the body, and viscous resistance is relatively small. This is known as turbulent resistance.

5). Classifiers consist essentially of a sorting column in which a fluid is rising at a uniform rate. particles introduced into the sorting column either sink or rise according to whether their terminal velocities are greater or lesser than the upward velocity of the fluid. the sorting column therefore separates the feed into two products an overflow consisting of particles with terminal velocities lesser than the velocity of the fluid and an underflow or spigot product of particles with terminal velocities greater than the rising velocity.

- **Types of Classifiers :-**

Based on their separation principle classifiers are classified into two types :-

i). Wet classification.
ii). Dry classification.

i). Wet classification:-

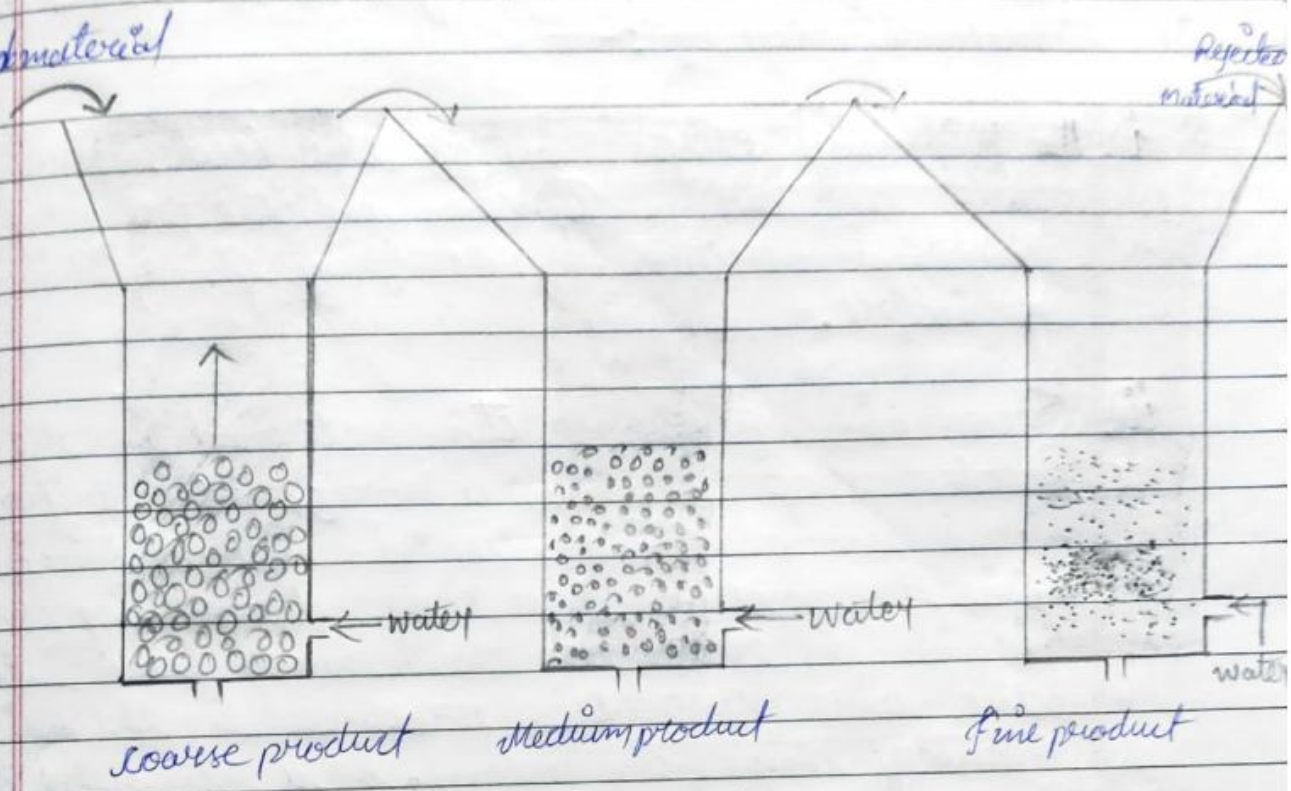
ⓐ. Mechanical classifiers.
ⓑ. Spiral classifiers.
ⓒ. Hydraulic classifier.
ⓓ. Hydro-cyclone classifiers.

ii). Dry classification:-

ⓐ. Gravitational classifiers.
ⓑ. Gravitational inertial classifiers.
ⓒ. Centrifugal classifiers.

