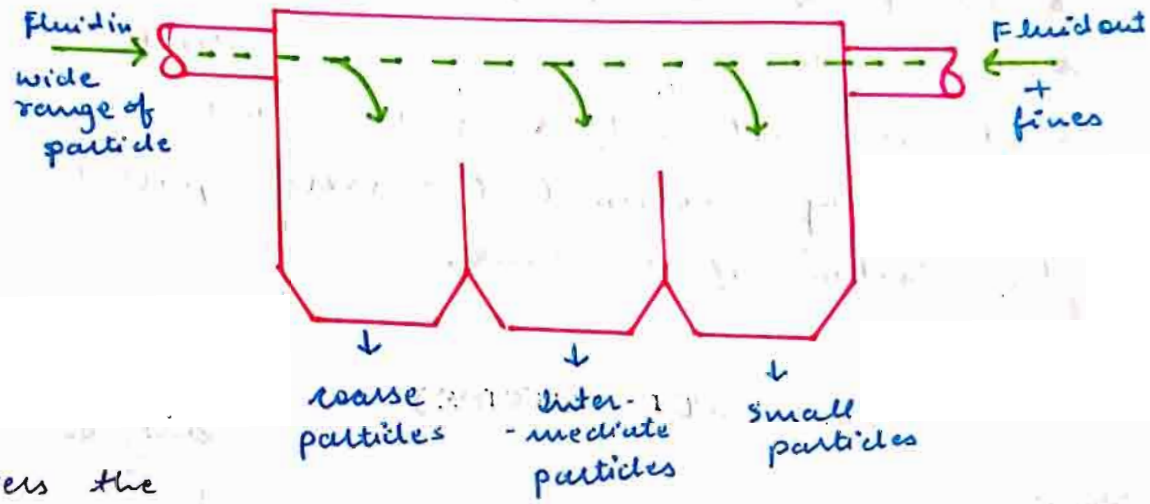
1 GRAVITY SETTLING TANK

PRINCIPLE

It works on the principle of sedimentation & gravitational force.

CONSTRUCTION

It consists of
- inlet, outlet connections
- vertical baffles



WORKING

- Slurry feed enters the tank through an inlet connection.
- Vertical baffles placed at various distances from the inlet within the tank allow for the collection of several fractions according to the terminal velocities.
- The very fine particles are now carried away in the liquid overflow from the tank.

(2) RAKE CLASSIFIER

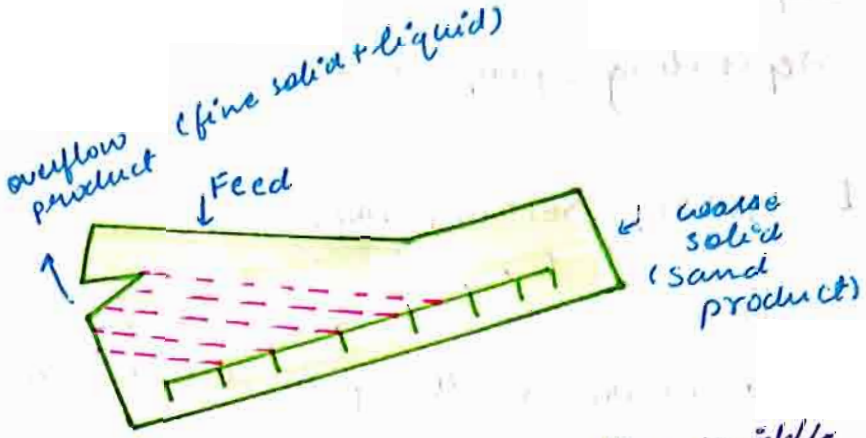
PRINCIPLE:

It depends on differences in the behaviour of particles.

CONSTRUCTION

It consists of

- rectangular tank
- movable rakes



WORKING

The feed in the form of a slurry is introduced continuously near the middle of the tank. The lower end of the tank has a weir overflow (discharge weir) from which the fines that are not settled leave with overflow liquid. The heavy material (coarser particles) sink to the bottom of the tank.

(3) SCRUBBERS (WET COLLECTOR)

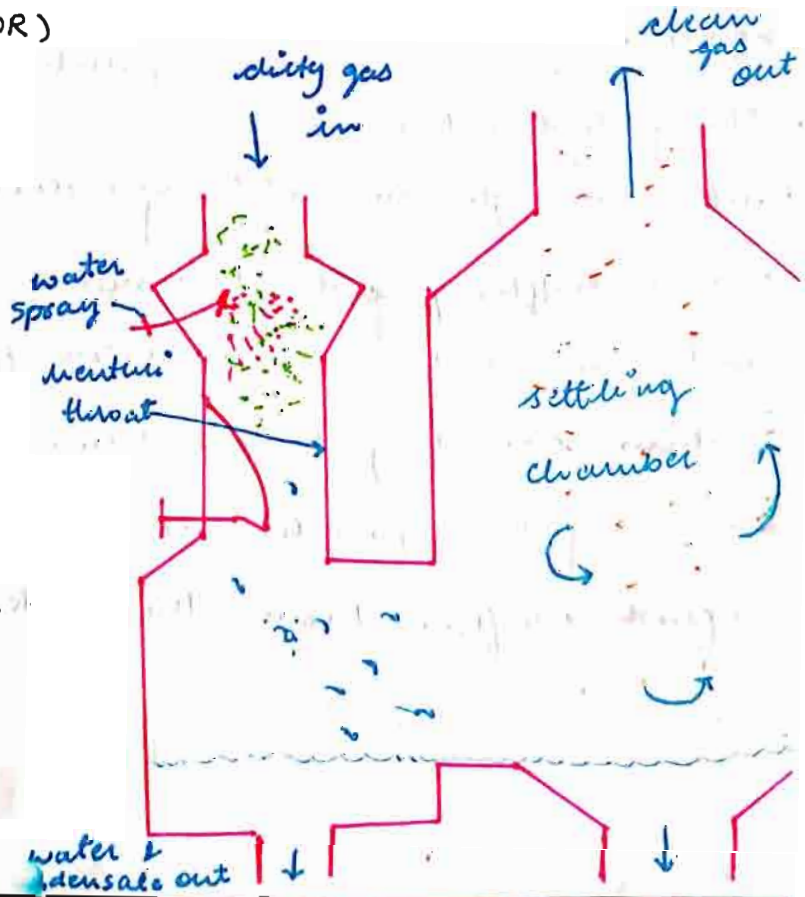
PRINCIPLE:

It works on the principle of 'gravitational settling' and 'air-water contact'.

CONSTRUCTION

It consists of

- dirty gas inlet
- water sprayer
- venturi throat
- settling chamber
- water & condensate outlet



- The contaminated gas passes through a duct that has a venturi shaped throat section.
- A coarse water spray is injected into the throat
- The liquid droplets collide with the particles in the gas stream and the water and particle fall down for removal and clean gas passes through outlet.

4. BAGHOUSE FILTERS (FABRIC FILTERS)

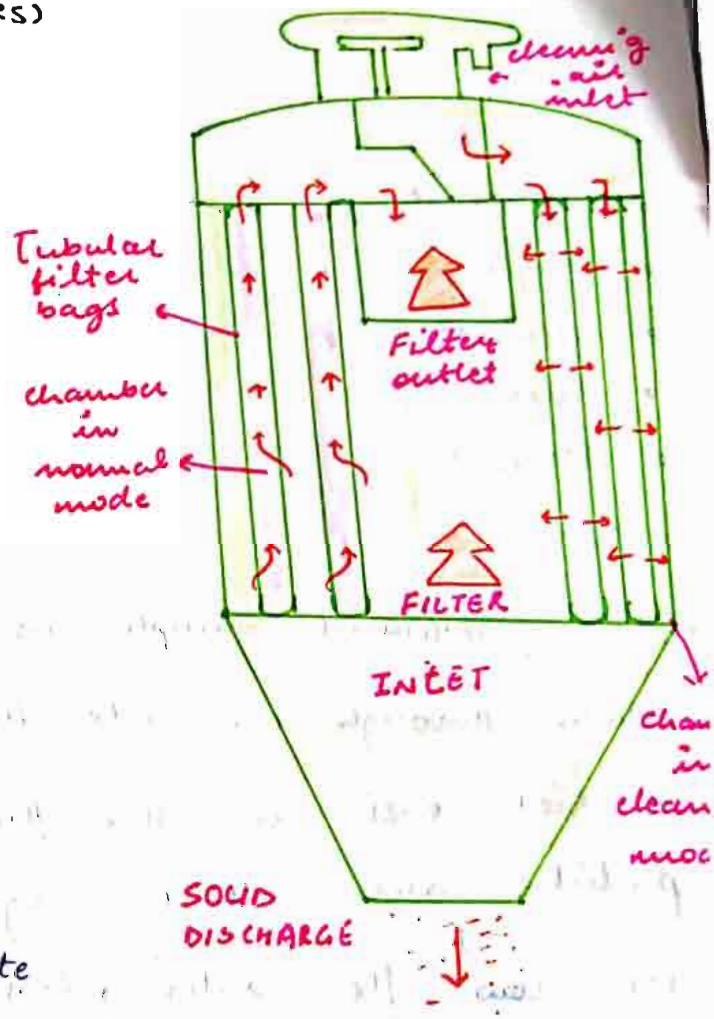
PRINCIPLE:

It is based on filtering rates of air to cloth ratio.

