Q) Explain the storage of solid • piles , Bins, Siloes

Bin storage ⇒ ① A bin is typically much shorter than a silo, and it is typically use for holding dry matter

② Bins may be round or square

③ Stored material may be powdered as seed pernels or caf corn

Piles ⇒

① Hopper is a small vessel with a slopy botto as a temporary storage befor feeding soli do a proces

② It is filled at top and discharge is from p

③ Hopper can be vibrated excternaley

④ Angle of stoping side ≥ angle of repter

iloes ⇒ Siloes is a storage structure for storing bulk material like storage of grain, oal, cement, food particles etc. Siloe is all and relatively small in diameter which ; used in bin storage.

Types of Siloes

Cursent storage siloes

Tower siloes

Low oxygen tower siloes

Bag siloes

There are Two methods of storage of particulate solids:
1) Open or unprotected Storage
2) closed or Protected storage

Open storage: Course solids like coal, sulphur, sand and gravel are commonly stored outdoors as large open piles unprotected from the weather. The max. height at which the solids can be stored in piles depends on the angle of repose (α_R) of material. It is the maximum angle measured from horizontal at which heap of solids will stand without sliding. If the solid mass is truly homogeneous then α_R will be equal to the angle of Internal friction α. In practice however, α_R is always smaller than α ($\alpha_R < \alpha$). The value of α_R is 27° for anthracite coal, 31° for fine sand, 17° for wet clay and 39° – 48° for gravel. outside storage in open piles is restricted to water-insoluble solid materials when thousands of tons of material are to be stored. This is the most economical method of storage when thousands of Tons of material is to be stored. The solids are removed from the pile by tractor shovel and delivered to a conveyor or to the process unit. Outdoor storage can lead to environmental problems such as dusting or leaching of stored soluble material from the pile. Dusting can be prevented by covering the stored solids by a protective cover. Leaching can be controlled by covering the pile or by locating it in a shallow basin with an impervious floor from where water can be safely withdrawn. Eg- Rock salt - where a part of salt get dissolved in water and resultant brine is pumped to the nearby process units

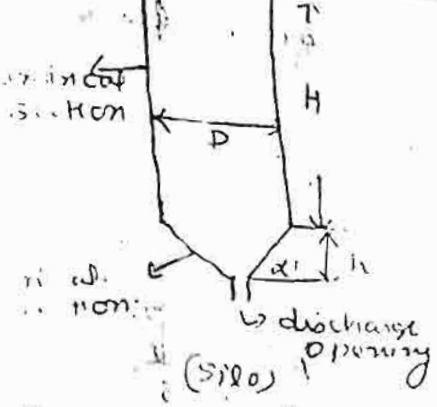
Protected or closed Storage:- Solids which are valuable and to or very soluble to expose them in open piles are stored indoors in bins, as silos or hoppers. These are cylindrical or rectangular vessels made of metal, reinforced concrete or wood.

Silo - is tall and small in diameter

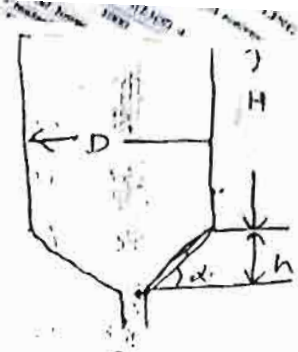
Bin:- is not so tall but with large diameter. Every storage bin has two sections: 1) cylindrical or rectangular upper section and a conical lower section with a discharge opening

Hopper - is a small vessel with a sloping bottom. It is used for temporary storage before feeding solids to a process

All these containers are loaded from top by elevator an elevator and discharged through openings in the bottom



(Silo)



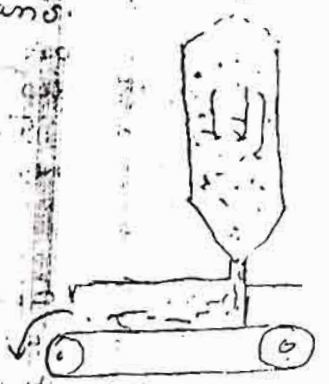
(Bin)