- **Hydraulic classifier:-**

The hydraulic classifier works on the differences in settling rates of particles of feed pulp against the rising water current. the unit consists of a series of conical sorting columns of successively larger size with relatively lower current velocity. the relative rate of settling against the up-flow of water current accumulates the coarsest particles in the first and the finest in the last conical vessel sediment is removed from the bottom of the settling zone and treated accordingly. very fine slime overflows in the last column.



- **Pneumatic classifier :-**

The pneumatic classifier as disclosed includes a main body, means to produce air circulation in the body, means to feed material to be classified thereto, cyclone means to collect the final fine product, hopper means to collect the final coarse product.

The classifier including an ejector as primary dispersion means located within the classifier body on a selected reference level, horizontal centrifugal classifier means located above the said reference level, and a secondary dispersion means located below the said reference level.

The classifier being arranged to carry out the method step of :-

i). Primary dispersion of the feed material into an air suspension in the primary dispersion means by applying the ejection principle.

ii). Separation of the fraction retained in the created suspension in a horizontal centrifugal field on a higher elevation into a final fine product and a coarser middling product which is returned downward back into the air suspension produced in the said primary dispersion means, or is removed as a separate middling product.

iii). Secondary dispersion of the fraction settling by gravity from the said air suspension in the secondary dispersion means on a lower elevation by means of a desired part of the total air stream used for classification into a final coarse product and a finer middling product which is directed upward with the air medium directly into the said horizontal centrifugal classifier.

- **Sampling:-**

Sampling is the removal from a given lot of material a portion that is representative of the whole yet of convenient size for analysis. it is done either by hand or by machine.

Hand sampling is usually expensive, slow, & inaccurate, so that it is generally applied only where the material is not suitable for machine sampling or where machinery is either not available or too expensive to install.

many different sampling devices are available, including shovels, pipe samplers, & automatic machine samplers.

For these sampling machines to provide an accurate representation of the whole lot, the quantity of a single sample, the total number of samples, and the kind of samples taken are of decisive importance. a number of mathematical sampling models have been devised in order to arrive at the appropriate criteria for sampling.

- **Importance of Sampling:-**

Sampling is a vital component during all stages of the mine value chain. it includes the sampling of in-situ material & broken rock for geological, metallurgical & geoenvironmental purposes

- **Types of Sampling:-**

i.) Chemical Sampling:-
In chemical sampling the sampling are taken for assaying and determining the content valuable & deleterious components in the body of the useful minerals.

ii). Technological Sampling:-
In this method samples are collected for the study of technological properties of the raw material made in the course of its beneficiation and processing.

iii.) Technical Sampling:-
Samples are taken to study a technical properties of raw materials which does not requires metallurgical or chemical treatment.
(Mineralogical Sampling, Geo-physical Sampling).

- **Method of Sampling:-**

- Sampling method vary from simple grab samples on existing exposures to sophisticated drilling methods.

Generally there are two Sampling methods such as :-

- Surface Sampling.
- Underground Sampling.

In any method of Sampling, the records kept are as important as in the field practices it is used.

Here,
- Type of Sample.
- Size of Sample.
- True thickness of vein.
- Intervals b/t Sample location.
- Naming of Samples date & other relevant data are to be recorded.

Experience in Sampling profession provides for deciding the proper Spacing & number of Samples to be taken & selection of methods.

- The important surfacial Sampling method are as follows.

- Channel Sampling
- Groove Sampling
- Chip Sampling
- Muck Sampling
- Grab Sampling
- Car Sampling & chute Sampling
- Drill hole Sampling

- The some of important underground sampling methods.

1. Face Sampling.
   - Regular channel or groove sampling
   - Pick sampling
2. Grab Sampling.
   - Muck-pile samples
   - Car & chute samples
3. Bulk Sampling.
4. Drill Sampling.
   - Churan drill samples
   - Diamond drill samples
   - Rock drill samples (with piston/hammer drill)