CONSTRUCTION

It consists of

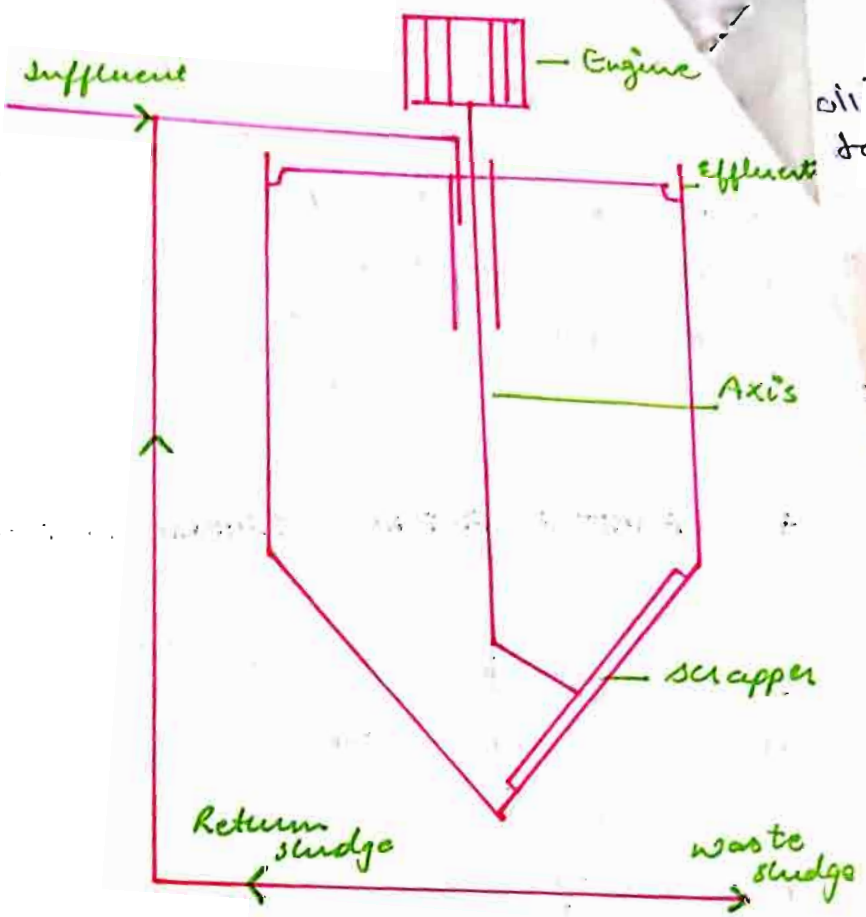
- cleaning air inlet
- normal mode chamber
- operation mode chamber
- outlet (solid discharge)
- Filter inlet & outlet
- Tubular filter bags



WORKING

- The contaminated or particulate laden gas stream passes through a woven fabric.
- The particulate is passed through the fabric ~~dust~~ and the particles are retained by diffusion, direct interception gravitational settling.

5) ELUTRIATION TANK



PRINCIPLE

It follows on the basis of physical properties like size, density etc and on the process of sedimentation.

CONSTRUCTION

It consists of

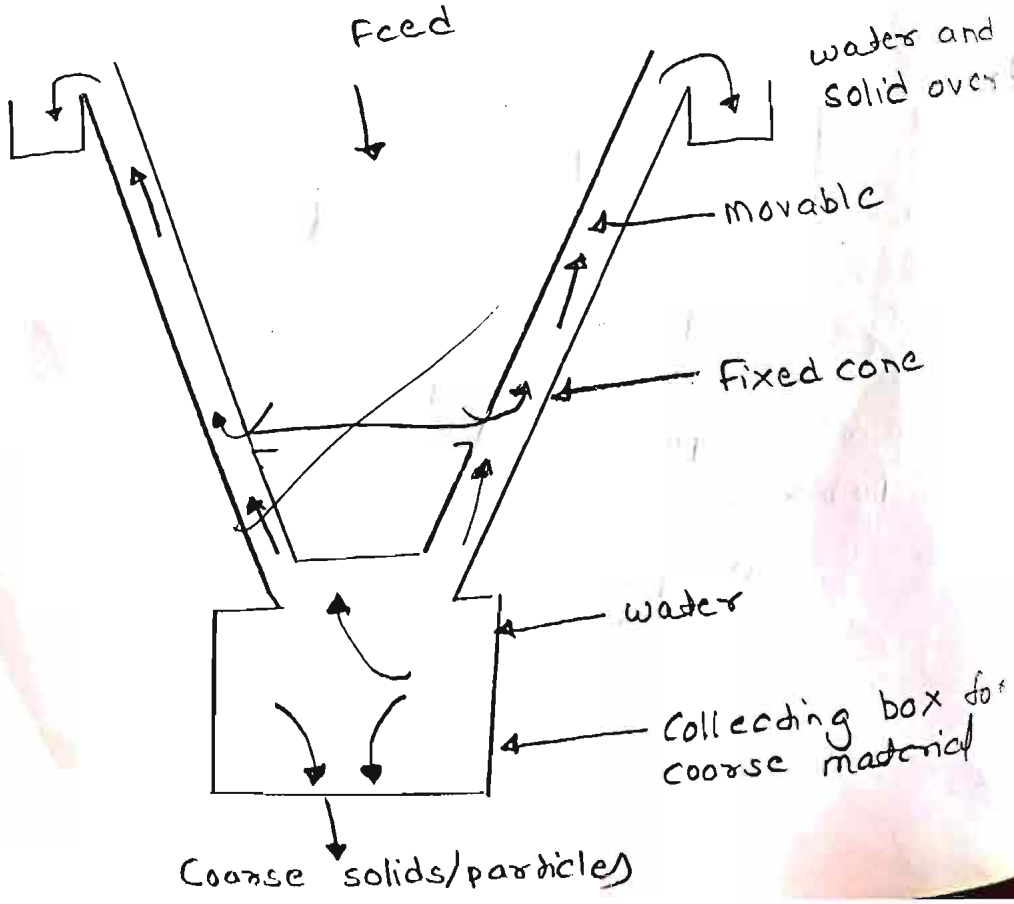
- sludge path
- influent
- engine
- effluent
- axis
- scrapper

WORKING

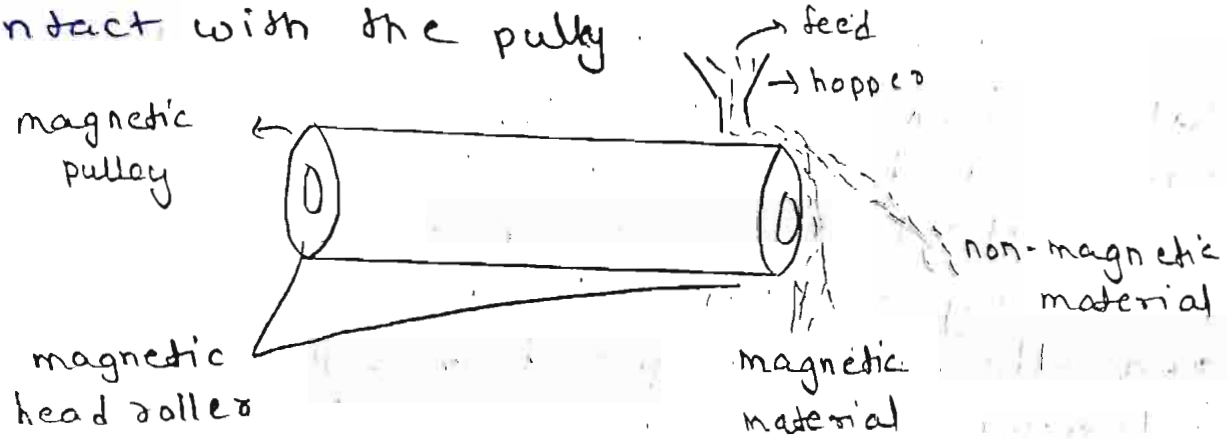
- The sediment sample is fed and then agitated constantly
- Then through the side tubes, the smaller particles are carried over in the fluid stream while the larger particles are settled against the upward current. For low flow rates, less dense particle attain their terminal velocities and then get seperated in overflow.

