The term mixing implies taking atleast two separate phases and causing them to distribute randomly through one another.

A substance which is uniform throughout in physical state and chemical composition is called a homogeneous substance or a phase. Phases may be liquid, solid or gaseous. Therefore, mixing may involve gases, liquids or solids in any possible combination of two or more components - two different liquids, a liquid and a gas, a liquid and a powdered solid or two different or same solids.

The practical aims of mixing are :

1. To promote a chemical reaction. It is the most important use of mixing in the chemical industry, since intimate contact between reacting phases/substances is necessary for a reaction to proceed properly.
2. To produce simple physical mixtures - of two or more uniformly divided solids, two or more miscible liquids, etc.
3. To carry out physical change - formation of crystals from a supersaturated solution.
4. To accomplish dispersion in which a quasi-homogeneous material is produced from two or more immiscible fluids and from one or more fluids with finely divided solids.

In this chapter, we will deal with mixing of liquids with liquids, gases with liquids, liquids with solids and solids with solids.

When the ratio of liquid to solid is large, mixing of solids with liquids can be performed in the same fashion as mixing of liquids with liquids. On the other hand, if the ratio of liquid to solid is small, solid-liquid mixing becomes similar to mixing of solids with solids (solid-solid mixing).

MIXING LIQUIDS WITH LIQUIDS

A propeller or a turbine in a tank is the most commonly used equipment for operations involving liquid-liquid and to some extent liquid-solid mixing.

In liquid-liquid mixing, a system may contain liquids with or without solids that are not viscous (e.g., light oils) liquids with or without solids that are viscous but pourable (e.g. paints, heavy oils) and liquids with solids that form stiff pastes (oil-bound distempers).

The usual form of equipment is a vertical tank fitted with an agitator (i.e. an agitated vessel). The height of the vessel ranges from 1.5 to 2 times the diameter. The impeller diameter is usually one-third of the tank diameter.

It should be noted that agitation and mixing are not synonymous. Agitation refers to the induced motion of the material in a circulatory pattern inside a tank or vessel, while mixing is the random distribution into and through one another, of two or more initially separate phases. Based upon the objectives of the processing step, liquids are agitated for the following

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(i) Blending miscible liquids

(ii) Dispersing gas in liquid

(iii) Suspending or dispersing solid particles in liquid to produce uniformity required for promoting mass transfer and assisting chemical reaction.

(iv) Dispersing or contacting immiscible liquids

(v) Promoting heat transfer between liquid and jacket or coil.

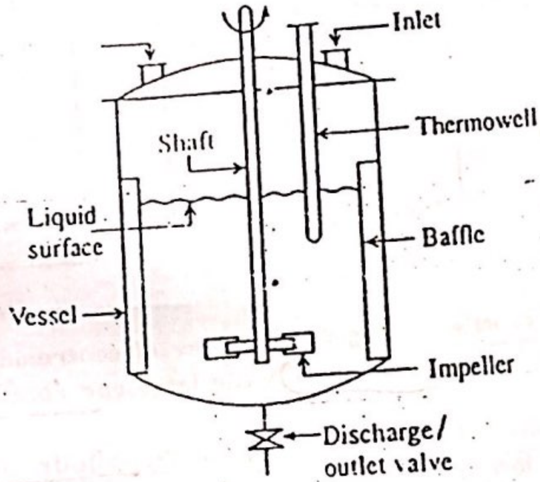


Fig. 6.1 : Typical Agitated Vessel

In the agitated vessel, an impeller creates a flow pattern, causing the liquid to circulate through the vessel and return eventually to the impeller.

An agitator is a combination of impeller and shaft i.e. impeller attached to the shaft. There are various types of impellers and so the agitator types. When we say turbine impeller, it is also termed as turbine agitator. The terms Impeller and Agitator are used interchangeably.

IMPELLERS

There are two types of impellers :

1. Axial flow impellers and
2. Radial flow impellers.

Axial flow impellers generate flow currents parallel to the axis of shaft and radial flow impellers are those which generate flow currents in tangential or radial direction (in direction perpendicular to shaft).

Three main types of impeller are propellers, paddles and turbines.

Propeller and pitched blade turbine are axial flow impellers; while paddles and flat blade, disk flat blade turbines are radial flow impellers.

PROPELLERS

A propeller is an axial-flow, high speed impeller commonly used for low viscosity liquids. It may be mounted centrally, off-centre or at an angle to the tank. It is simple and portable. The diameter of propeller is usually between 15 to 30% of the diameter of tank. A typica.. .opeller is shown in Fig. 6.2. Standard three bladed marine propellers with square pitch are most common. A propeller is shaped with a tapering blade to minimise the effect of centrifugal force and produce maximum axial flow.

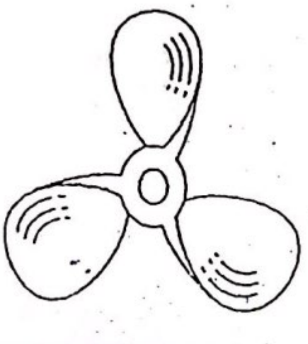


Fig. 6.2 : Standard three blade propeller

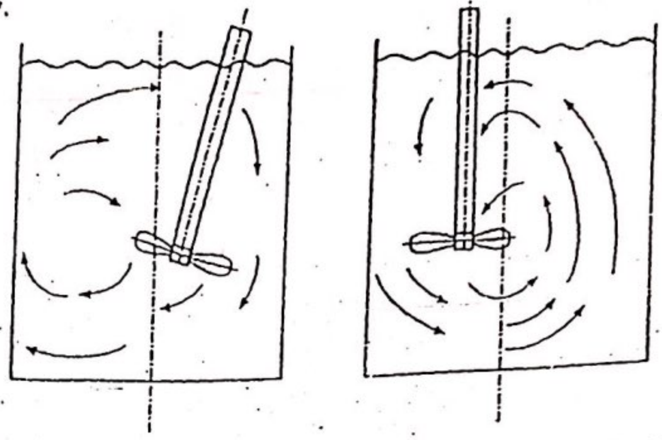


Fig. 6.3 : Propeller, off centre and angular (unbaffled)

Small propellers rotate at full motor speeds while large one rotate at speed of 400 to 800 r.p.m.

Propellers may also be mounted near the bottom of the cylindrical wall of a vessel as shown in Fig. 6.4 for blending low viscosity fluids or suspending slow settling sediments in very large tanks.