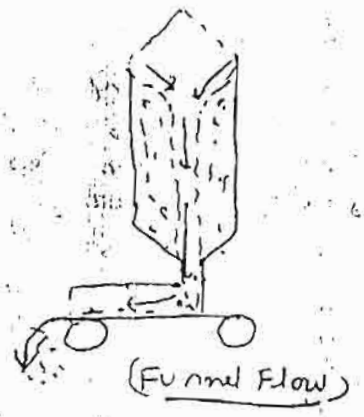
The shape of a storage vessel should be such that almost ... loading and unloading without the formation of ... ad zones are the zones where material is retained ... not flow by gravity to the discharge opening. ... mostly due to an insufficient slope of side walls ... which the material is directed to the discharge.

Two important flow patterns of storage vessel are:

1) Mass Flow in Bins: ~~when~~ whenever the outlet at the bottom of bin is opened, the material in the all type vessel begins to flow. Mass flow occurs in cone-bottomed bins with tall, steep slope - all the material moves downward uniformly from the top of the bin.

2) Funnel Flow bins: ~~occurs when~~ develop · occurs in bins with a shallow cone angle. Here a vertical column of solids above the opening moves downward without disturbing the material at the sides. A conical depression is formed in the surface of mass. The material slides into the central column at an angle approx: equal to angle of friction of solids. The solids near the bin walls remain stagnant and do not discharge. ~~These type~~ Funnel flow bin do not flow by itself and therefore are made to flow by some means.


Mass Flow


(Funnel Flow)

differences between Mass Flow & Funnel Flow bins

Mass Flow Bins	Funnel Flow Bins
1) Particles segregate but discharge out through opening of solids	1) Particles segregate and remain segregated and do not discharge
2) Particles don't flood when system discharges	2) First portion of solid Top most layer comes out first while first portion is last to leave
3) Flow is uniform	3) Flow is erratic
4) Density of flow is const.	4) Density of flow varies
Product does not remain in dead zones (degradation of product does not occur)	5) Products tends to bridge or arch and then to rat hole when discharging (degradation of product may be Products can remain in dead zones until complete clearing of system is carried out
Bins can function as a blender	6) Bins perform satisfactorily with free flowing, large particle solids

The rate of flow of solids by gravity through a circular opening in the bottom of bin depends on dia. of opening and on the properties of solid. It does not depend on height of bed of solids. With free flowing solids the rate of solid flow ($\dot{m}$) varies approx. D_0^3 (D_0 = dia. of discharge opening)

UNIT III

This unit involves following topics.

1. conveying of bulk solids
2. classification of conveyors
3. selection of conveyors
4. storage of solids in bulk, protected piles, bins, silos, hoppers, mass flow and funnel flow bins, flow assisting device.
5. weighing of bulk solids, batch and continuous weighing techniques.

CONVEYING –

CONVEYER – conveyor is the devices which is used to convey the material inside the factory region. And the prowss which is involved in this operation is known as conveying.

There is the difference between the conveying and transportation.

Difference between conveying and transportation

TRASPORTATION	CONVEYING
1. transportation involves the transfer of product from factory to outsider and transfer of raw material from out-side to factory (inside)	1. conveying involves the transfer of material inside the factory region
2. It is generally used for crude and raw material	2. It is generally used for valuable material such as products for handling and storage
3. Transportation is cheap than conveying	3. It is costly than transportation
4. It has environmental problem such as leaching and dusting	4. It has no such type of problem
5. It has no extra costs such as maintenance of plants and inner handing devices	5. It has extra costs of handling and storage of material

SELECTION OF CONVEYER

CAPACITY REQUIREMENT

capacity requirement is the prime factor for the selection of conveyor.
The belt conveyors are manufactured in large size and operated at high speed but screw conveyors are manufacture in smaller size and cannot be operated at high speed.