- Double-cone classifier

This classifier use hydroylic water for clas-cation. The feed to be seperated is feed in the form of a suspension to the centre of a inner cone. It flow downward through the i cone and out at the bafle at the bottom the inner core. Hydroylic water is feed nea the outlet for the coure material. The solid from the inner cone and arising steam of water are mixed below the inner cone an the flow through an angular space b/w th two coner. Classificeation action occurs in th angular space, the small fine particles are carried away in the over flow while the la course particles settle aganist the hydroly tic the bottom and a remove periodi cally.



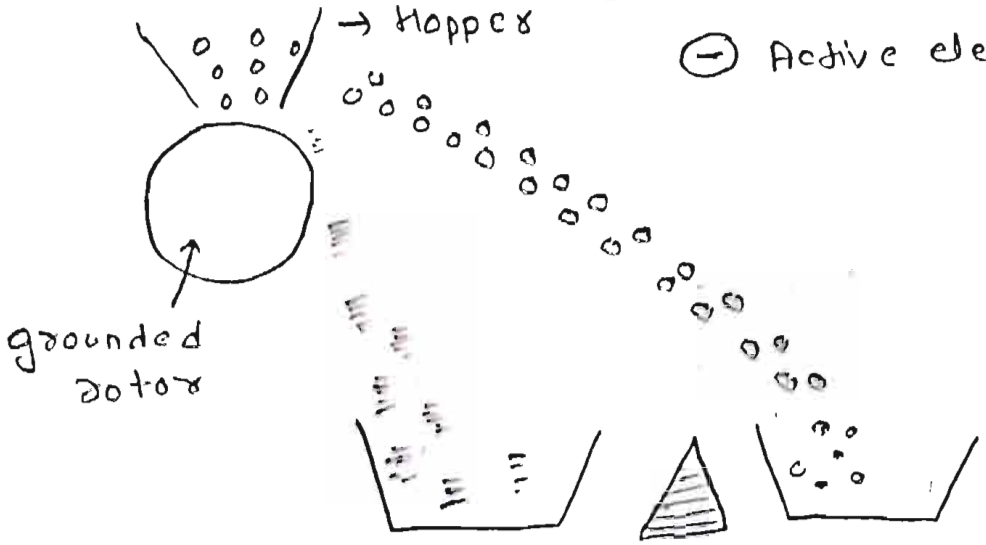
② Magnetic Separators ⇒ A magnetic pulley is incor-porated in a belt conveyor (carrying the charge) at the discharge end. As the material is conveyed over this pulley, the magnetically inert material / non-magnetic material drops-off the belt (or is discharged from the belt) in a normal manner while the magnetic material drops-off the belt in a normal manner while the magnetic material adheres to the belt and falls off from the underside where the belt loss contact with the pulley.



③ Electrostatic seperator

In electrostatic seperator, the difference is electrical properties of different material is exploited to effect of seperation.

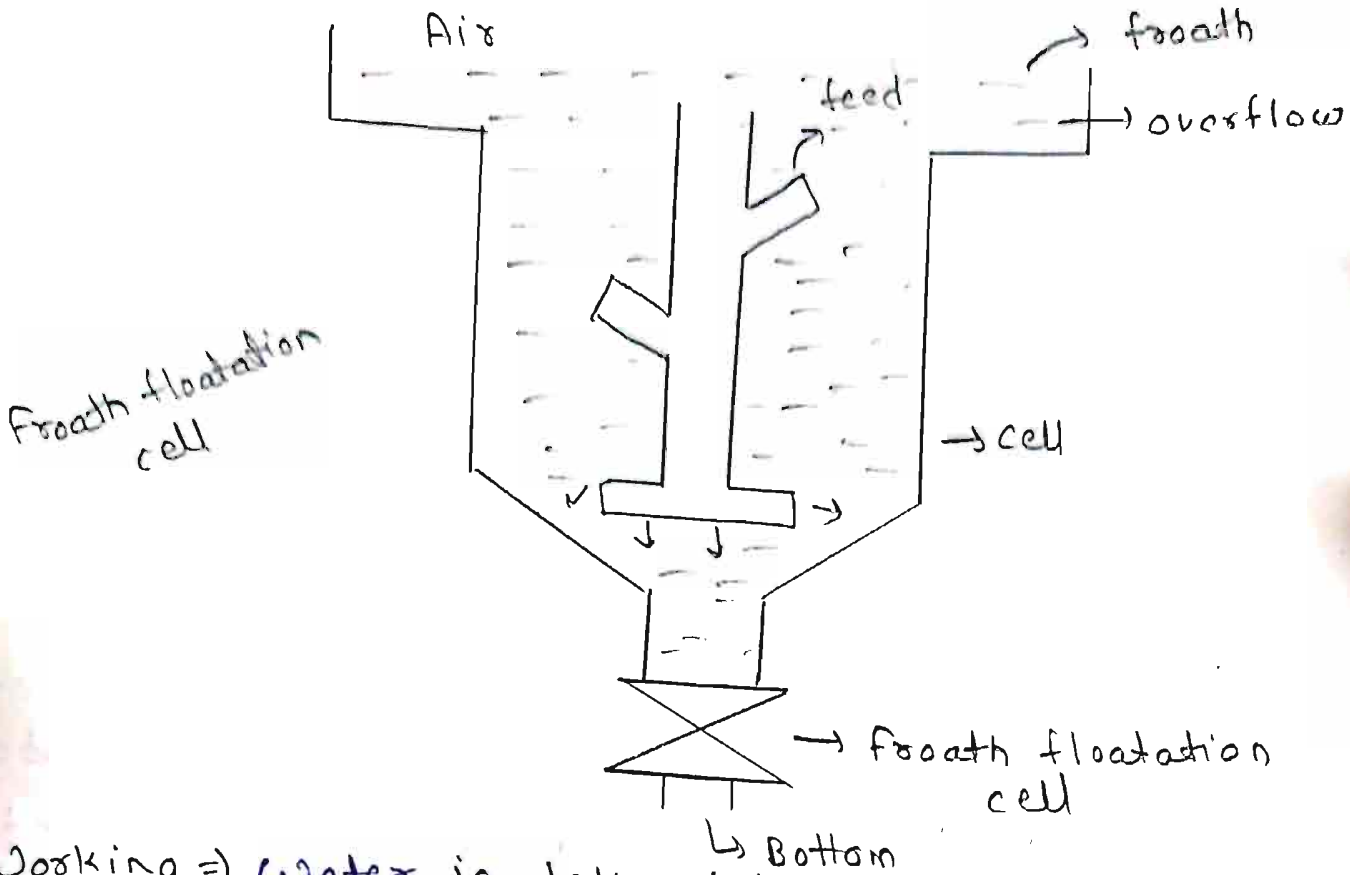
Construction ⇒ It consist of grounded rotor/ rotating drum, a hopper for feeding the solids, an active electrode situated / placed at a small distance from the rotating drum and collecting drum.



Working ⇒ The solid to be seperated are fed on to the rotating drum either charged or grounded from a hopper. The conductive parti in a very short time will assume the potenti of rotating drum, which is opposite to the active electrode and hence, they get attracted towa the active electrode. The non-conductive mater is repelled by electrode. ~~The non-conductive mat~~ -rial and attracted by the drum. The non cond -tive falls down stright wholer the influnce of gravity and is colleeted in a seperated bins