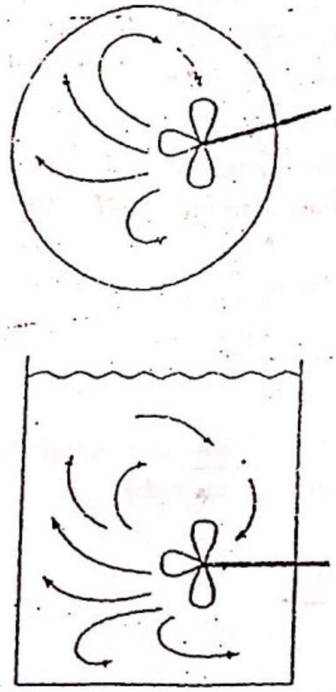


Fig. 6.4 : Side entering propeller

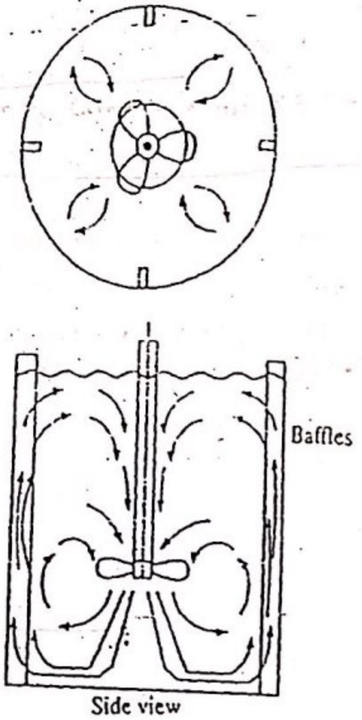


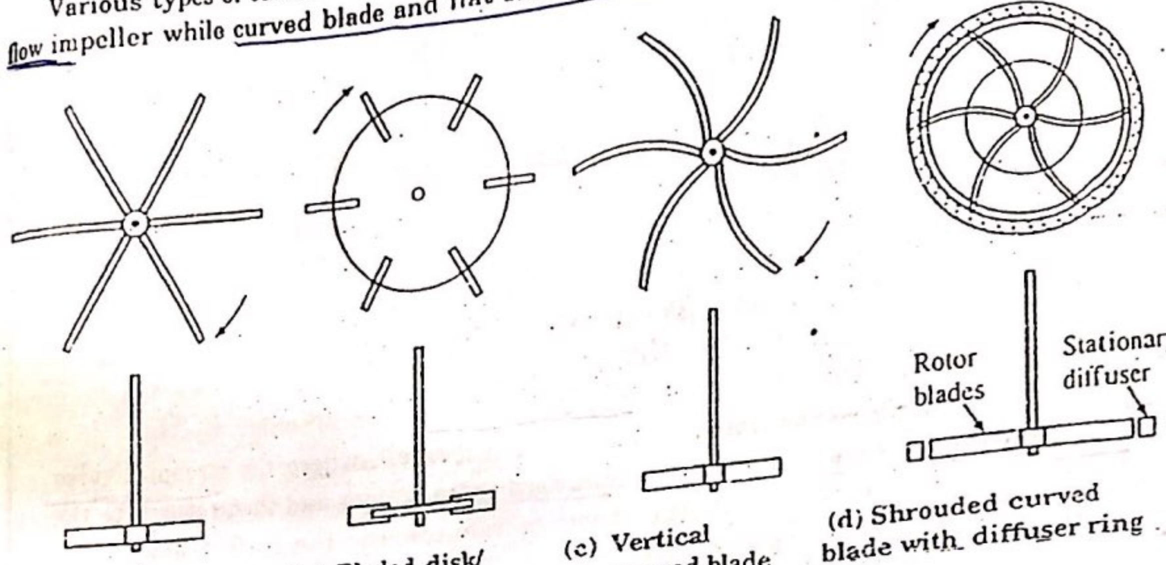
Fig. 6.5 : Flow pattern in a baffled vessel with ce... rally mounted propeller or axial flow turbine

Propeller drives the liquid straight down to the bottom of a tank, at the bottom the stream spreads radially in all directions towards wall, then the liquid flows upward along the wall, and finally returns to the suction of impeller from the shaft. Such flow pattern is shown in

Fig. 6.4. Propellers are used in situations where strong vertical currents are desired e.g. for suspending heavy particles.

TURBINES

Various types of turbine impellers are shown in Fig. 6.6. Pitched blade turbine is an axial flow impeller while curved blade and flat blade turbines are radial flow impellers.

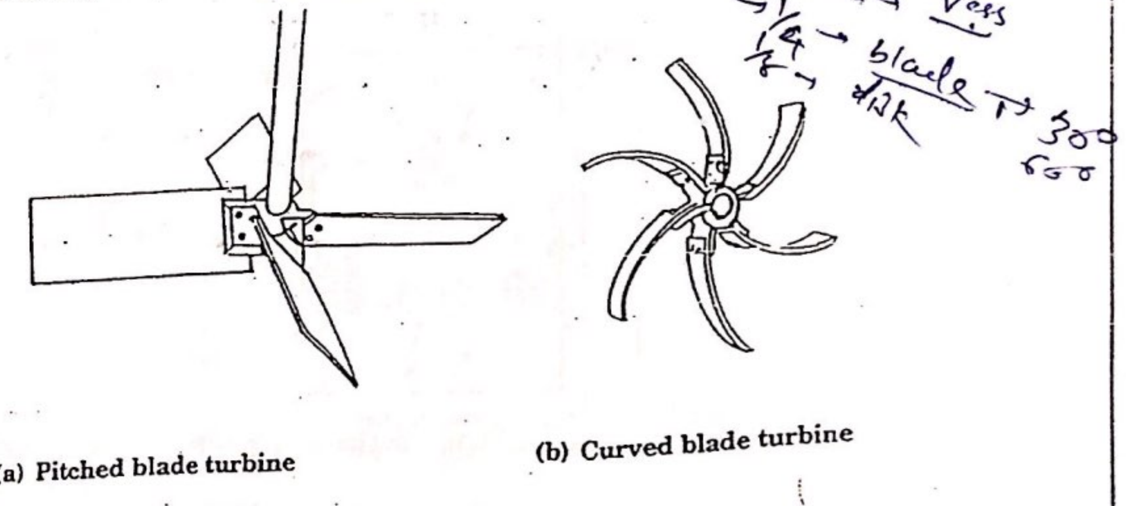


(a) Open straight blade (b) Bladed disk/ flat disk blade (c) Vertical curved blade (d) Shrouded curved blade with diffuser ring

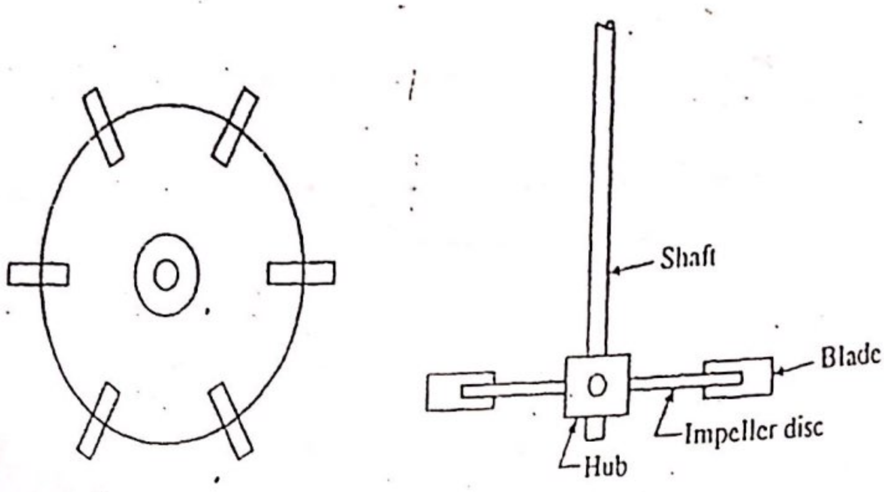
Fig. 6.6 : Turbine impellers

They are capable of creating a vigorous mixing action due to centrifugal and rotational motion generated by them. A stator ring surrounding this impeller gives an efficient mixing action.

The blades of the impeller may be attached to a central hub or to a central disc. The diameter of the impeller is kept between one-third and one-sixth of the vessel diameter. The blade length is one-fourth of the impeller diameter. With a central disc, it is $1/8^{th}$ of the impeller diameter. The blade angle of curved blade turbine may be between 30 to 60°. The impeller speed usually ranges from 50 to 250 r.p.m.



(a) Pitched blade turbine **(b) Curved blade turbine**



(c) Disk flat blade turbine

Fig. 6.7

Turbines are very effective over a wide range of viscosities (upto 10^4 cP).

Turbine impellers drive the liquid radially against the wall, where the stream divides into two portions. One of the portions flows downward to the bottom and then returns to the centre of impeller from below while other flows upward towards the surface and finally returns to the impeller from above. See Fig. 6.8. Turbines are especially effective in developing radial currents, but with a baffled vessel they also induce vertical flows. To avoid vortexing and swirling with turbines, baffles or diffuser ring can be used.

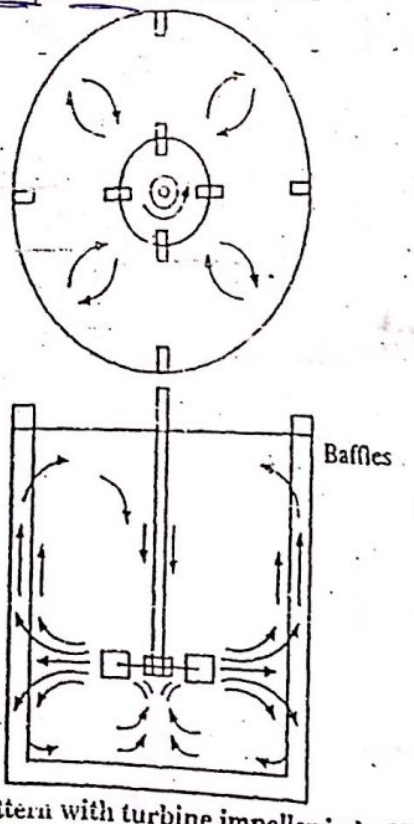


Fig. 6.8 : Flow pattern with turbine impeller in baffled tank

It is common to locate the agitator at a height not less than one agitator / impeller diameter length from the bottom of the vessel and the agitator should be submerged with liquid by a depth equal to twice the diameter of agitator / impeller at low speeds and four times at high speeds. When the depth of the liquid is more than twice the agitator diameter, it may be advisable to use two impellers on the same shaft.