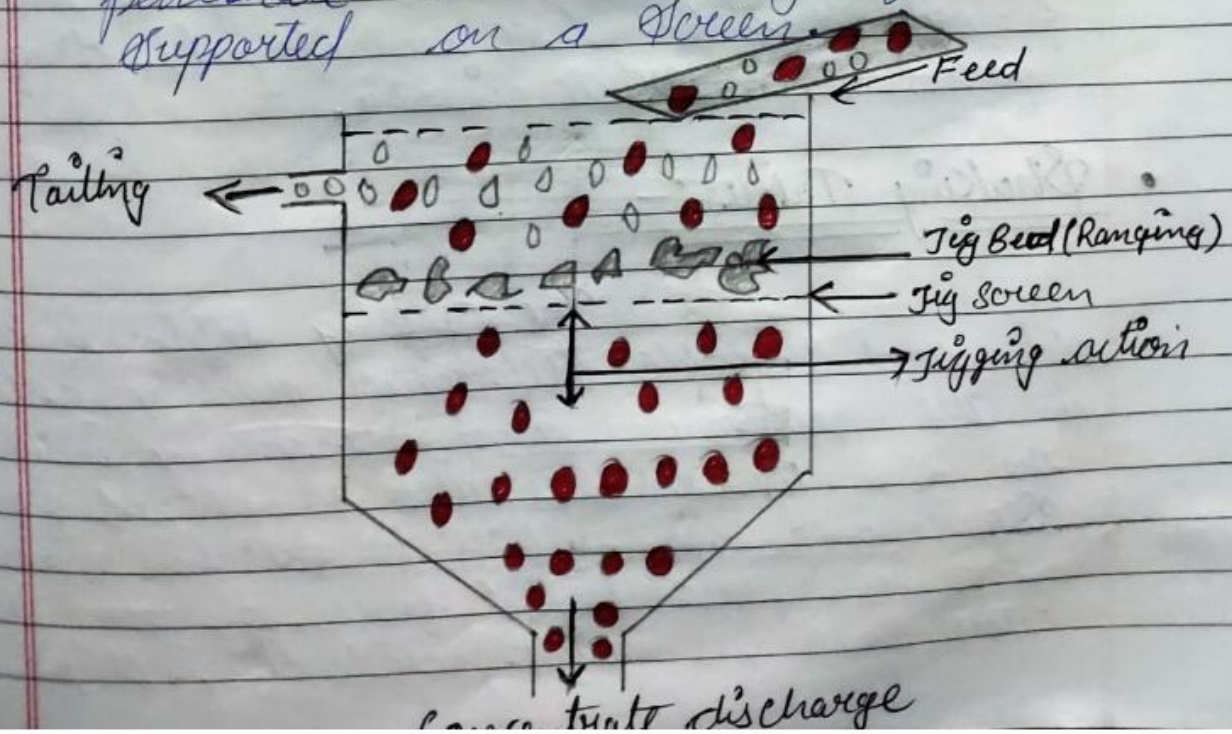
:- Unit :- 03 :-

- **Gravity concentration :-**

Gravity concentration can be defined as the process by which particles of different sizes, shapes, & densities are separated from each other by the force of gravity or the centrifugal force. the method is one of the oldest in mineral treatment.

- **Jigging :-**

Jigging is another technique, which has been used for almost 200 yrs in ore dressing to separate mineral with significant differences in specific gravity. the light & heavy particles are separated by using their abilities to penetrate an oscillating fluid bed supported on a screen.



The practical importance of Jigging is that stratification occurs with the denser minerals at the bottom of the bed & the lighter minerals at the top.

Two main Jig types:-

- Rectangular
- Circular

are linked through a trapezoidal Jig form.