④ Froath Floatation Cell

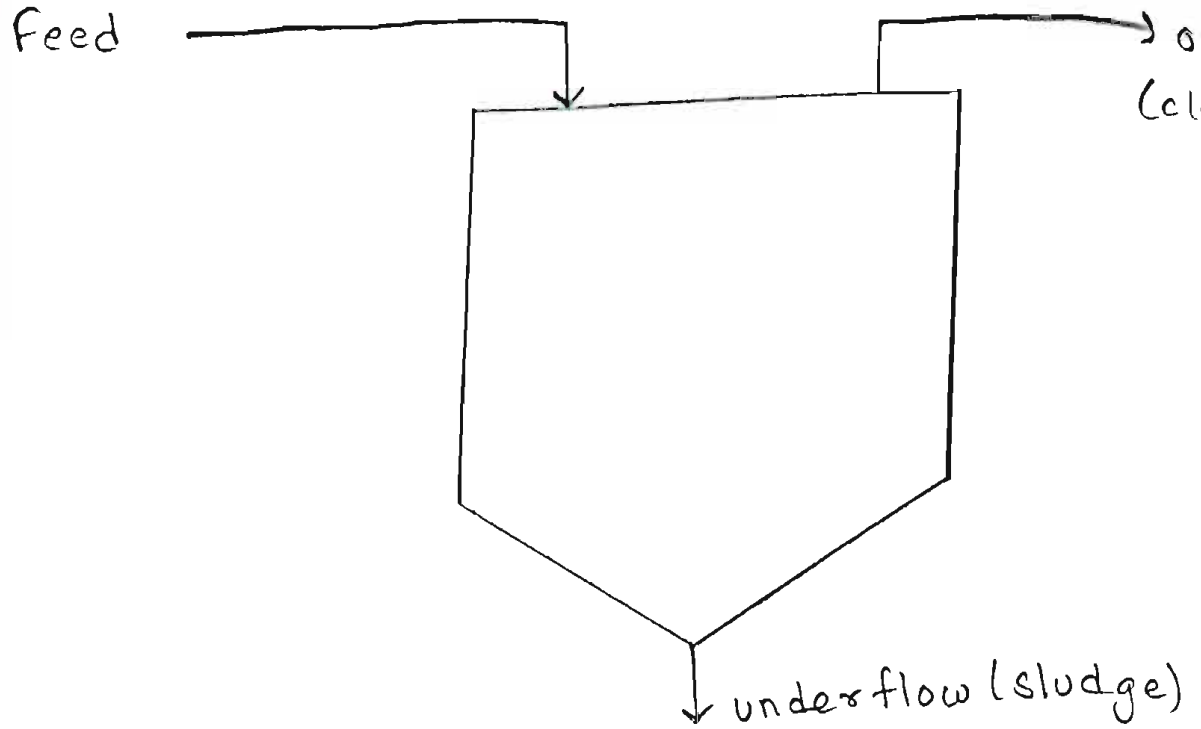
Construction ⇒ The mechanically agigated cell cons of a tank having square or circu cross-section. It is provided with an agigator wh revolently agigated the pulp. The air from a compressor / blower to introduction into system thro a downpipe surrounding the impeller shaft. / The bot of the tank is conical and is pravided with a dischang trailings. An overflow is provided at the top for emeralised froath removal.



Working ⇒ Water is taken into the cell, material is feed to the cell. The promotors and froath are added. Agigators are given and air is bubbled into the form of fine bubbles. Air avid particles they are discharged from the overflow Hydrophillic particles sink to the bottom and removed from the discharge for tailings

5) Thickeners

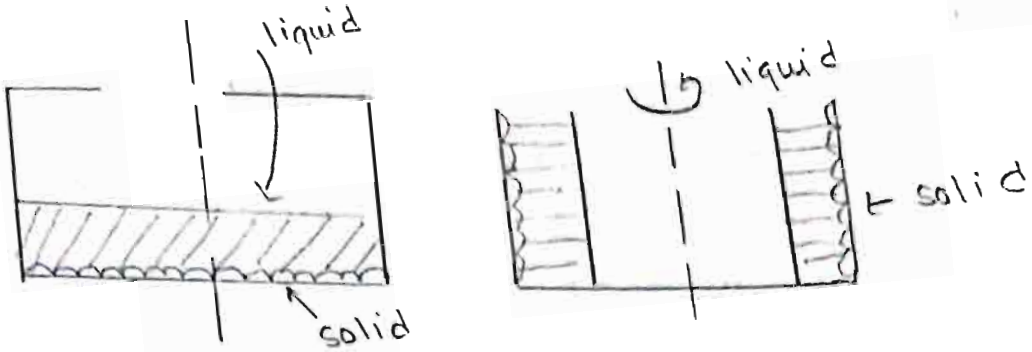
Construction ⇒ It consist of a relavely shallow tank from the top which clear liquid is taken off and the thickened liquid is withdrawn/removed from bottom. In majority, cases the conc^n of a suspension is high and hindred settling taken place.



Working ⇒ The conc^{n} of the suspension is high, hindered settling takes place. The rate of sedimentation can be artificially increased by the addition of coagulation agents such as alum etc which causes reduction in the viscosity of liquid. Further the thickners is frequently heared which causes reduction in the viscosity of the liquid. Further, the thickener is frequently provided with a slow stirrer which helps in the consolidation of sedimat and also the apparent viscosity of the suspension.

⑥ Centrifugal Seperation

A stationary cylinderical bowl contains a slu since the bowl is not rotating solids which set at the bottom and with horizontal liquid su -face. It shows that the bowl about its vertical axis. In the case, the liquid and solid are acted upon by two force - the gravity force downward and the centrifugal force acting horiz

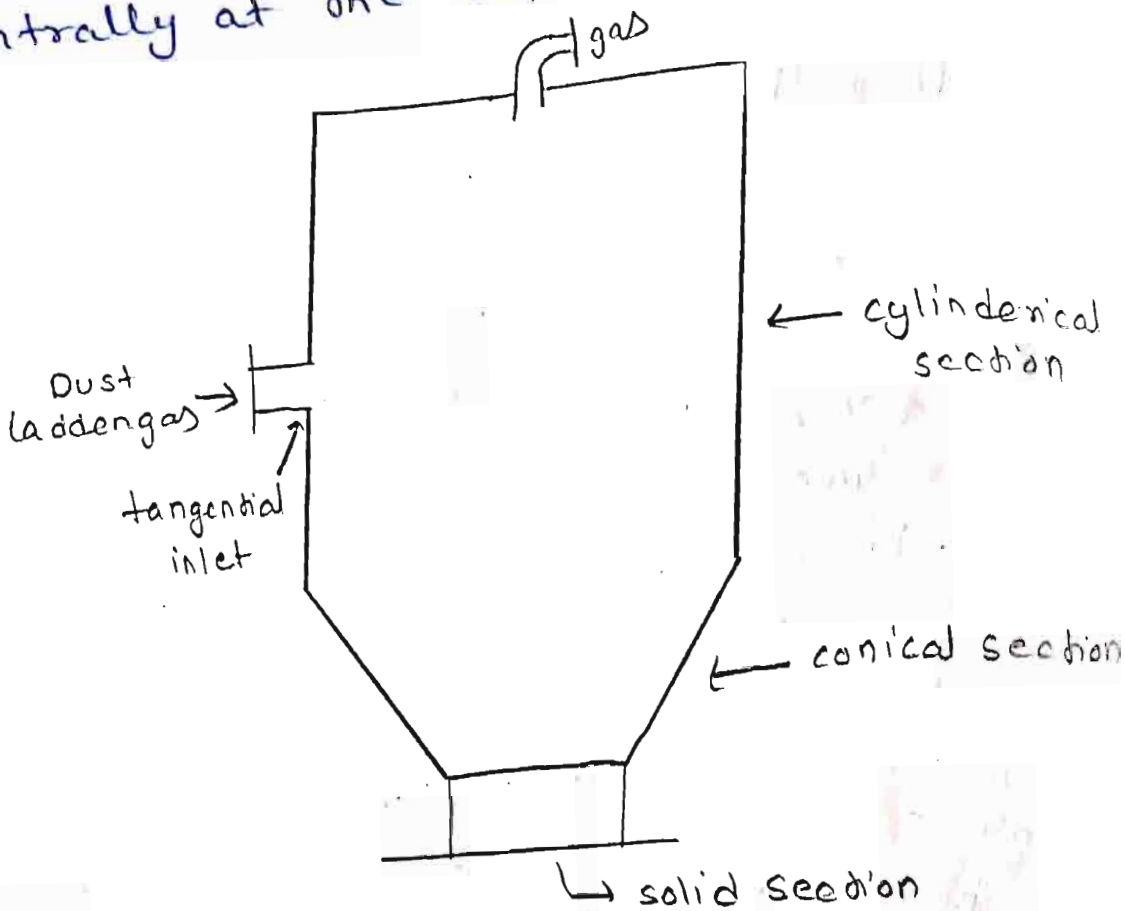


Working ⇒ Normally, the centrifugal force is very large as compared to gravity force and hence, the same may be neglected in comparision with the centrifugal force, Under the action of centrifugal force, the solid particles are pressed aganist the vertical bowl wall and the liquid layer the assume the equilibrium and for cutting the vortax. In this seperation used for the seperation of due particles are most from gream the dust loaded gas is introduced tangentially then a cylinder vessel at a higher velocity (30m/s) Centrifugal force throws the solid particles out against the wall of the vessel. Position with an almost vertical inner surfece as shown in fig. If the wall of the bowl is perforated and perforation covered with a filter medium such as they fine were screen. The liquid is free to flow ownward but the solids are not.