PADDLES

For simple situation, a flat paddle turning on a vertical shaft is used. Paddle agitators with two or four blades are very common. The blades of these agitators normally extend close to the tank wall. They are simply pushers and cause the mass to rotate in laminar swirling motion with practically no radial flow along the paddle blades or any axial flow (vertical motion). The circulation is poor and the mixing action is insufficient. The speed of rotation is very low and is generally between 20 to 150 r.p.m. The total length of the paddle impeller is typically 50 to 80% of the inside diameter of the vessel (commonly 80% of the diameter). The width of the paddle is 1/4 to 1/10th of the paddle diameter.

In some design, the shape of the blades is more or less same as the shape of a dished or hemispherical vessel so that they scrap the surface or pass over it with a close clearance. A paddle of this kind is known as an anchor agitator. Anchors are very useful for preventing deposits on a heat transfer surface as in reaction vessels and are commonly employed for obtaining improved heat transfer in high viscosity fluids. High viscosity liquids and pastes are agitated by multiple paddle blades.

Paddles cover a wide viscosity range, not easily destroyed in operation and are relatively low in cost.

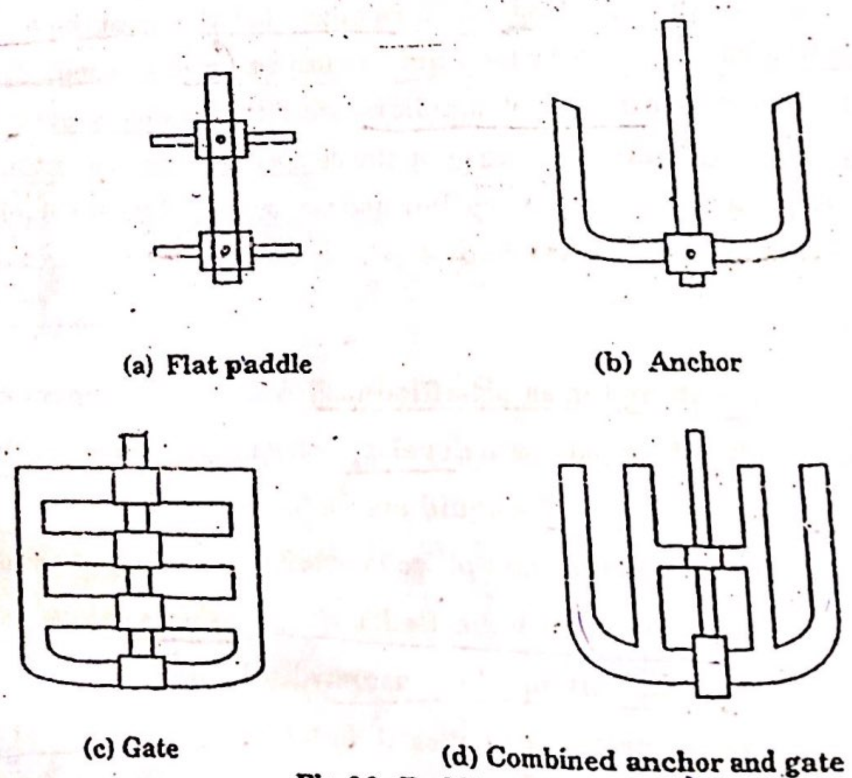


Fig. 6.9 : Paddle agitators

FLOW PATTERNS IN AGITATED VESSELS

The factors on which the type of flow in an agitated vessel depends are :

(i) Type of impeller

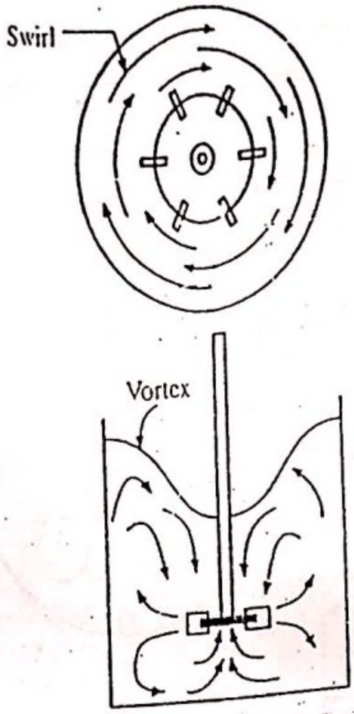
(ii) Characteristics of fluid and

(iii) Size and proportions of vessel baffles and agitator.

The velocity of a fluid at any point in an agitated vessel has three components, namely radial, longitudinal and tangential. The overall flow pattern depends upon the variations in these velocity components from point to point. The radial velocity component acts in the direction perpendicular to the shaft of the impeller. The longitudinal velocity component acts in the direction parallel with the shaft. The tangential or rotational component acts in the direction tangent to the circular path around the shaft. In the case of the vertical shaft in a vessel, the radial and tangential components are in horizontal plane and the longitudinal component is vertical. The radial and longitudinal components are useful and provide flow necessary for the mixing action. When a shaft is vertical and located at the centre in a vessel or tank, the tangential component is generally disadvantageous as the tangential component follows a circular path around the shaft and creates a vortex at the surface of the liquid and tend to perpetuate, by a laminar flow circulation, stratification at various levels without accomplishing longitudinal flow between the levels. In circulatory flow, the liquid flows with the direction of motion of the impeller blades. The relative velocity between the blade and the liquid is reduced and power absorbed by the liquid is limited. In case of unbaffled vessels, circulatory flow is generated by all types of impellers. When the swirling is strong, the flow pattern in the tank is virtually same irrespective of the design of the impeller. At high speeds, the vortex may be so deep that it reaches the impeller and the gas from above the liquid is drawn down into the charge. Generally, this is not desired.

UNBAFFLED TANKS

If a low viscosity liquid is stirred in an unbaffled tank by a centrally mounted agitator, there is a tendency for a swirling flow pattern to develop, for the lighter fluid (usually air) to be drawn in to form a vortex at the surface of the liquid and for the degree of agitation and mixing to be reduced. The above said phenomenon takes pl ce in unbaffled tanks regardless of the type of impeller. A typical flow pattern in an unbaffled tank for either axial or radial flow impeller is shown in Fig. 6.10. In the vortexing low viscosity liquid, the vertical velocities are low relative to the circumferential velocities in vessel. In the vortexing, the surface of the liquid takes roughly U-shape and efficient mixing no longer takes place. A vortex is produced owing to centrifugal force acting on a rotating liquid.



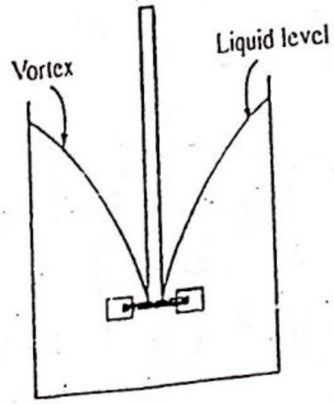


Fig. 6.10 : Vortex formation and circulation pattern in an agitated tank

Fig. 6.11 : Vortex at very high impeller speed

There is, however, a limit to the rotational speed that may be used, since, once the vortex reaches impeller, a severe air entrainment may occur. In addition, the swirling mass of liquid generates an oscillating surge in a tank which when coupled with deep vortex may create a large fluctuating force acting on a agitator shaft.

PREVENTION OF SWIRLING AND VORTEX FORMATION

There are three methods of prevention of swirling and vortex formation :

(i) Off-centre mounting of the impeller.

(ii) Use of baffles.

(iii) Use of diffuser ring with turbines.

In small tanks, the impeller can be mounted off-centre as shown in Fig. 6.12. In larger tanks, the agitator may be mounted in the side of the tank with a shaft in horizontal plane but at an angle with radius, as shown in Fig. 6.13.