CONVEYOR SELECTION ON THE BASIS OF SPECIAL FUNCTION

	Belt
1. conveying material horizontally	Apron, continous flow, flight, screw, Bucket, air, vibrating,
2. conveying material up & down	Apron, belt, continuous flow, air, screw, elevator, flight
3 conveying material both the combination of horizontal and up & down	continous flow, air, bucket, gravity discharge bucket, plated bucket,
4 Distributing material or collecting the material from Bin	continuous flow, air, gravity discharge bucket, plated bucket Belt, & screw
5. Removing material from Rail & truck	car dumper car shaper, air

6. Elevating the material — Bucket elevator, continous flow air, skip hoist

CLASSIFICATION OF BULK SOLID

A bulk solid can be classified by its following properties.

1. SIZE
   - very fine — minus 100 mesh screen
   - fine — 100 mesh to 1/8 inch
   - granular — 1/8 inch to 1/4 inch
   - lumpy — 1/4 inch or greater
   - Irregular — 1/4 inch
2. flowability
   - very free flowing — angle of Repose ≤ 30°
   - free flowing — " " ≥ 45°
   - sluggish — " " > 45°
3. ABRASIVE NESS
   - Non abrasive
   - mild abrasive
   - very abrasive
4. Special Characteristic
   - non corrosive
   - corrosive
   - hygroscopic
   - mildly corrosive

CLASSIFICATION OF CONVEYORS -

Conveyors are mainly classified into following kinds.

1. SCREW conveyor
2. Belt conveyor
3. Vibrating conveyor
4. Bucket elevator
5. Continous flow conveyor
6. Pneumatic Pneumatic conveyor
7. Apron conveyor

Conveying of Bulk solids:

Conveyor Selection: Selection of correct conveyor for a specific bulk material in a specific situation is complicated by large no. of inter related factors dat must be considered.

Accep standardized equipment design and complete engg. data r available for many common types of conveyors, dere performance can be accurately predicted wen dey r used with materials having well known conveying characteristics.

Capacity req. is a prime factor in conveyor selection. Belt conveyors which can be manf. in a relatively large sizes to operate at high speeds, deliver large tonnages economically.

*Length of ~~trouble~~ travel is definately limited for certain types as a length of travel increases, a choice among alternatives becum narrower.

In general conveyors

* Lift can usually be handled most economically by vertical or inclined bucket elevators, bt wen lft and horizontal travel r combined, d other conveyors shld be considered. Conveyors dat combine several direc of travel in a single unit r generally more expensive.

* Material characteristics: both chemical and physical characteristics shld be considered. Spcly flowability and lump size & also imp. chemical effects (i.e. effect of acid on metal) & may dictate d structural material out of which conveyor components r fabricated. Moisture or acid effect from exposure to air may b harmful to d being conveyed and

enclosure of a conveyor.

* Processing requirements can be met by some conveyors with little or no change in design.
For ex: a continous flow may be provide a desired cooling of solids simply because it puts a conveyed material into direct contact with heat conducting metals.

* Initial cost of conveyor system is usually rated to life expectancy as well as to a flow rate chosen.

Comparitive cost for conveyor system can be based only on a studies of specific problems.
For eg: Belt conveyors idlers is available in a range of qualities that may with more unit cost 3 times as much as cheapest.

* Conveyors Drives may account from 10-30% of total cost of conveyor system depending on specific jobs requirements.

Classification of Conveyors & use of following types:-

(i) Screw Conveyors: (SC)
(ii) Belt " (BC)
(iii) Bucket " (BuC)
(iv) Vibrating / Oscillating Conveyors. (VC)
(v) Continous flow " (CC)
(vi) Pneumatic " (PC)

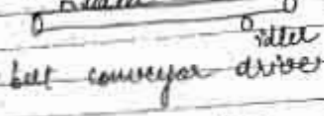
(i) SC: it most versatile conveyors it consist of a helicoid flight or helical flight (individual sections trimmed to fit from flight plate) mounted pipe or shaft.

* Simple design - easy maintenance
+ high power consumption

in a trough. Power to convey must be transmitted through a pipe or shaft. Screw / roller / or capacity is generally limited to around 10,000 ft³/hr.

In addition to their conveying ability, screw conveying can be adapted to a wide variety of processing operations. Almost any degree of mixing can be achieved with screw conveyors. Use of hollow screens or pipes for circulating hot or cold fluids allows a screw conveyor to be used for heating, cooling or drying operations.