- **Flowing film concentrator:-**

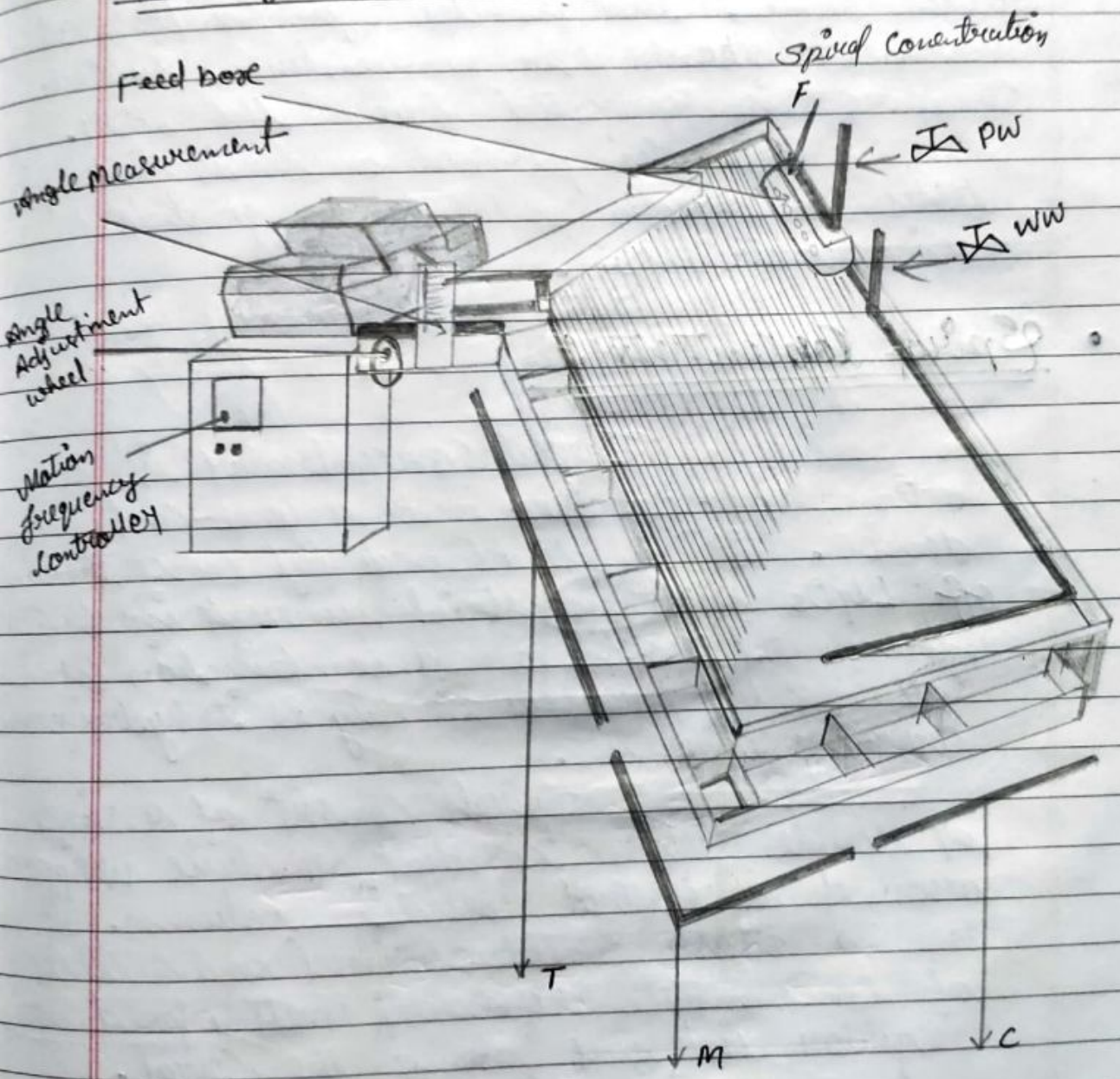
Flowing film concentrators involve particle motion through water and separation between particles of different size and density takes place as a result of the interplay of body forces (gravitational or centrifugal), drag forces and particle inertia.

- **Shaking Tables:-**

The Shaking table is an old and reliable technique widely used in the mining and Recycling industry. the Shaking table is also known as gravity separation, has different relative movements against gravitational forces, depending on factors such as weight, particle size, & shape by

taking advantage of the density differences between mineral particles.

- **Working principle of Shaking table :-**



Shaking tables are rectangular-shaped tables with ribbed decks with a water film flowing on them. Water flowing along the long axis of the table washes the fed sample. Low-density particles are transported

in the fast-moving film, causing fine, high-density particles to fall into the beds behind riffles.

the rapid backward movement of the table, the particles gain a forward movement thanks to momentum. So each structure is separated from the other.

Separation performance in shaking tables is directly related to particle size distribution.