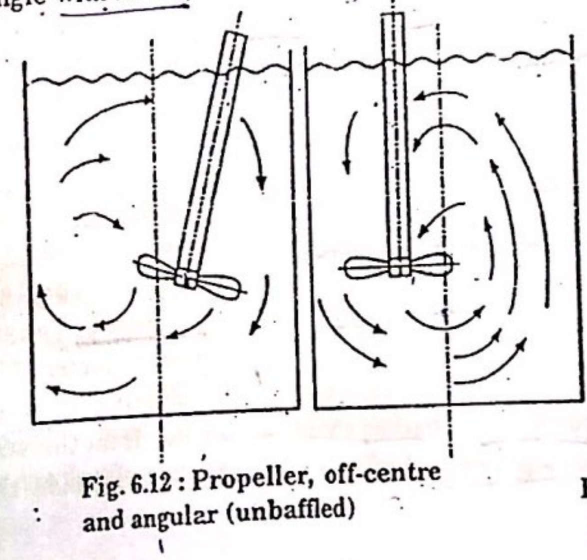


Fig. 6.12 : Propeller, off-centre and angular (unbaffled)

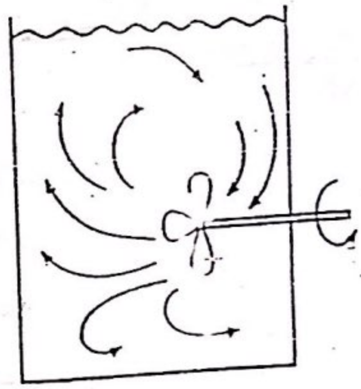


Fig. 6.13 : Side entering propeller

In large tanks with vertical agitators, most common method of reducing swirling is to install baffles which impede rotational flow without interfering with radial or longitudinal flow.

In an unbaffled vessel, there are strong tangential flows and vortex formations at moderate speeds. In the presence of baffles, the vertical flows are increased and there is more rapid mixing of the liquid.

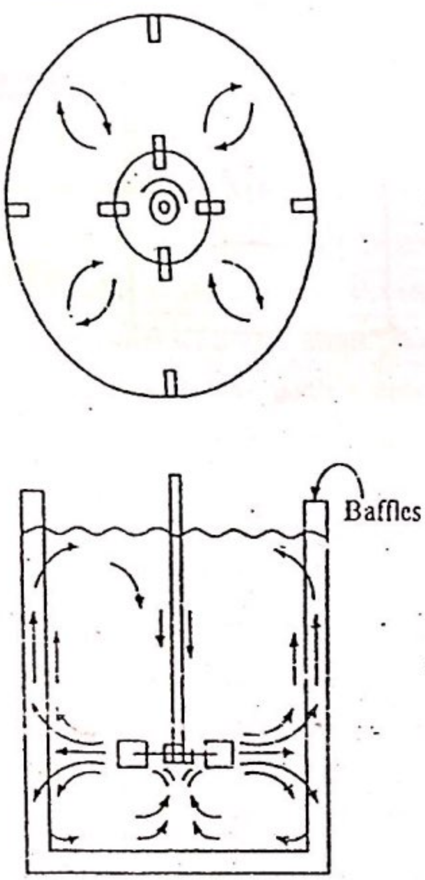


Fig. 6.14 : Flow pattern with turbine impeller in baffled tank

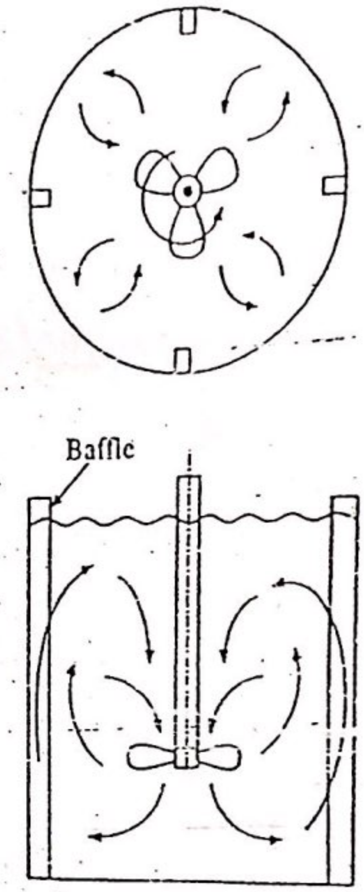


Fig. 6.15 : Flow pattern in a baffled tank with centrally mounted propeller agitator

With side entering, inclined and off-centre propellers, baffles are not needed.

In case of turbines, the principal currents are radial and tangential. The tangential components induce (lead to) swirling and vortexing that must be stopped by the baffles or by the use of diffuser ring for impeller to be most effective.

BAFFLING

Use of baffles in a vertic l vessel is essential for the efficient mixing action and minimisation of vortex formatio. Baffles are flat vertical strips and mounted against the wall of a vessel as shown in Fig. 6.15. It is common practice to use four baffles. They are mounted vertically on the vessel wall, projecting radially from the wall and located 90° apart. The width of the baffle should be one-tenth to one-twelfth of the tank/vessel diameter. The baffle height should be at least twice the diameter of the impeller and approximately centred on the impeller. If the solids are to be kept in suspension, baffles should be set out from the wall with a gap of about 1/5th of the baffle width between baffle and vessel to minimise the

MIXING OF GASES WITH LIQUIDS

This is usually accomplished by spraying a gas under a turbine (flat blade) near the bottom of a cylindrical vessel. Injecting the gas under a propeller is useless because the flow from the propeller is axial and downward. The equipment which can be used for the said purpose consists of a baffled vertical vessel incorporating a flat blade turbine agitator. The diameter of turbine is one-third of the tank diameter. The depth of a pool of liquid is equal to the tank diameter. A sparger (ring shaped) is mounted below the impeller with holes on the top. The diameter of the sparger is equal to or less than the diameter of the impeller. The gas is introduced from the top and injected in a pool of liquid in the form of fine bubbles through the sparger as shown in Fig. 6.17.

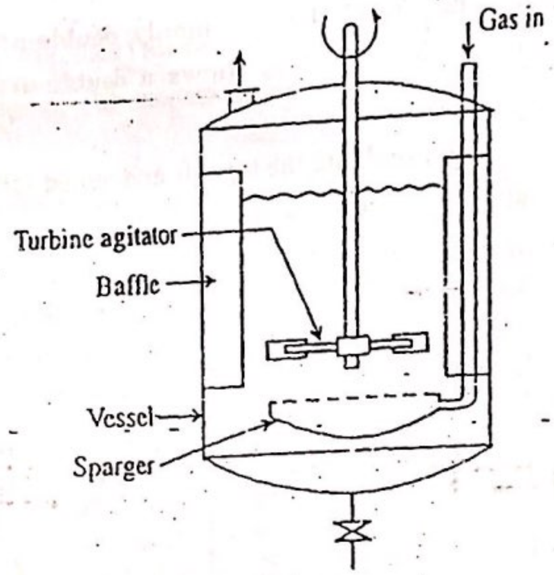


Fig. 6.17 : Mechanically agitated vessel for gas-liquid system

MIXING OF SOLIDS WITH LIQUIDS

In situations, where the solids are not too coarse, the liquid is not viscous, and the amount of solids per unit volume of liquid is not too great, the solids can be suspended in liquids with the help of a flat blade turbine type of agitator. If any of the above cited conditions do not hold, then for carrying out mixing, one has to look for a kneading machine or some equipment primarily used for mixing solids with solids.

MIXING OF VISCOUS AND PLASTIC MASSES

In machines used for viscous and plastic masses, either the material must be brought to the agitator or the agitator must visit all parts of mix. The mixing action in these machines is described as a combination of low-speed shear, smearing, wiping, folding, stretching, and compressing. These machines must be ruggedly built because the forces generated in these mixers are large. The power consumption with these mixers is high. Mixers described in this part are double arm kneaders, banbury mixers, pug mills and mullers.

DOUBLE-ARM KNEADER (KNEADING MACHINE)

The kneading machine consists of a rectangular trough curved at the bottom to form two longitudinal half cylinders and a saddle section. Two counter rotating blades (roughly z-shaped outline) are incorporated in the trough. The blades are so placed and so shaped that the material turned up by one blade is immediately turned under the adjacent one. The blades are driven by gearing at either or both ends. These machines are operated batchwise and may be designed to consume very large amounts of power. The trough may be open or closed and may be jacketed for heating or cooling.

The machine can be emptied through the bottom valve where 100% discharge or thorough cleaning, between batch is not as essential. More commonly, double-arm kneaders are tilted for discharge by power operated jacks. Fig. 6.18 shows a double-arm kneader employing sigma blades.