② Belt Conveyor: It is almost universal in application. It can travel for miles at a speed upto 1200 ft / min and handle upto 5000 tonnes/hr. It can also operate over short dist at slow enough for manual putting, a capacity of only a few kg



belt conveyor drives

Belt conveyor slopes r limited to a max of abt 20° with those in the 18-20° are more common. The belt conveyor design begins with the study of material to be handled. Temp and chemical activity of the conveyed material play imp role in the belt selection. Rotex natural rubber shld be avoided with oil materials Spl rubber, cotton, asbestos fibre are available to meet varying degree of material temp and they r used whenever high temp exist. Moisture may create [illegible] discharge. Condition [illegible] of material [illegible] the [illegible] may [illegible] + rt

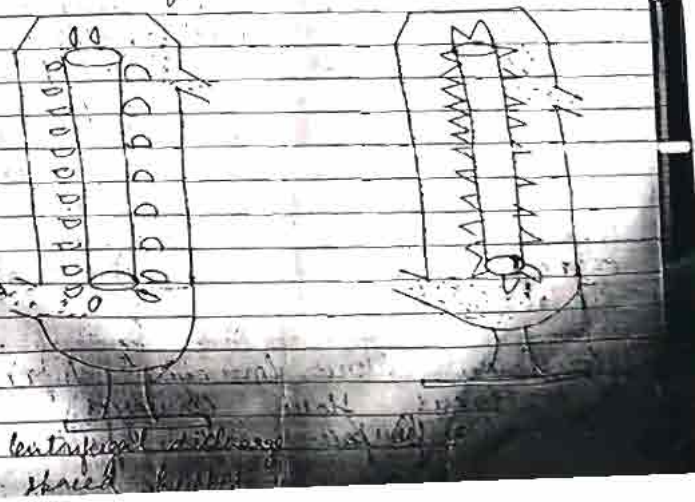
operating conditions which affect the belt conveyor design include climate, surroundings and hours of continuous service. Temp and humidity may dictate the total enclosure of the belt.

③ Bucket Elevators: They are simplest & most dependable units for raising vertical lifts, they are available in a wide range of capacities and may operate entirely in the open or be totally enclosed.

(i) Spaced bucket centrifugal discharge elevators: These elevators are most common mounted on a belt or chain, & buckets are spaced to prevent interference in loading or discharging. This type of elevator will handle almost any free flowing fine or small lump material such as grain, coal or dry chemicals. Speeds can be relatively high for fairly dense material.

(ii) Continuous bucket elevators: These elevators are generally used for large lump materials or for materials too difficult to handle with centrifugal discharge units. Buckets are closely spaced and this close bucket spacing reduces the speed at which elevator must run to maintain the capacity comparable with spaced bucket elevator.

Super capacity continuous bucket elevator: Elevator of this type is designed for high lifts and large lump material. They handle high tonnages and are usually operated at an incline to improve loading and discharge conditions.



(i) Centrifugal discharge spaced bucket

* Simple design ... cont ...

(4) Vibrating / Oscillating conveyors: Most vibrating conveyor consist of springs supported horizontal pan vibrated by a direct connected eccentric arc or an electro-magnet. A motion imparted to d material particles may vary bt its purpose is to throw material upward and forward so dat it will travel along d conveyor part.

A capacity of flow through vibrating conveyor is determined by magnitudes of trough displacement freq. of displacement, angle of trough slope & trough. Each vibrating conveyor is designed to operate at specific freq and do not perform well at other frequencies. ∴ dey r not adapted to frequent capacity changes. Capacity of vibrating conveyor is extremely broad ranging from two tonnes to 4m.

(5) Continuous Flow Conveyors: A principle of continuous flow conveyor is dat when a surface is pulled transversely through a mass of granular, powder or lump material, it will pull along at a mass-rate of material. Continuous flow conveyor is a totally enclosed unit which has a relatively high capacity per unit area & relatively low-rate. Dese conveyors employ a chain supported conveying element.