7) Cyclone seperator

Construction ⇒ It consist of a tappering cylindr-cal vessel, a cylinderical vess consisting of a top vertical seation and low conical / tappering section derimination in an apex opening a short vertical cylinder

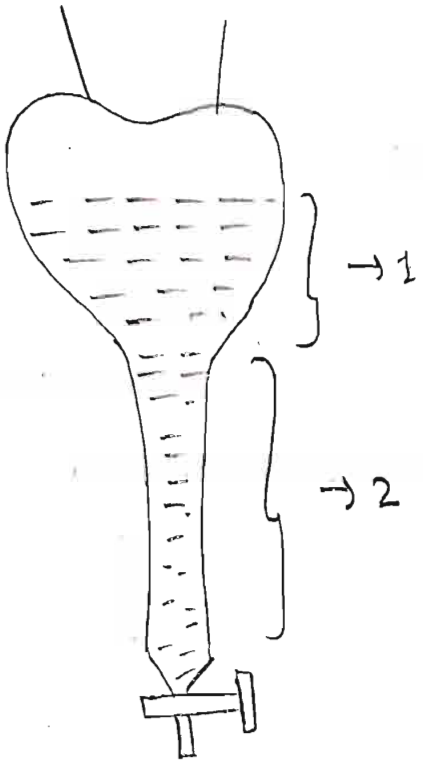
which is closed by a flat plate on top by a conical bottom. It is provided with a tangential feed inlet nozzle in the cylindrical section near the top and outlet for the gas centrally at the top.



Working ⇒ The outlet is provided with a downward extending pipe. A pipe that extends upward into the cylindrical section to prevent the gas short circuiting directly from the inlet in the outlet and for cutting the vortex. In this separation used for the separation of due particles are most from greater, the dust loaded gas is introduced tangentially then a cylinder invessed at a high velocity (30 m/s). Centrifugal force throws the solid particles out against the

wall of the vessel and they drop into a conical section of the cyclone and removed from the bottom apex opening the clean gas is taken out through a central outlet at top.

(8) Decantation



1) upper phase 2) lower phase

Principle ⇒ Decantation is a process for the seper-ation of mixture, by removing a larger of liquid, generally one from which a ppt. has settled. The purpose may be either to produce a clean duant or to remove undesstred liquid from ppt.

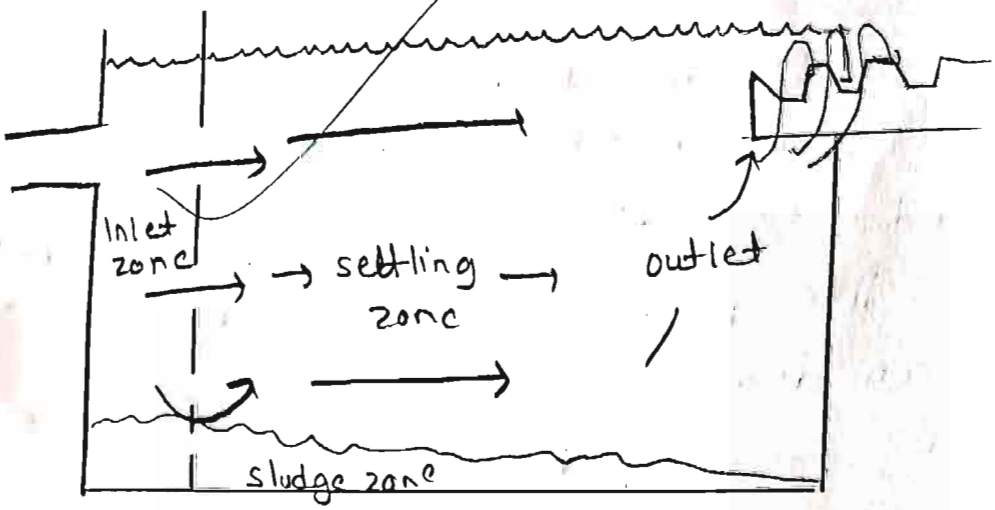
Working ⇒ A mixture of an insoluable solid in liquid is allowed to stand. If the is more dense than the liquid it will settle bottom if kept undesturbed for time. This is called sedimentation. A centrifuge cause the ppt. to be forced to the bottom of container if the force is high enough, the ppt. may form a compact solid. Then liquid can be more easily powred away, as ppt. will tend to remain in its compressed form. Similarly a mixture of two emmiscible liquid can also be seperated by decantation.

(9) Gravity central tank

Principle ⇒ To seperate solids from liquid using force of gravity. On sedimentation, suspended solids are removed

Construction ⇒ Sedimentation tank can be divided a different function zones

① Inlet zone ② Settling zone ③ Sludge zone ④ Outlet z

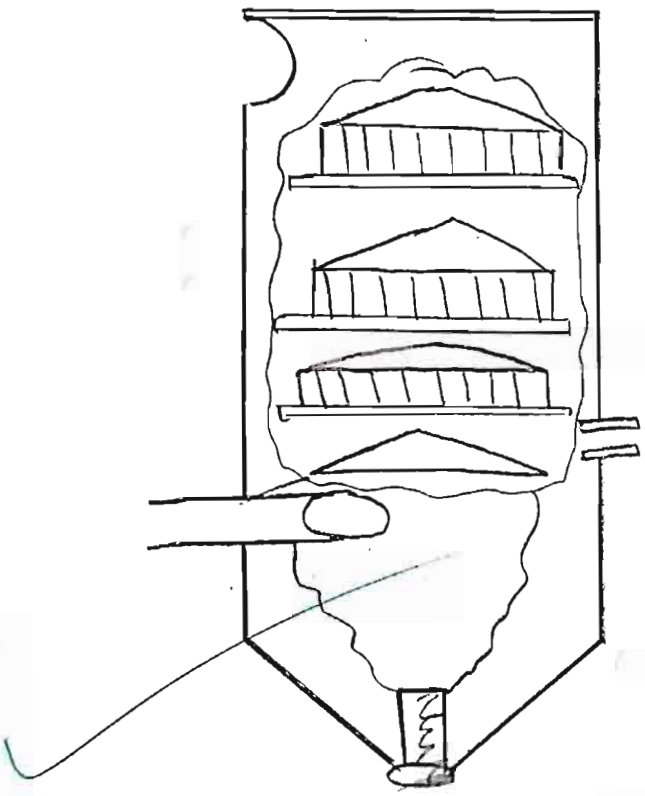


Working

Water flows to a tank called a sedimentation basin.

Gravity causes the force to settle to the bottom Large particles settle more rapidly then small particles it would take a very long time for all particles to settle out and that would need a very large sedim-entation basin. So, the clearified water, with most of the particles removed, moves on to the filteration step where the fine particles are remove

(10) Back filters & Scrubbers



Scrubber

Contruction & Working

This equipment consists of a cylinderical shell with conical bottom. The gas carrying suspended particles enters through a tangential entrance and pass upward through curtain of water or liquid

falling from deflector cones. The liquid used is introduced at top cones. Removal of entrained droplets of liquid from gas before leaving the seperator is accomplished by the seperator. The equipment combines the action of a cyclone with the scrubbing action of liquid. The discharge from scrubber goes to a cyclone seperator where the coalesced particles are removed from gas stream very effective and economical removal of sulphonic acid and mist is claemied

Qus no 41:- electrostatic seperation technique and equipment..?

Ans electrostatic seperation method:-

Q) From this method we seperate the mixture of particles in which one particle is different from another in electrostatic property. the ~~particel~~ particle that contains electrical property, if we put it between two electrods ~~cathode and anode~~ one of ghvoltage, the particle gets charged and attracted towards another electrode (say it is earthed) and thus we can easily distinguish between two particles and seperate them.

Any solid particle can receive a surface charge by any one of the following methods :-

a) contact electrification
b) electrification by conductive induction
c) electrification by ion bombardment

Electrification by conductive induction is one of the major electrification mechanism of separation of solid materials, if a particle is placed on grounded conducter in presence of an electric field the particle will rapidly aquire a surface charge by induction.