The material to be kneaded is dropped into the trough and mixed for a period of about 5 to 20 minutes or longer. The trough is then unloaded by tilting it.

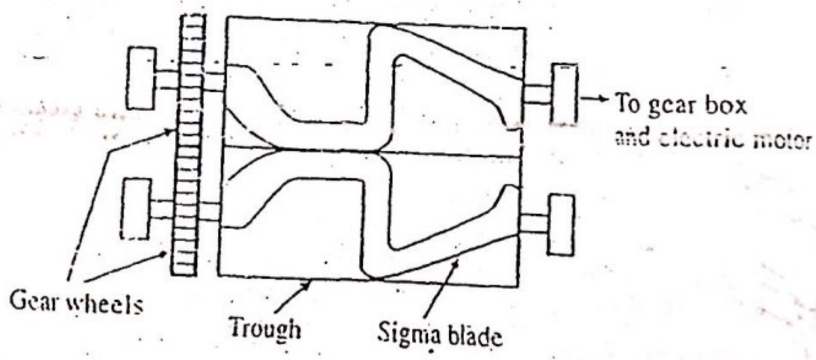


Fig. 6.18 : Kneading Machine/Double arm kneader (sigma mixer)

In kneading machines, the mixing action is a combination of bulk movement, smearing, stretching, folding, dividing and recombining as the material is pulled and squeezed against the blades, saddle, and the walls of trough.

Various designs of mixing blades are shown in Fig. 6.19. The sigma blade [Fig. 6.19 (a)] is most widely used. The mixer employing sigma blades is capable of starting and operating with either liquids or solids or a combination of both. The sigma blade has good mixing action and is relatively easy to clean when sticky materials are being handled.

The dispersion blade (Fig. 6.19) was developed particularly to provide high shear forces needed to disperse powder or liquids into plastic or to rubbery masses. The double-naben blade [Fig. 6.19 (c)] is good for heavy plastic materials.

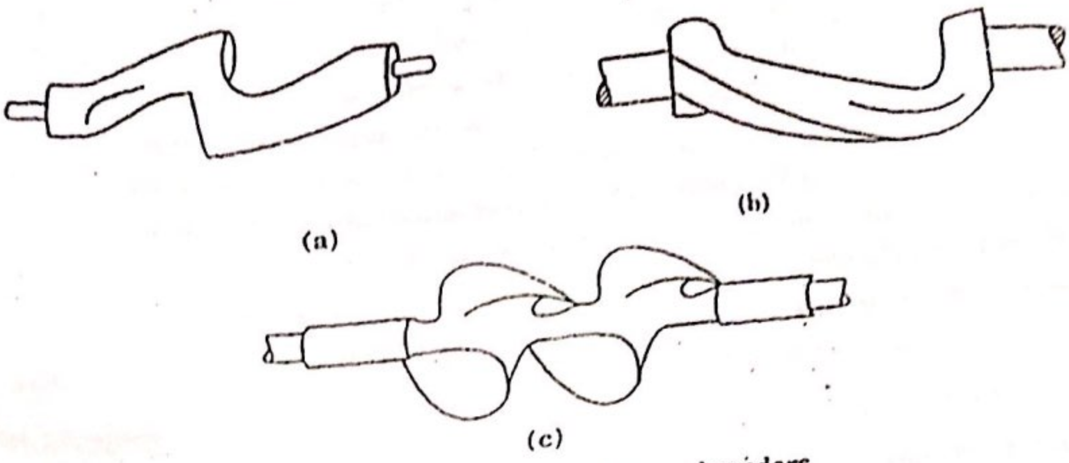


Fig. 6.19 : Blades for double arm kneaders
(a) Sigma, (b) Dispersion and (c) Double-naben blade

BANBURY MIXER

In case of internal mixer, the mixing chamber is closed during the operating cycle. Thus. cover can be used on the kneader as shown in Fig. 6.18. Such a mixer do not tilt. This mixer is used for dissolving rubber and for making dispersions of rubber in liquids. The common type of internal mixer is the Banbury mixer (Fig. 6.20). It is a heavy duty machine with two blades each rotating in a cylindrical sheet, but these cylinders partly intersect with each other. In this mixer, the blade is pear shaped, but the projection is spiral along the axis and the two spirals interlock The machine operates at a speed of 40 rpm or lower. The clearance between the blades and the walls is extremely small, and it is here that the mixing action takes place. The material is fed from above and held in trough during mixing by an air-operated piston under a pressure of 1 to 10 kgf/cm^2. Mixed material is discharged through a heavy sliding door which is provided at the bottom of the trough. The heat generated is taken out by spraying cooling heater on the walls of the mixing chamber and circulating it through the hollow agitator shafts during operation. The banbury mixer is used mainly in plastic and rubber industries.

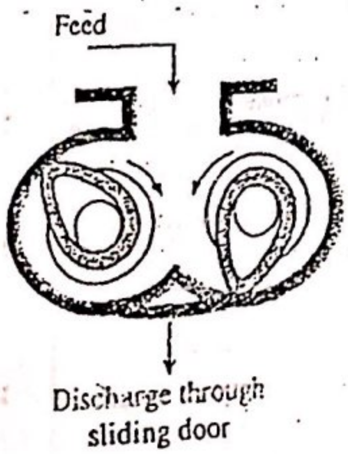


Fig. 6.20 : Banbury internal mixer

PUG MILLS

A pug mill consists of a horizontal open trough or closed cylinder. One or two rotating shafts fitted with short heavy paddles or inclined blades are incorporated in the trough or cylinder. (Fig. 6.14). The rotating shafts are parallel to the trough length and are situated near the bottom. The paddles may or not intermesh and clearances are wide so that there is considerable mass mixing.

The unmixed or partially mixed ingredients are continuously fed at one end of the mixing chamber and the product is discharged from the other end. In the mixing chamber, the ingredients are cut, mixed and moved forward to be acted upon by each successive blade (paddle). The product may be discharged through one or two open ports or through extrusion nozzle(s) which give roughly shaped, continuous strips. To make the blocks from the strips, automatic cutters may be used. Usually, the chamber of closed mills is cylindrical but in some cases it may be polygonal in cross section for preventing sticky solids from being carried along the shaft. The mills may be jacketed for heating or cooling. Pug mills are widely used for blending and homogenizing clays, breaking up agglomerates in plastic solids, and mixing liquids with solids to form thick slurries.

MULLER MIXERS

Mulling is a smearing or rubbing similar to that in a mortar and pestle, which is given by wide, heavy wheels of the mixer in large scale processing. A muller mixture consists of a pan incorporating muller wheels. In one of the designs of muller mixer, the pan is stationary and wheels rotate (Fig. 6.20); while in other design, the pan is rotated and the axis of the wheels is held stationary. In the stationary pan muller mixer, the central vertical shaft is driven, causing the muller wheels to roll in a circular path over a layer of solids on the pan floor. Flows guide the solids under the muller wheels during mixing or to an opening in the pan floor for discharge of the mixer at the end of the cycle. The muller wheels crush the material, breaking down lumps and agglomerates.

Capacity of the muller mixer ranges from a fraction of cubic meter to more than 1.6 m³ and the corresponding power requirement ranges from 1/3 to 75 hp. Mullers are good mixers for handling batches of heavy solids and pastes and are especially effective in uniformly coating the particles of granular solids with a small amount of liquid.

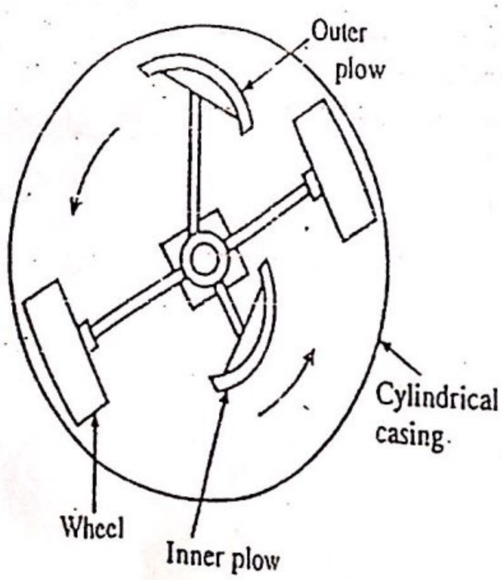


Fig. 6.21 : Muller mixer (Top view)

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MIXING OF SOLIDS WITH SOLIDS

Machines such as pug mills and mullers can blend solids when they are n. flowing as well as when they are pasty, rubbery, or elastic. These machines are en when the properties of material change markedly during mixing operation. These are n effective on dry powders than on other materials and are heavier and more powerful than required for free flowing particulate solids. The lighter machines described here such as ribbon blenders and tumbling mixers are effective for dry powders. The ribbon blenders mix solids by mechanical shuffling while tumbling mixers mix solids by repeatedly lifting and dropping the material and rolling it over.