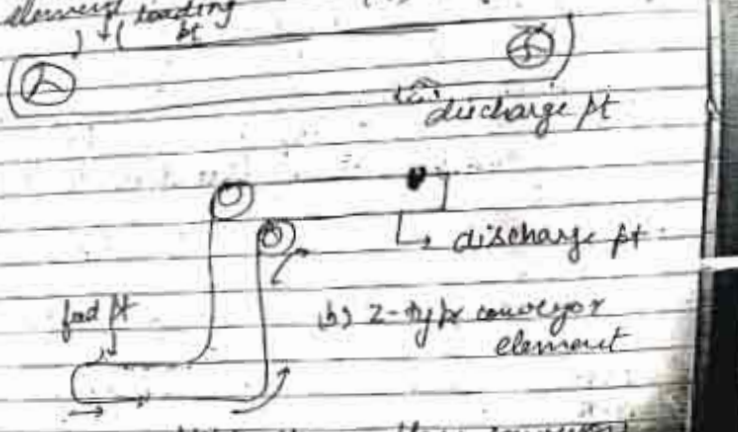


fig: continuous flow conveyor

Capacity of continuous flow conveyor depends on ... of particles being ... per ...

$\frac{dv}{dt} = \frac{F \cdot dt}{dv} \cdot \frac{1}{\rho V}$

fitting of conveying element within it, continuous flow conveyor is normally an expensive limit, continuous flow conveyor is widely use in a chemical industry in which there is a great demand of rehandling or reg. of many fed and discharge pt.

(6) Pneumatic Conveyors: A method extensively used for d conveying of lyt and bulky material is d pneumatic conveyor. In dis system d material is transferred in suspension in a stream of air. There r a variety of system, bt dey all involve a pump or fan for producing d stream of air, a cyclone for sep. d larger particles and usually, bt not necessarily, a bag filter for removing d dust. D material is sucked up through a nozzle which may be fixed or movable. D stream of air with d solid in suspension goes

$= \frac{1}{2} \cdot \frac{\rho V^2}{2}$ ...

to a cyclone separator, and den to the pump where d material carries dust dat would be harmful if discharged into d air.

Storage of solids in Bulk protected and Unprotected piles:

Open yard storage is probably best handled by belt conveyors. When tonnages r large, fig. below shows discharge arrangement possible for single, multiple or moving tripper discharge from belt conveyor. Most of dese discharge methods r equally applicable for indoor storage. Belt may move along d length of belt forming a file on one or both side of belt.

fig: Conveyor belt at d end of file

* Simple design & easy maintenance
* finish &.

A storage vessel is considered as consisting of a bin and a hopper. ~~Desc bin, hopper or~~ ~~r: ty~~ or reet vessel or concrete or metal. A silos is a tall or relatively small in dia, a bin is ht so tall and usually fair wide. A hopper is a small vessel wid a sloping bottom for temporary storage, before feeding solid to a process.

2 imp definition of flow characteristic of a storage vessel r mass flow wch means dat all d material in d vessel whenever any amount is withdrawn

desired flow.

fig: mass flow bin d material does nt channel on discharge.

undesired flow

fig: funnel flow d material segregates

Funnel flow wch occurs when ~~portion~~ portion of material flow when material is withdrawn. mass flow bin featured d most sought after characteristic of storage vessel. Although a mass flow bin is obviously preferably to a funnel flow vessel, d additional investment generally req must be justified. Degree of finish of a metal surface can have a large effect in determining whether d vessel will flow in mass or funnel flow.

Specifying Bulk Material for best flow &

Many flow problems can be eliminated at source by rigid, accurate and sensible specification of physical characteristic of material :-

(1) particle size is one of the most common and controllable factors which effects the flowability of the gun material. In genl it may be assume dat larger d particle size and freer d material is from fines d more easily d material will flow. Large particle size, uniformity of particle size and hard, smooth surface of tablets pellets all contribute to gud flow.

(2) Moisture content is another common and controllable factor and generally utilized to protect d material from certain type of deterioration.

(3) High temp can cause serious flow problems in some materials or effect soluble or low mp component and it may be necessary to install d cooling equipments. Gates r used to control flow from bins, hoppers and processing equipment to feeders or directly to conveyors.