Q.47:- Give the construction and working of Electrostatic precipitator

Solution:

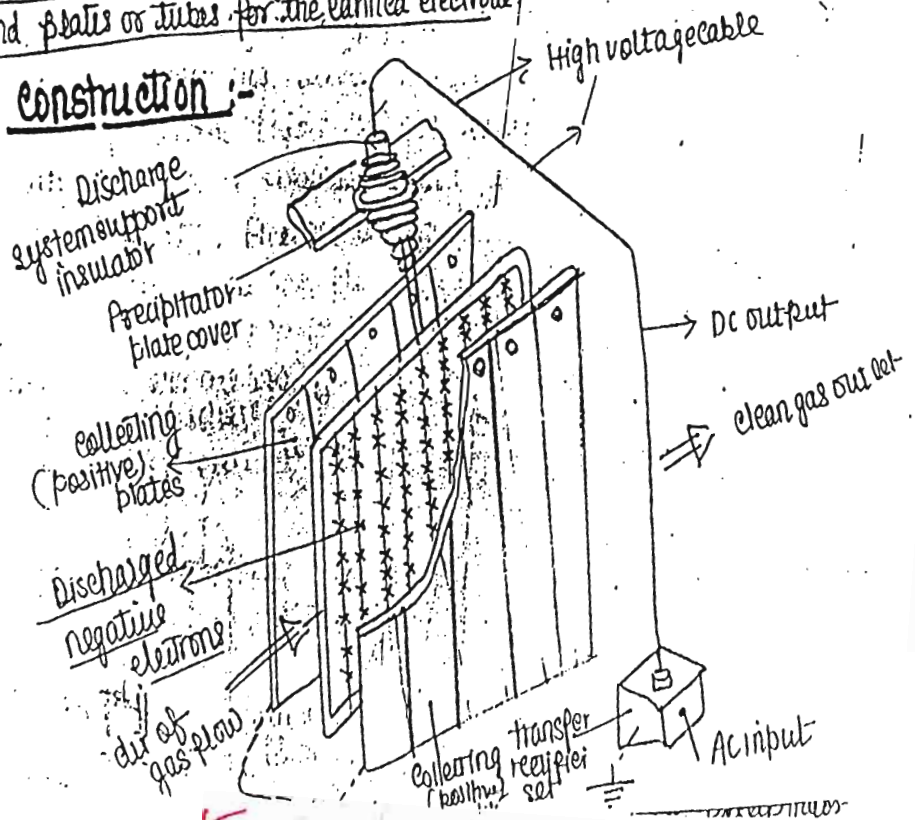
Electrostatic precipitator :-

Introduction :- Electrostatic precipitators are capable of collecting very fine particles ($< 2\mu m$), at high efficiencies. Since their capital and operating costs are high, electrostatic precipitation should only be considered in place of alternative processes such as filteration where the gases are hot or corrosive. Electrostatic precipitators are generally used in the metallurgical, cement and electrical power industries. Their main application is probably in the removal of fine fly ash formed in the combustion of pulverised coal in power station boilers.

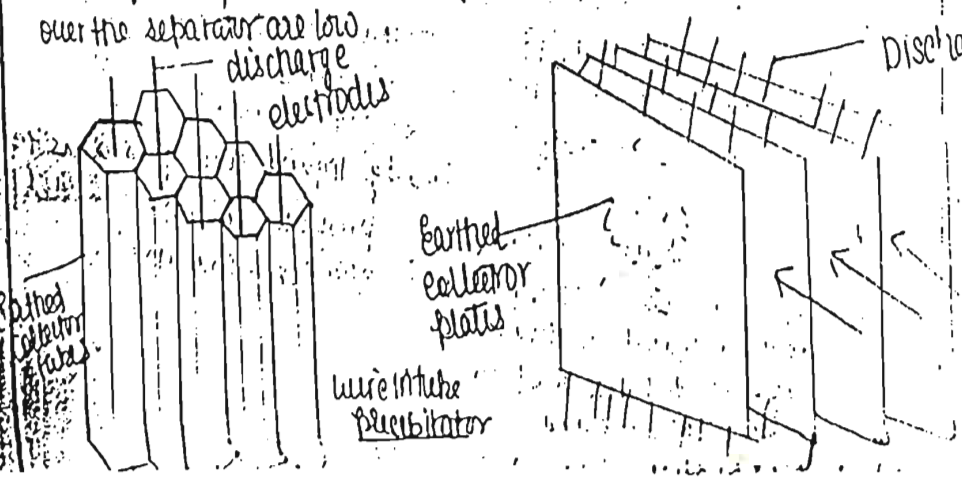
Basic principle of operation :-

The basic principle of operation of electrostatic precipitators are simple. The gas is ionized in passing between a high voltage electrode and an earthed (grounded) electrode. The dust particles become charged and are attracted to the earthed electrode. The precipitated dust is removed from the electrodes mechanically. usually by vibration or by washing. Wires are normally used for the high voltage electrode and plates or tubes for the earthed electrode.

Construction :-



Working :- gf the gas is passed between two electrodes - supplied to a potential difference from 10kV to 60kV, it is subjected to action of corona discharged ions which are given off by the smaller electrodes which the charge density is greater attach themselves to the particles which are then carried to the larger electrode under the action of the electric field. The smaller electrode is known as discharge electrode and the larger one which is usually earthed as the receiving electrode. Most industrial gases are sufficiently conducting to be readily ionized. The most important conducting gases being carbon dioxide, carbon monoxide, sulpher dioxide and water vapour but if the conductivity is low water vapour is added. The gas velocity over the electrodes - values between about .6 and 3 m/s with an average contact time of about 2 second The maximum velocity is determined by the maximum distance through which any particle must move in order to reach the receiving electrode and by the attractive force acting on the particle. This force is given by the product of charge on the particle and the strength of the electric field but calculation of the path of a particle is difficult because it gradually becomes charged as it enters the field and the force therefore increases during the period of charging. This rate of charging can not be estimated with any degree of certainty. The particle moves towards the collecting electrode under the action of the accelerating force due to the electric field and the retarding force of fluid friction and the maximum rate of flow of gas is that which just allow the most unfavourably located particle to reach the collecting electrodes before the gas leaves the precipitator. collection efficiency of nearly 100% can be obtained at low gas velocities but the economic limit is usually about 99%. Electrostatic precipitators are made in a very wide range of sizes and will handle gas flows up to about 50 m³/s. Although they operate more satisfactorily at low temp they can be used up to about 800K. Pressure drops over the separator are low.



Normally $r\omega^2 > g$, the surface is nearly vertical and y_0 has a very large negative value. Thus in practice the free surface of the liquid will be effectively concentric with the walls of the bowl. It is therefore seen that the operation of a high speed centrifuge is independent of the orientation of axis of rotation.

Centrifugal pressure:

A force balance on a sector of a fluid in the rotating bowl gives the pressure gradient at a radius r:

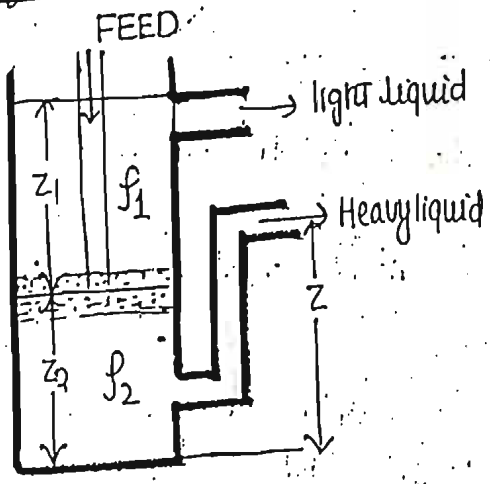
$$\boxed{\frac{\partial P}{\partial r} = \rho \omega^2 r}$$

Unlike the vertical pressure gradient in a column of liquid which is constant at all heights the centrifugal pressure gradient is a function of radius of rotation r and increases towards the wall of the basket.

Integration of the above equation at a given height gives the pressure P exerted by the liquid on the walls of the bowl of Radius 'R' when the radius of the inner surface of the liquid is r_0 as

$$\boxed{P = \frac{1}{2}\rho \omega^2 (R^2 - r_0^2)} \quad \text{---------- (A)}$$

Seperation of immiseible liquids of different intensities



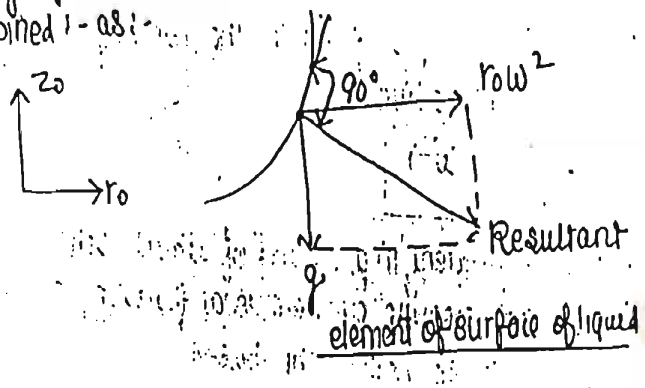
Gravity seperation of two immiscible liquid

For equilibrium the hydrostatic pressure exerted by height z of the denser liquid must be equal that due to height z_2 of the heavier liquid and a height z_1 of the lighter liquid in the seperator

$$z \rho_2 g = z_2 \rho_2 g + z_1 \rho_1 g$$

$$z = \frac{z_2 \rho_2 g}{\rho_2 g} + \frac{z_1 \rho_1 g}{\rho_2 g} \Rightarrow \boxed{z = z_2 + z_1 \frac{\rho_1}{\rho_2}}$$