RIBBON BLENDERS

A ribbon blender consists of a horizontal trough incorporating a central shaft and a helical ribbon agitator. A typical ribbon blender is shown in Fig. 6.22. In this mixer, two counteracting ribbons are mounted on the same shaft. One of the ribbons moves solids slowly in one direction while the other one moves solids quickly in the other direction. The ribbons may be continuous or interrupted. Mixing takes place due to the turbulence induced by counteracting ribbons, not by mere motion of the solids through the trough.

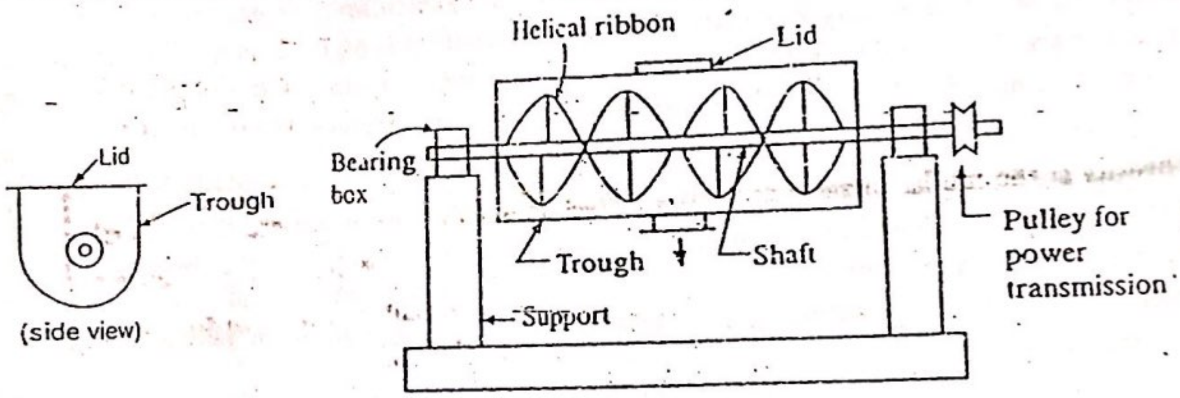


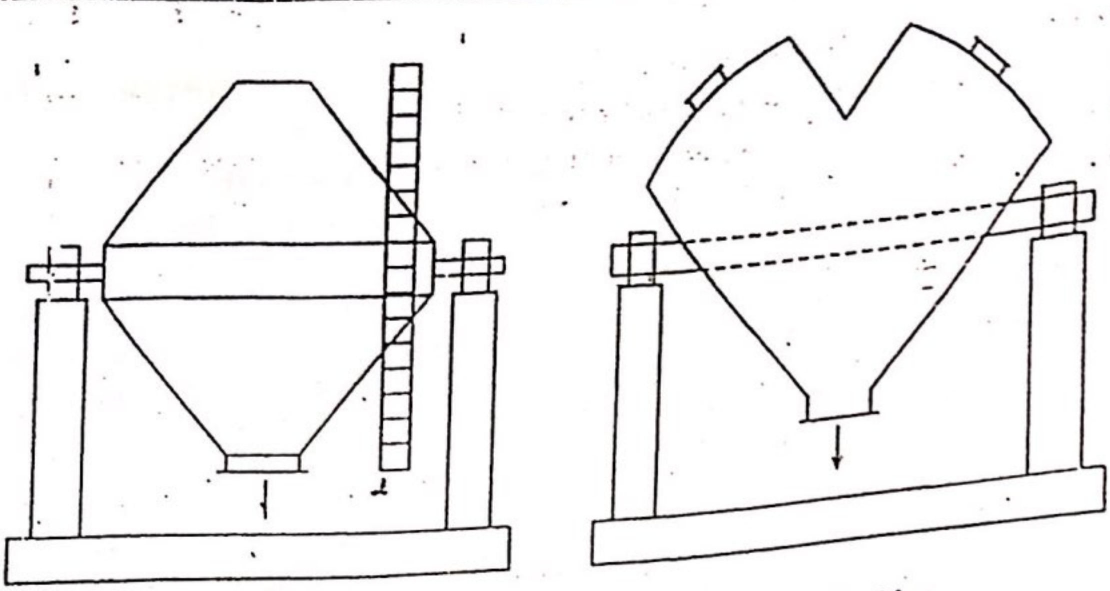
Fig. 6.22 : Ribbon blender

Ribbon blenders are used for batch or continuous mixing. In batch operated ribbon blenders, the solids are charged and mix until satisfactory and discharged from the bottom. In continuously operated units, the solids are fed from one end of the trough and discharged from the other end. In the path from feed to discharge end, solids are mixed.

For light duty, the trough is open or lightly covered; while the operation under pressure or vacuum the trough is closed and heavy-walled. Ribbon blenders are very effective for thin pastes and for powders that do not flow readily.

TUMBLING MIXERS / TUMBLERS

Many materials are mixed by tumbling them in a partly filled container that rotates about a horizontal axis. Tumbling mixers such as double cone mixer and twin shell blender, shown in Fig. 6.23, are suitable for free flowing dry powders.



(a) Double Cone Tumbler (b) Twin Shell Tumbler

Fig. 6.23 : Tumbling Mixers

The double cone mixer [shown in Fig. 6.23 (a)] consists of a container made up of two cones, base to base with or without a cylindrical section in between. The mixer is mounted so that it can be rotated about an axis perpendicular to the line joining the points of the cones. The material to be mixed is charged to the mixer from above until it is 50 to 60% full. The ends of the container are closed and the solids are tumbled for a period of about 5 – 20 min. Finally, mixed material is dropped out from the bottom of the container into a conveyor or bin.

The twin shell blender [shown in Fig. 6.23 (b)] is formed out of two short cylinders. These cylinders are joined to form a V-shaped container (their axes are about 90° to each other) and rotated about a horizontal axis. It may contain internal sprays to introduce small amounts of liquid into the mix or mechanically driven devices to brake agglomerates of solids. Tumbling mixers are capable of handling large volumes, easily cleaned, and draw a little less power than ribbon blenders.

EXERCISES

1. State various types of impellers and draw a sketch of disk flat blade turbine.
2. State the methods of avoiding vortex in agitated vessel.
3. Draw the sketches of flow pattern with propeller and turbine impeller.
4. Write in brief on two arm kneaders.
5. Draw the sketches of different blades used in kneading machines.
6. Write short notes on :
   (i) Ribbon blender,
   (ii) Tumbling mixer, and
   (iii) Pug mill.
7. Explain in brief the power consumption of impellers.

❑❑❑

(b) Continuous

(i) horizontal (conveyors)

Any one of the mechanical conveyors is also an elevators (vertical transportation), **except belt conveyor.** Even screw conveyor act as an elevator if closed casing. Any conveyor may be inclined and made to travel upward at an angle from the horizontal and it is applied particularly to belt conveyor

Only one device - Bucket elevator, is an elevator and not a conveyor.

(1) BELT CONVEYOR

Components : Endless Belt

It is made up of rubber it consist of a core of plies of cotton duck, impregnated with rubber and bonded with rubber. Other are leather, white cotton belting, canvas reinforced rubber.