- **Spiral Concentrator:-**

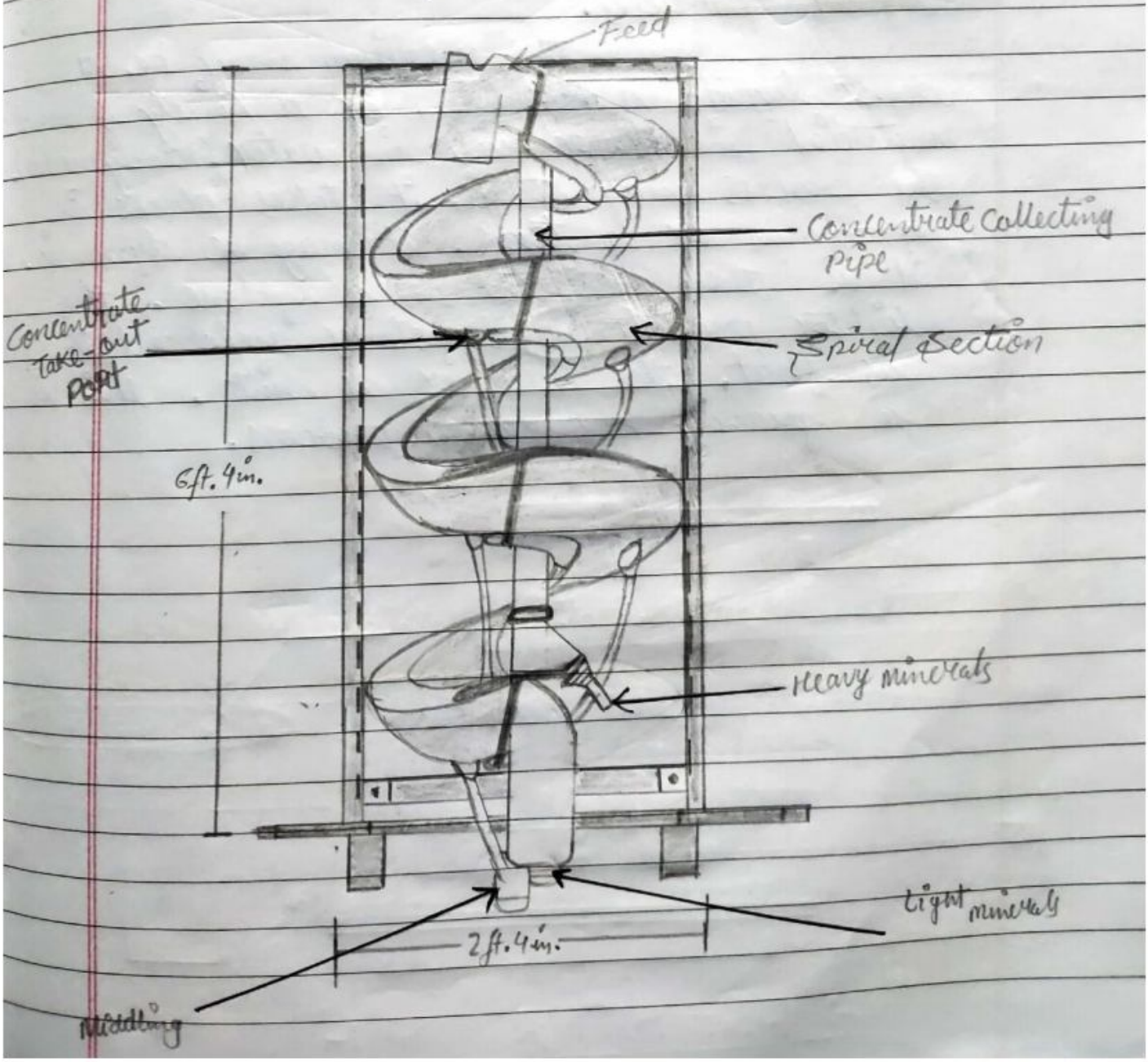
Spiral concentrator is a modern high-capacity and a low-cost device. it is developed for concentration of LGDs and industrial minerals in slurry form. it works on a combination of the solid particle density & its hydrodynamic dragging properties.

Spirals consist of a single or double helical conduit or sluice wrapped around a central collection column. it has a wash water channel and a series of concentrate removal ports placed at regular intervals along the spiral.

Separation is achieved by stratification of material caused by a complex combined effect of centrifugal force, differential settling and heavy particle migration through

the bed to the inner part of the conduit. the most extensive application is treatment of heavy mineral beach sand consisting of monazite, ilmenite, rutile, zircon, garnet etc. It is widely used to upgrade chromite concentrate.

two or more spirals are constructed around one central column to increase the amount of material that can be processed by a single integrated unit.



- **Heavy medium Separation:-**

Concentration process based on the ability of denser particles to float to the surface and lighter particles to sink to the bottom of a medium when the specific gravity of the medium is between those of the denser and lighter particles.

the medium may be a dense liquid, a solution, or a finely ground material in suspension in water (heavy media) the process may static. it takes places in a drum or a tank. it may be dynamic it is then effected in a cyclone. the lighter product is sometimes referred to as float, the heavier as sink. this is a gravity separation process.

* FLOTATION *

: Unit :- 04 :-

- **Physico-chemical principle :-**

The methodology of physical-chemical modeling of flotation systems is considered and effectiveness of its application for fundamental investigations in flotation is shown. using iron sulphides as the example, reliable information has been received on the surface state of iron sulphides, optimal conditions for their activation with copper salts & deactivation with cyanide & sulphide ions. The composition of sorption layer on the mineral surface forming during its interaction with xanthate or dixanthogen, the influence of collector forms sorption on the iron sulphides notability and on the optimal conditions of these minerals flotation.

From a single position the determined physico-chemical models in the form of quantitative equations have been derived for the optimal conditions of flotation and depression of iron sulphides under changing pH value and of the sodium sulphide, cyanide or lime additions.