(4) Mid level controls r imp for detecting level of materials from bins and hoppers and can also protect conveyors from damage due to jamming.

Flow-Assisting Devices and feeders & here r situations in which mass flow bins cannot be installed for reasons such as space limitations and capacity requirement. A no. of flow assistors are available, d most desirable of which is use of a feeder to enlarge d flow channel of a further flow bin.

Vibrating Hoppers :- r one of d most imp and versatile flow assistors. They r used to cause flow by breaking up material bridges. 2 types are i- i.e. d operating

fig :- Vibrating Hopper

which vibration is applied to flow channel and whirlpool type which by providing a combined twist and lift to a material causes bridging to brick.

③ Screw feeders are also used to assist in bin unloading and in producing uniform feed.

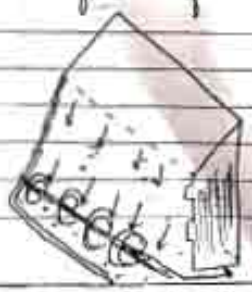


fig: screw feeder.

④ Belt / Apron feeders & can also be used to give uniform feed from a bin, but as care must be taken that dead spots are not produced in a flow channel above a feeder belt

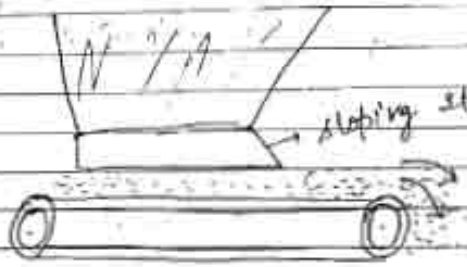
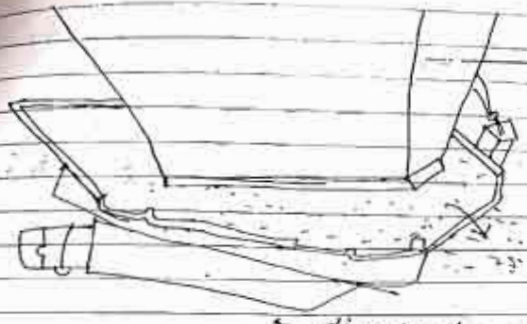


fig: sloping and strike plate in a belt of an apron feeder

Capacities of belt feeders can be increased by tapering a outlet in a horizontal and vertical plane

⑤ Vibrating Feeders also provide uniform flow along a slot opening of limited length. Here also a distance between feeder pan and hopper is increased feed discharge as given in fig.



← direction of motion

fig: Vibrating feeder.

(5) Star feeder: wid a rotating screw conveyor provide highly uniform withdrawn along a slot opening at vertical wall of at least one outlet wid width. Shld be added above d feeder to ensure uniform withdrawal across d opening

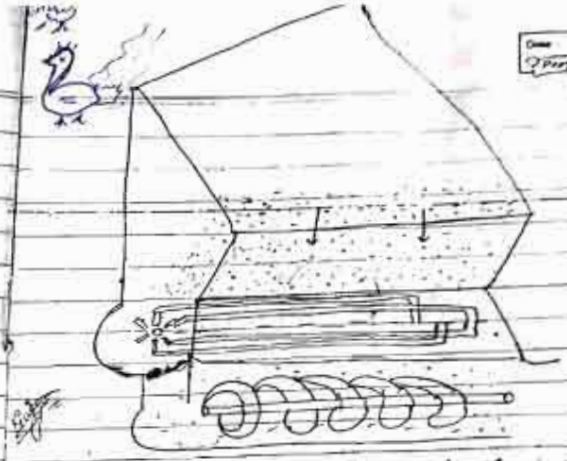


fig: star feeder. the rotating screw ensures uniform withdrawn.

Ans

8 A certain set of crushing rolls has a roll of 40 cm dia. with 50 cm width of face. Dey r set so dat d crushing surfaces r 1.25cm apart at d narrowest pt. The manufacturer recommends dat dey may be run at 50 - 100 rpm. Dey r to crush a ore having a specific gravity of 2.5 and d angle of nip is 20°. Wat is d max. permissible size of feed and d