- **Belt tighting system :** slender loop
- **Drive :** Head pulley and tail pulley
- **Power supply**
- **Belt supporter :** Flat rollers OR Idlers
- **Feeding arrangement :** Hopper, shaking screen, rotary drum, Reciprocating plate, Rotary vane
- Discharge arrangement

From the end	From intermediate point	From Multi points
Belt is Self-discharging	→ Scrapers → Tipping idlers → Trippers → Shuttle	

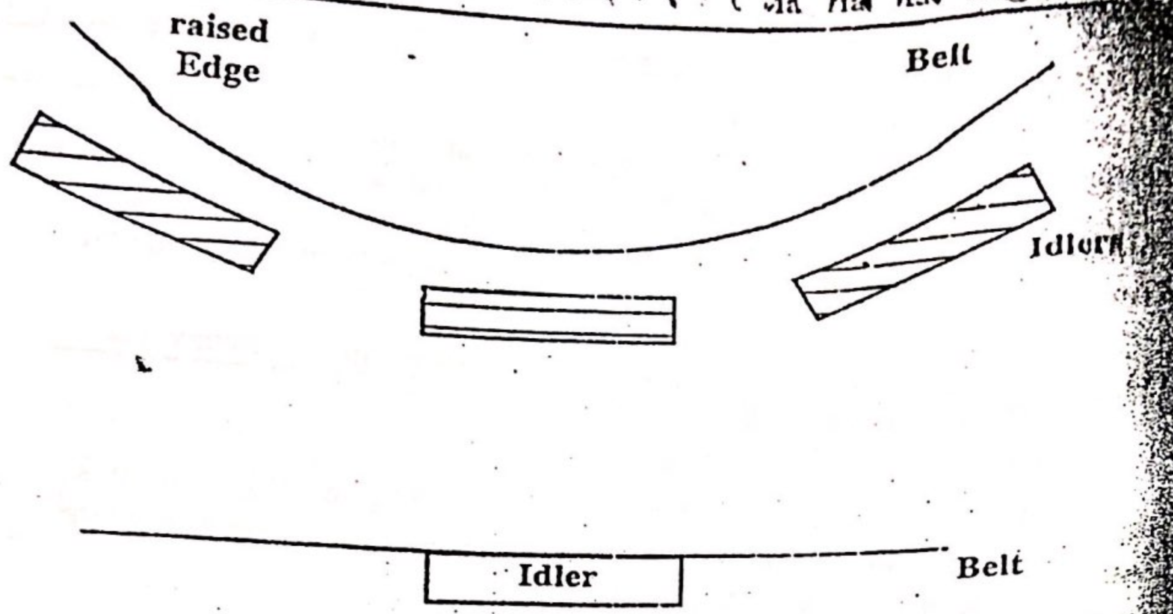
Construction-Working : Belt ends are jointed together. Belt can revolve horizontally or slightly inclined

Belt is allowed to move with the help of a belt drive.

The simplst belt drive is steel pulley run with same source of power. Drive pulley is fixed at the discharge end (rarely at feed end)

To make appropriate contact between the belt and pulley, there is Snubber idlers just below the pulley.

Belt is supported by rollers called **idlers.** Due to idlers, belt is depressed at centre and rise at the edges and hence carry more material than flat Belt.



A hopper is placed at one end (tail pulley), such that feed at centre of the be . and provision is made at the other end for discharging.

Cleaning devices such as revolving brush and rubber scrapper blades are placed in the path of the belt in order to clean.

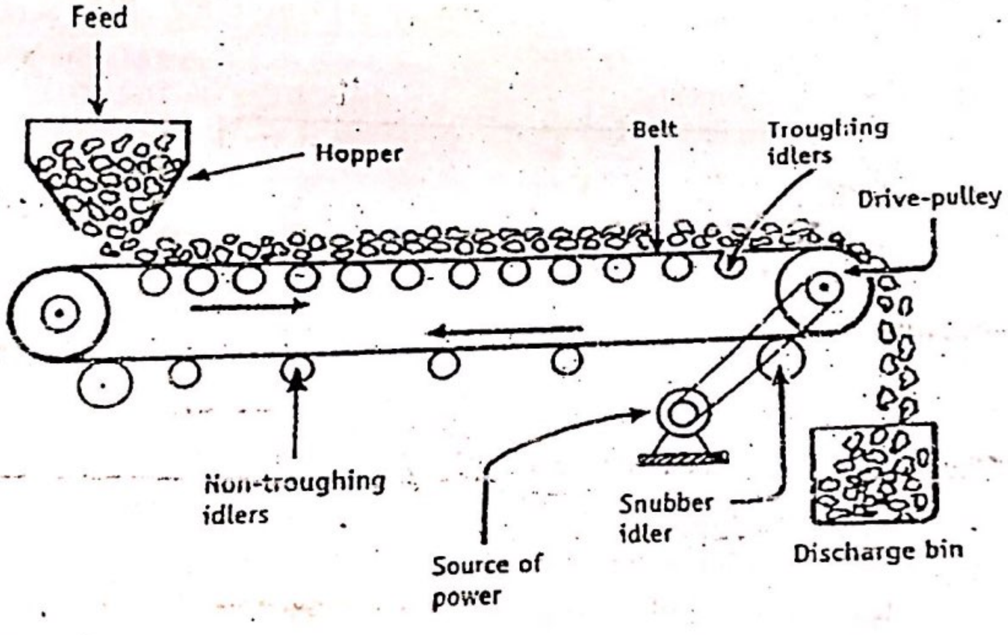


Fig 9.26 Belt Conveyor

Advantages

(1) Large Size and can travel Several Kilometers
(2) Maintenance is easy
(3) Economical in terms of cost per unit tonne handled.

Disadvantages:

(1) Expensive

Application:

(1) Transporting of containers for filling, capping, sealing, labelling, visual inspection

(2) Conveying of strips

(3) Manufacturing of lozenges

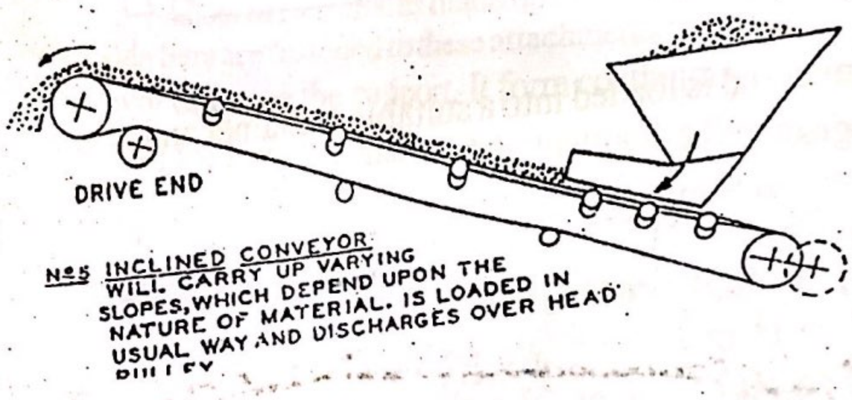
Modification:

(i) **Troughed conveyor** : Here Belt is supported on rollers (carriers) in group of three instead of single flat roller in case of flat belt.

- Belt take shape of shallow trough

(ii) **Inclined belt conveyor**

- Slope should not exceed the angle that material begins to slide and roll on the belt. In the broader sense it is an elevator.



(2) CHAIN CONVEYORS

Components

Chain Element : Made of malleable cast iron or stainless steel. The links are so cast that can be assembled and detached without tools.

Chains are endless and move continuously

Chain attachment - It is a special links

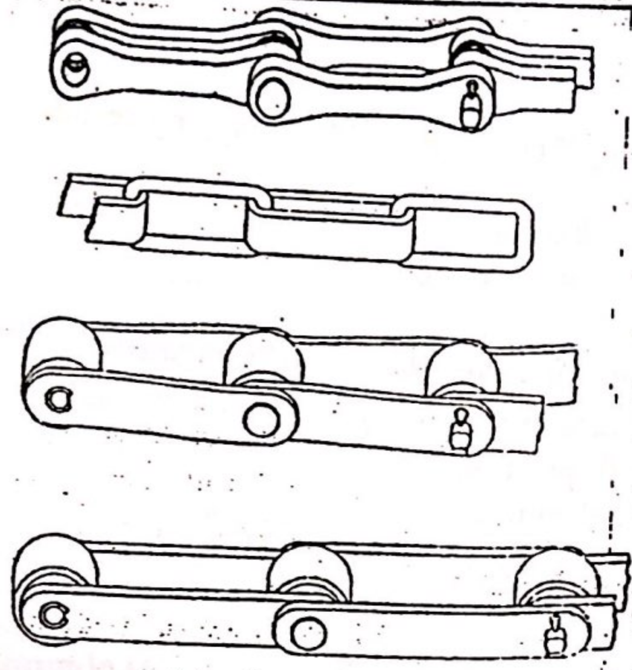
Different types available are –

Side Lugs, pushers, pins for rollers, vertical lugs, side lugs, flat lugs

Driver : Known as sprockets

Chain conveyors fall into two classes :

- Carry goods on their upperside
- Ouerhead conveyors - goods are suspended. Conyeyors of the 1st class may fitted with wooden Aprons, steel Aprons, slats.