The following figure shows an element of the free surface of a liquid in the bowl which is rotating at a radius r_0 about a vertical axis at a very slow speed, the centrifugal and gravitational fields will then be the same order of magnitude. The centrifugal force per unit mass is $r_0\omega^2$ and the corresponding gravitational force is g. These two forces are ⊥r to one another and can be combined as:



to give resultant force which must be at equilibrium be at right angle to the free surface. Thus the slope at this point is given by

$$\frac{dz_0}{dr_0} = \frac{\text{Radial component of force}}{\text{axial component of force}}$$

$$= \frac{r_0\omega^2}{g}$$

where z_0 is the axial coordinate of the free surface of liquid

$$dz_0 = \frac{r_0\omega^2}{g} dr_0$$

$$\int dz_0 = \int \frac{r_0\omega^2}{g} dr_0 + \text{const.}$$

$$\boxed{z_0 = \frac{r_0^2\omega^2}{2g} + \text{Constant}}$$

If z_a is the value of z_0 which corresponds to the position where the free surface is at the axis of Rotation ($r_0 = 0$) then

$$\boxed{z_0 - z_a = \frac{\omega^2 r_0^2}{2g}}$$

Taking bottom of bowl as the origin for the measurement of z_0. positive values of z_a correspond to conditions where the whole of the bottom of bowl is covered by liquid. Negatives values of z_a implies that the paraboloid of revolution describing the free surface would cut the axis of Rotation below the bottom and therefore the central position of the bowl will be dry.

Q.NO49:-

Give the construction and operation of a cyclone seperator?

Ans:- **Cyclone seperator:-**

Introduction :- most centrifugal seperators for removing particles from gas streams contain no moving part. They are typified by the cyclone seperator.

Construction :- cyclone consists of a vertical cylinder with a conical bottom, a tangential inlet near the top and out let for the dust at the bottom of the cone. The inlet is usually rectangular. The outlet pipe is tended in to the cylinder to prevent short circuiting of air from inlet to outlet.

Operation :- the gas is introduced tangentially in to the cylindrical u.nel at a velocity of about 30 m/s and the clean gas is taken off through a central out let at the top. The solids are thrown outward against the cylindrical wall of the vessel and then move away from the gas inlet and are collected in the conical base of the vessel. This seperator is very effective unless the gas contains a large proportion of particles less than about 10 μm in diameter and is equally effective when use with either dust or mist-laden gases. Because the rotating motion of gas in the cyclone seperator arises from its tangential entry and no external energy is imparted with in the seperator body, a free vortex is established. The energy per unit mass of the gas is then independent of its radius of rotation and the velocity distribution of gas may be calculated.

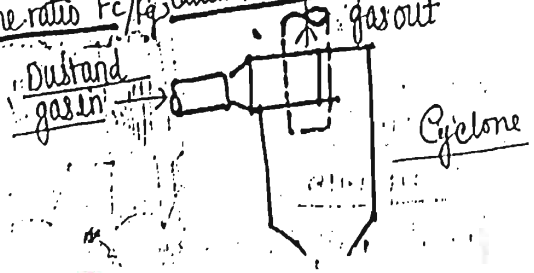
The incoming dust-laden air travels in a spiral path around and down the cylindrical body of the cyclone. The centrifugal force developed in the vortex tends to move the particles radially towards the wall and the particles that reach the wall slide down in to the cone and are collected. The cyclone: basically a settling device in which a strong centrifugal force, acting radially is used in place of relatively weak gravitational force acting vertically.

The centrifugal force Fc at radius r is equal to $= \frac{m U_{tan}^2}{r g_c}$

where m is the mass of the particle and U_{tan} is its tangential velocity. The ratio of centrifugal force to the force of gravity is then:-

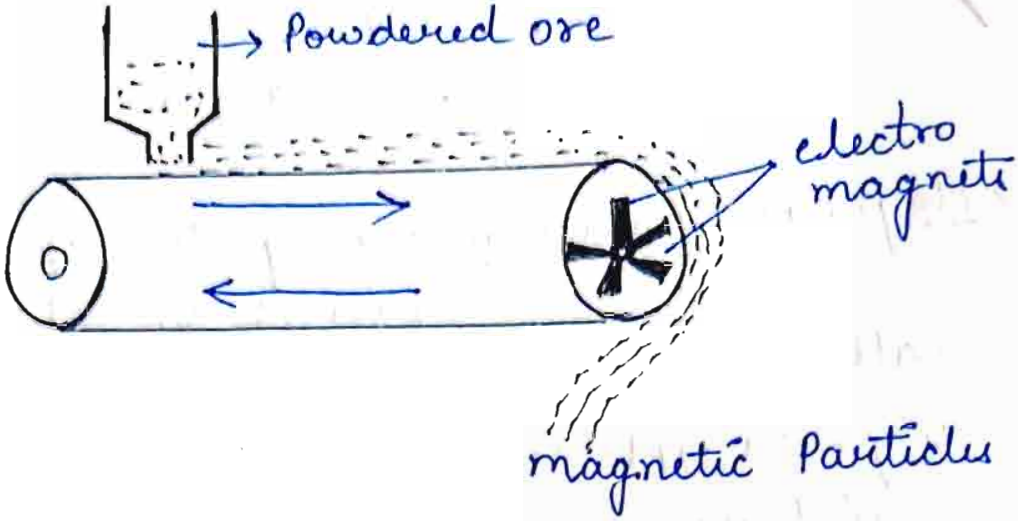
$$\frac{F_c}{F_g} = \frac{m u_{tan}^2 / r g_c}{mg/g_c} = \frac{U_{tan}^2}{rg}$$

For a cyclone 1 ft (.3m) in diameter with a tangential velocity of 50 ft/s (15 m/s) near the wall, the ratio F_c/F_g called the seperation factor is $2500 (0.5 \times 32.2) = 155$.



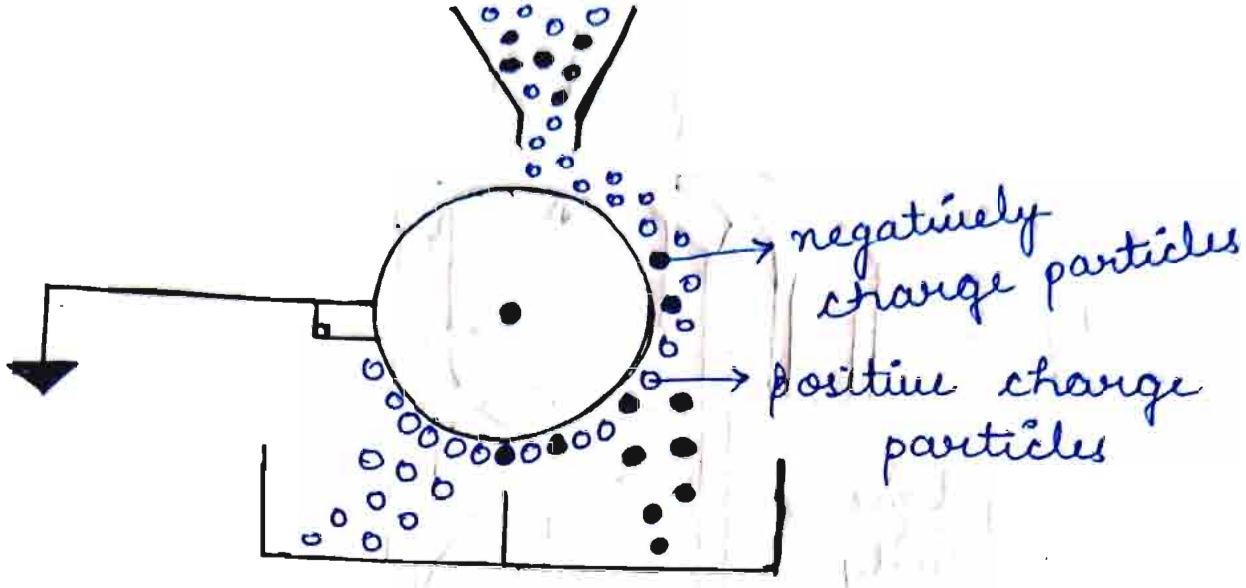
→ Magnetic Sepration :→ Magnetic sepration is a process in which magneti- - cally susceptible is a process in which magneti- - cally susceptible material is extracted from a mixture using a magnetic force. This sepration technique can be useful in mining iron as it is attracted to a magnet.

In this machine, the raw ore after calci- -nation was fed onto a moving belt which passed underneath two pairs of electromagnet under which further belts ran at right angles to the feed belt. The first pair of electromagnets was weakly magnetised and served to draw off any iron ore present. The second pair were strongly magnetised & attracted the wolframite, which is weakly magnetic. These machines were capable of treating 10 tons of ore a day.