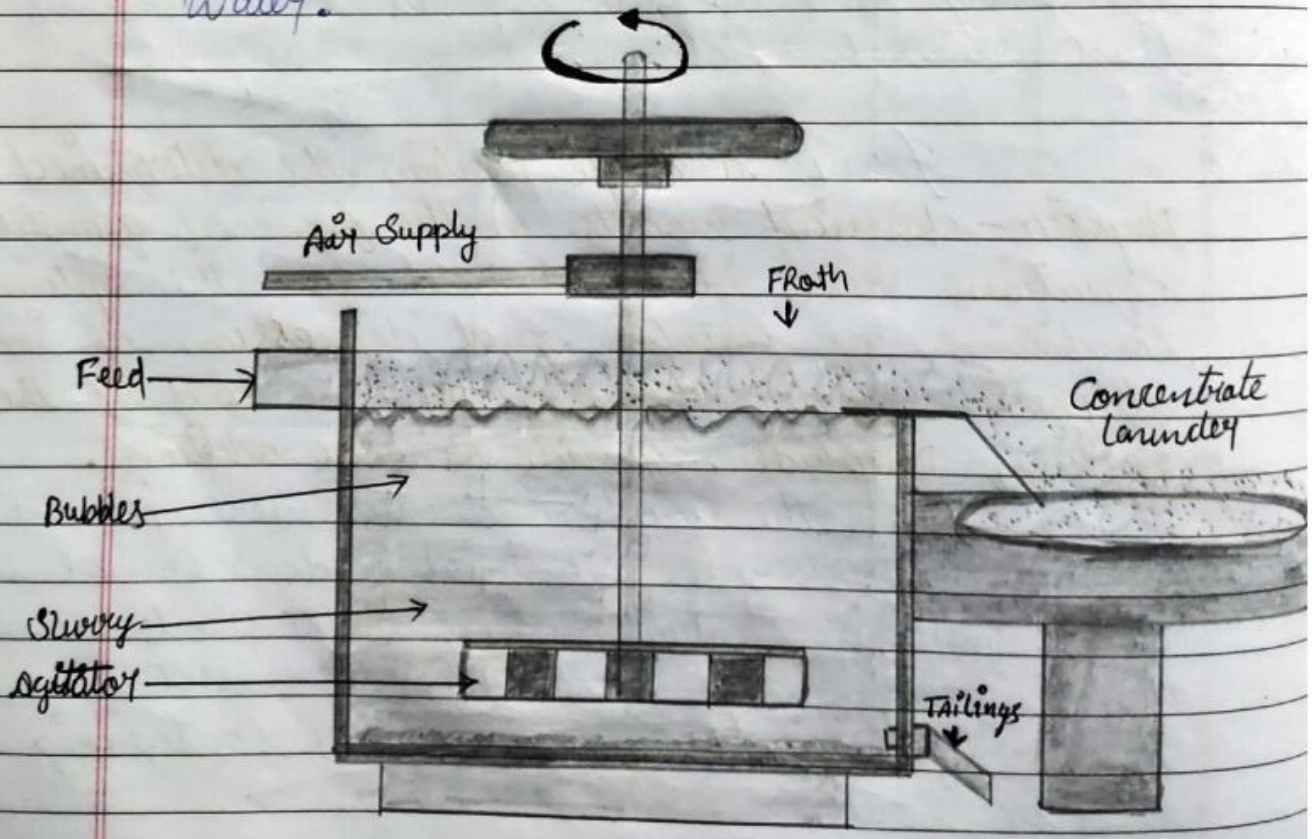
the equation derived were proven in the laboratory & industrial scale & can be used in automatic control systems at the plants as well as for improvement of technological processes of selective flotation of iron sulphides containing ores or coals.

- **Principle :-**

Flotation is a physico-chemical separation process that utilises the difference in surface properties of the valuable minerals and the unwanted gangue minerals.

- **Flotation :-**

Flotation, in mineral processing, method used to separate and concentrate ores by altering their surfaces to a hydrophobic or hydrophilic condition. this is the surfaces are either repelled or attracted by water.



: Flotation Process :-

• Function of various flotation reagents:-

Flotation is the most widely used industrial process for the separation of finely liberated minerals. the process involves the aeration of minerals in water in the presence of flotation reagents which facilitate the attachment of air bubbles to and levitation of select minerals. Once at the surface, the select minerals are supported by a froth layer until they are removed. Unattached materials remain submerged in the pulp.

The surface properties of a mineral determine its ability to float. collectors, some of the most important flotation reagents used in the flotation process, are used to modify the surface properties of minerals.

A collector is a chemical that selectively binds to the surface of target minerals and imparts hydrophobicity to those mineral particles, a necessary condition for air bubble attachment.

• Collectors can generally be classified into 3 categories:-

① Non-ionic :- Non-ionic collectors are simple hydrocarbon oils.
② Anionic and :- Anionic & cationic collectors consist of a
③ cationic polar component that selectively attaches to mineral surfaces & non-polar component that projects out into the solution making the surface hydrophobic.

- **Important machines in flotation:-**

Industrial flotation machines can be divided into 4 classes:-

1. Mechanical Machine.
2. Pneumatic Machine.
3. Froth Separation Machine.
4. Column Machine.

- **Mechanical Machine:-**

A mechanical machine consists of a mechanically driven impeller that disperses air into the agitated pulp. in normal practice. This machine appears as a long tank-like vessel having a number of impellers in series. Mechanical can have open flow of pulp between the impellers or can be of cell-to-cell design with weirs between them. Below is a typical bank of flotation cells used in industrial practice.

- **Pneumatic machine:-**

As pneumatic and froth separation devices are not commonly used in industry today, no further discussion about them will be given in this module. the mechanical machine is clearly the most common type of flotation machine currently used in industry.

followed by the column machine which has recently experienced a rapid growth.

- **Froth Separation machine:-**

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.

- **Column Machine:-**

The most rapidly growing class of flotation machine is the column machine, which is as its name implies, a vessel having a large height-to-diameter ratio (from 5 to 20) in contrast to mechanical cells.

This type of machine provides a counter-current flow of air bubbles & slurry with a long contact time & plenty of wash water. As might be expected, the major advantage of such a machine is the high separation grade that can be achieved. So that column cells are often used as a final concentrate cleaning step.

Special care has to be exercised in the generation of fine air bubbles & the control of the feed rate to the column cell for such cells to be effective. column cell use is often of limited value in the recovery of relatively coarse valuable particles. because of the long lifting distance involved, the bubbles can not carry large particles all the way to the top of the cell.

- **Flotation of Sulphides:-**

Flotation is a method of separating an ore species from another, based on its hydrophobic surface characteristics either natural or induced when present as a suspension in water with air bubble. due to the affinity of the desired mineral to adhere to air bubbles it is floated out of the ore slurry.

- **Flotation of oxides:-**

Flotation method is used for ores with lower content that cannot be enriched by physical method. in flotation processes it is generally preferred to float the mineral with a low amount. if the precious mineral

is floated and the gangue remain in the sinking part, this process is called as direct flotation.

- **Flotation of Non-Sulphide ores:-**

The underlying principle behind the process is differential wettability of ore & matrix. in other words, if by adding suitable reagents, ore & gangue can be wetted differentially, then this method can be applied to non-sulphide ores as well.

:- Unit :- 05 :-

- ## Processing Methods of some common minerals

- ## Electrostatic Seperation :-

Minerals and other materials are separated electrostatically through the difference in degree of electrical conductivity of the particles. However many minerals, metallic and non-metallic and other materials, accumulate a surface frictional charge through rubbing together in transit conveying or through coming into contact with various metals and other surfaces while in motion. This material which accumulates a frictional static charge agglomerates and quickly plugs the screen cloth.

Advantages :-

i). The electrostatic forces work on the particles to be separated only. They do not affect the medium in which the particles are located.

ii). The trajectories of the particles under the influence of the electric field follow the electric field lines. the electric field lines may be shaped to suit the particular application

iii). The direction of electrostatic forces may be reversed by either changing the polarity of the charge or the direction of the external electrostatic field.

iv). The electrostatic forces may be arranged to work in combination with other forces such as gravitational or centrifugal forces.

Disadvantages:-

i). Limitation of maximum mass that it can effectively work upon.

ii). The size of the material to be separated should be very small which leads to the increase of comminution cost

- ## Magnetic Separation:-

Magnetic separation is the process of separating components of mixture by using magnets to attract magnetic materials.

The process that is used for magnetic separation detaches non-magnetic materials with those who are magnetic.

The technique is useful for not all, but few minerals such as ferromagnetic and paramagnetic.

Advantages :-

i). A significant advantage of magnetic separation is that no filter cloth or other consumables are necessary.

ii). If the particles are separated with minimal amounts of fluid, the waste that needs to be disposed of is partically limited to the pollution only. As with many separation techniques, the principle is simple.