(2.) Electrostatic Sepration :-

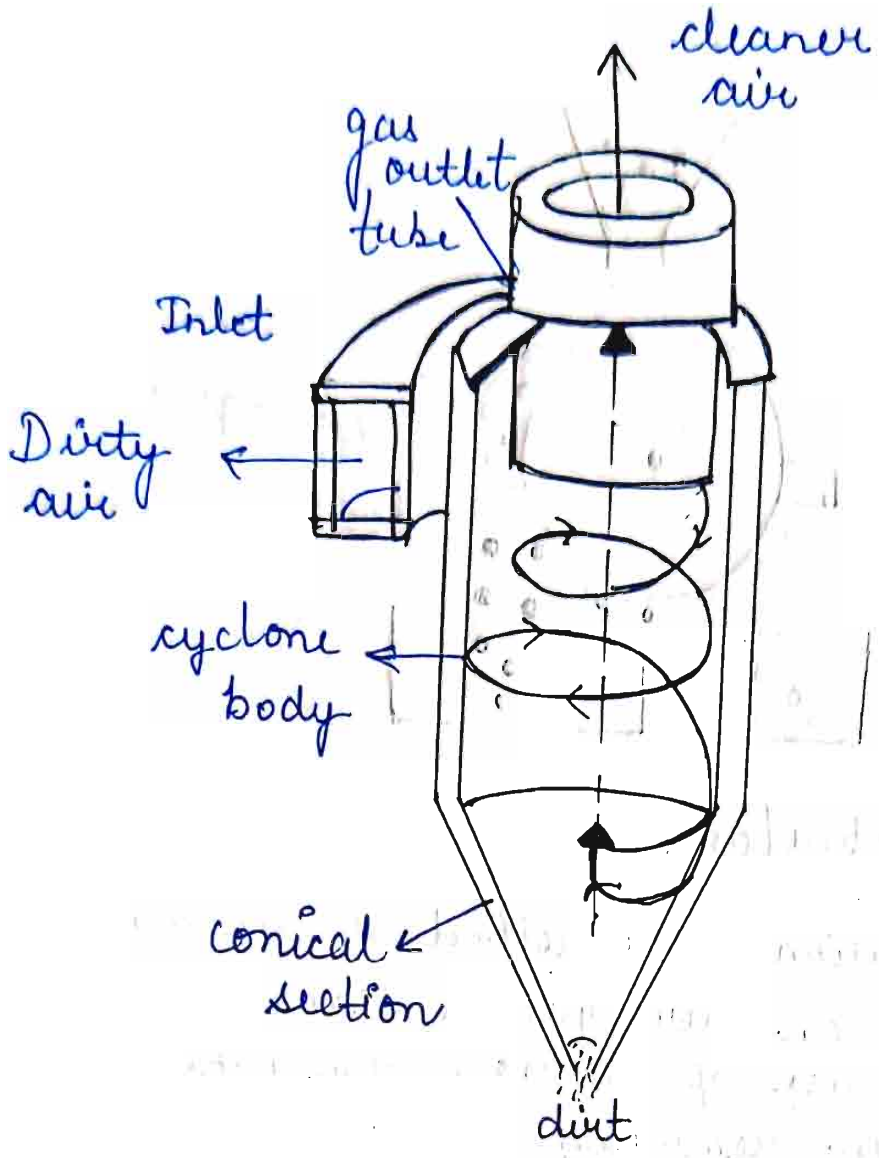
An electrostatic seprator is a device for seprating particles by mass in a low energy charged beam. It works on the principle of corona discharge, where two plates are placed close together and high voltage is applied. This high voltage is used to seprate the ionized particles. Usually these are used in power plants where the harmful gasses coming out of the chimneys are first treats using electrostatic seprator. Here the two electrodes are oppositely charge with a negative electrode the positive ions gets attracted and thus results in a reddish flame where as the positive electrode is used to treat the negatively charged ions results in a bluish white flame that is visible at nights.



(3.) Cyclonic Seprator :-

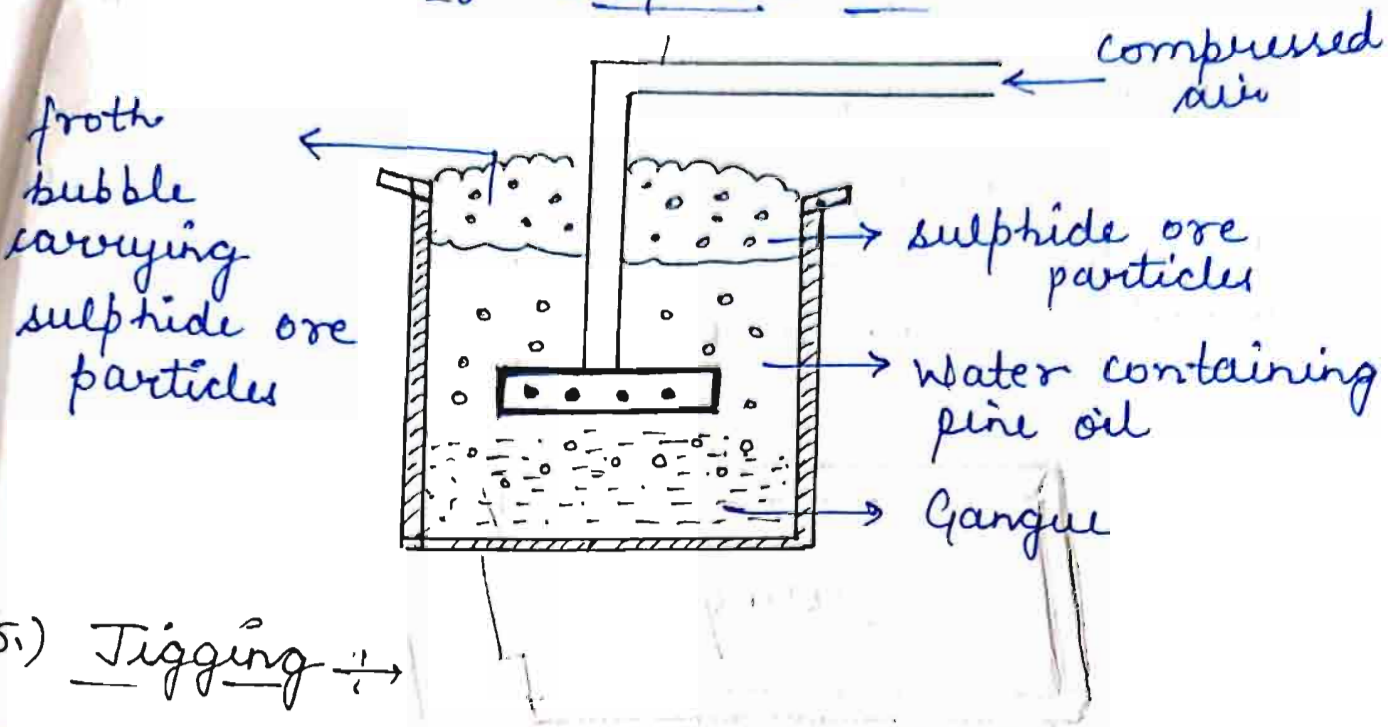
cyclonic sepration is a method of removing particulates from an air, gas or liquid stream., without the use of filters, through vortex sepration. When removing particulate matter rom liquids, hydrocyclone is used while rom gas, gas cyclone is used. Rotational ffects and gravity are used to seprate ixture of solids and fluids. The method can lso be used to seprate fine droplets of iquid from a gaseous stream.

high speed rotating (air) flow is established within a cylindrical or conical ainer called a cyclone.



(4) Froth Flotation Process :- froth-flotation is process for selectively seprating hydrophobic materials from hydrophill This is used in several processing industries. It has been described as "the single most important operation used for the recovery and upgrading of sulfideores". The development of froth flotation improved the recovery of valuable minerals, such as copper & lead bearing minerals, Along with mechanised mining, it allowed the economic recovery of valuable metals from much lower gradde ore than before

Froth flotation process for the concentration of sulphide ores.



(5.) Jigging :→

Jigging is a method of gravitational preparat of natural resources, based on sepration of mineral mixture on density in vertically oscillating water sepration of mineral mixt on density in vertically oscillating water strear of variable direction. The end products of jigging are the following.

→ concentrate with high content of useful com -onent and waster.

Jigging is referred to the most saving methods of preparation, especially in preparat of coals and ores of ferrous metals with large impregnation of useful components not requiring fine crushing.

(6.) Tabling :-

. Sepration of two materials of different densities by passing a dilute suspension over a slightly table having a reciprocal horizontal motion or shake with a slow forward motion and a fast return.