Disadvantages :-

i). The major disadvantage of magnetic separation method is that they are not quantitative and require secondary quantification method, that is, cell counts.

ii). Magnetic based methods can only perform positive & negative selections

- Pelletization of low grade iron ore :-

The geological assessment of the in-situ low-grade iron resources is difficult because of its heterogeneous distribution in the mineralised zone, that have different chemical, mineralogical, and textural characteristics through iron grade may be similar and the assessment of such

Sub-type resources becomes further more complex with high-grade iron ore reserve under the threat of depletion despite revision of threshold value of iron ores to 45% Fe & 35% Fe (from hematite ore and siliceous hematite ore respectively).

it is obligatory on the part of mining industry to consider exploitation & utilisation of low/lean-grade iron ores which hitherto were sidelined as waste for effective utilisation. the fresh exploration strategy would have to be drawn with cut-off / threshold grade ores as a target.

- **Drying & Dewatering - thickening :-**

Drying :-

A drying bed consists of a 30 cm bed of sand with an under-drainage. Sludge is applied on the sand bed and is allowed to dry by evaporation and drainage of excess water over a period of several weeks depending on climatic conditions.

Dewatering :-

Dewatering aims to reduce the water content further so that the solids content of the sludge is about 20% (equivalent to 1 kg dry sludge with 4 L of water). the sludge can then be handled like a solid. dewatering can be done mechanically using a filter press (employing pressure or vacuum), or a centrifuge.

it can also be done using drying beds.

Thickening :-

Thickening is carried out in a sedimentation tank or in a sedimentation pond. the latter is advantageous if land area is available, because the sludge can be allowed to settle over a much longer period and a higher solids content of the thickened sludge is achieved. the water removed from thicken needs treatment. it can be returned to the inlet of an off-site wastewater treatment plant, or in the case of sludge from on-site units by an aerobic treatment process.

• Filtration & drying :-

Filtration and drying are critical operations in a variety of industrial processes that require the separation of solid matter from a liquid. Solids can be discharged directly into a dryer, or in the case of a filter/dryer, the drying function is performed using the same equipment.

filtration can be broken down into two types of processes - continuous and discontinuous operations. Nutsche filtration, which we will be focusing on, is a batch filtration technique that uses vacuum and/or pressure in a closed vessel.

Some benefits of using this technology include product isolation, minimal operator exposure, reduced product handling and environment protection against solvent vaporization.

There are seven steps of Filtration process :-

i) Filling.
ii) Filtration.
iii) Displacement washing.
iv). Reslurry washing.
v). Smoothing.
vi). Drying / cooling.
vii). Discharging.

- **Coal Washing :-**

Coal that comes from a mine is a complex mixture of materials with a large variety of physical properties. In addition to the coal itself, pieces of rock, sand & various minerals are contained in the mixture.

Thus, before coal can be sold to consumers, it must be cleaned. The cleaning process consists of a number of steps that results in a product that is specifically suited to the needs of particular consumers.

Among the earliest of these steps is crushing and sizing two processes that Reduce the coal to a form required by the consumer.

The next step in coal preparation is a washing or cleaning step. This step is necessary not only to meet consumer requirements, but also to ensure that its combustion will conform to environmental standards.

Coal washing is accomplished by one of two major processes, by density separation or by froth flotation. both processes depend on the fact that the particles of which a coal sample are made have different densities.

when water, for example, is added to the sample, particles sink to various depths depending on their densities. the various components of the sample can thus be separated from each other.

In some cases, a liquid other than water may be used to achieve this separation. in a heavy medium bath, for example, a mineral such as magnetite or feldspar in finely divided form may be mixed with water, forming a liquid medium whose density is significantly greater than that of pure water.

A number of devices & systems have been developed for extracting the various components of coal. once they have been separated with a water or heavy medium treatment. one of the oldest of these devices is the jig.

In a jig, the column of water is maintained in a constant up-and-down movement by means of a flow of air. clean coal particles are carried to the top of the jig by this motion, while heavier refuse particles sink to the bottom.

Another method of extraction, the cyclone, consists of a tank in which the working fluid is kept in a constant circular motion. the tank is constructed so that lighter clean coal particles are thrown out of one side, while heavier refuse particles are ejected through the bottom.

Shaking tables :-

Shaking tables are another extraction method. as the table shakes back & forth, particles are separated by size, producing clean coal at one end and waste products at the other.

In cylindrical separators :-

a coal mixture is fed into a spinning column of air that throws the heavier waste particles outward. they coat the inner wall of the cylinder and fall to the bottom, where they are drawn off. the clean coal particles remains in the center of the air column & are drawn off at the top of the cylinder.

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Froth flotation processes:-

This processes depend on the production of tiny air bubbles to which coal particles adhere. the amount of absorption onto a bubble depends not only on a particles density. but also on certain Surface characteristics. Separation of clean coal from waste materials can be achieved in froth flotation by varying factors, such as pH of the solution, time of treatment, particle size and shape, rate of aeration, solution density and bubble size.