(a) Ice chain

(b) Flat and round

(c) Roller bushing

(d) Straight-side long-pitch

The material is loaded into a suitable container and placed on the chain.

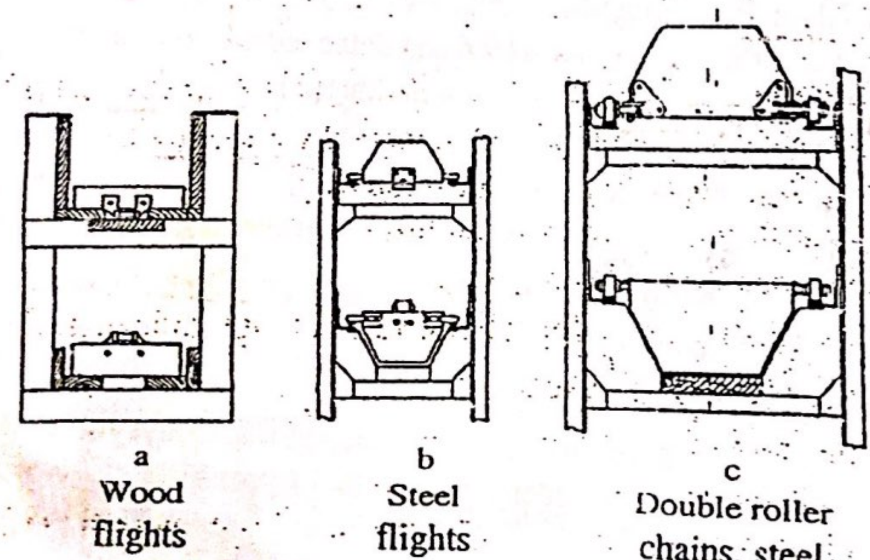
Advantages

(1) Cheap and Simple

Modification

(i) Scraper / flight conveyor

It consists of one or two endless chain passing through a through (wooden) oe set of guides. The chains have plates of wood or steel called flights attached at regular intervals. The flights are shaped to fit the trough. The drive is known as sprockets



a Wood flights

b Steel flights

c Double roller chains, steel flights

Advantages

Simplest and cheapest
Initial cost is low
Adaptability
Suitable for steeper inclines than the belt conveyor

Disadvantages:

(1) Heavy power requirements
(2) Repairing charges are high

Applications:

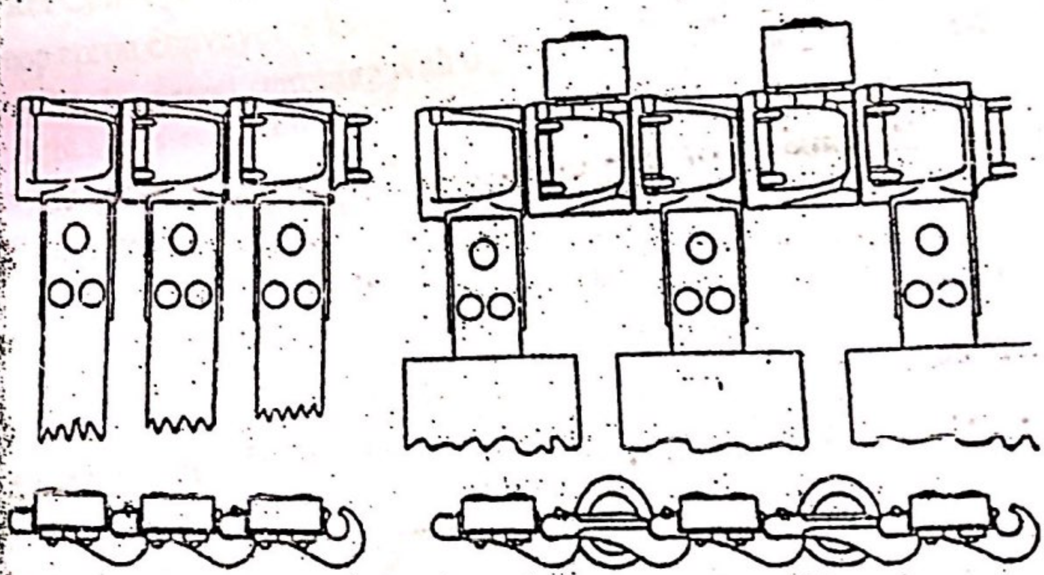
For saw dust, chips or any other light materials

(ii) Apron Conveyor

It is used for heavy loads and short runs

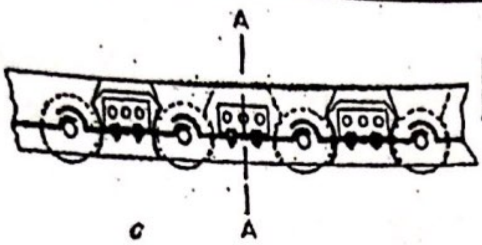
It consists of two chains made up entirely of malleable detachable links. Wooden bars are fastened to these attachments between the chains. The whole conveyor drags on the support. It form continuous moving platform.

Used for lumpy, abrasive, hot, injurious to flexible belts materials.



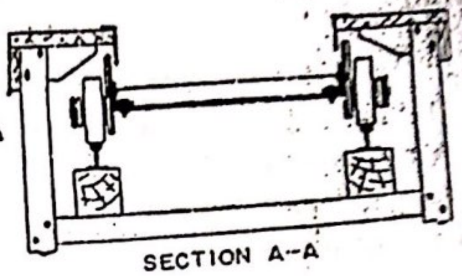
a
Detachable chain with `A' Link

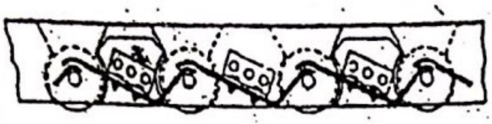
b
Detachable chain with `A' and `D' alternate Links



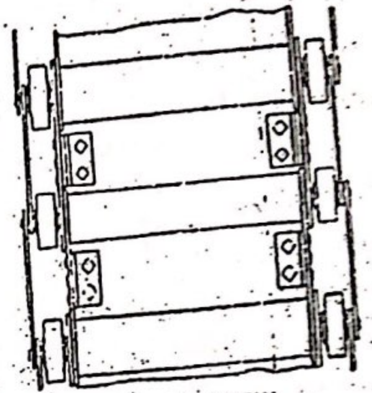
c

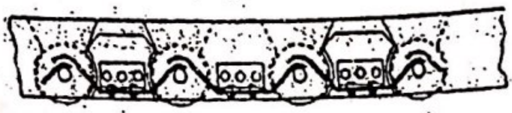
Overlapping flat steel plates


SECTION A--A


d

Overlapping stamped plates


PLAN VIEW


e

Recessed plates

(iii) Bucket Conveyors / Elevators

A deep apron conveyor is known as **bucket conveyor**

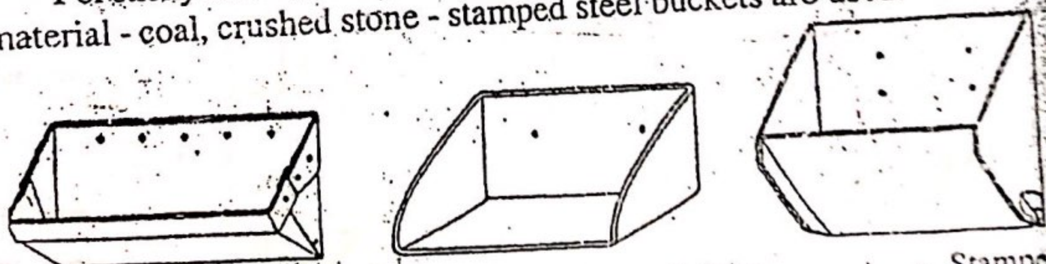
It consist deep steel stamping with overlapping edges carried on long pitch straight side steel chain

It is used in handling of coal in powerhouses.

A tripper may be located at any point in the horizontal run to discharge the buckets by inverting them over any desired portion of the bins.

Buckets may be of many forms. The Minneapolis - type bucket is almost used for grain and dry, pulverized materials.

For sticky materials flatter buckets are used. For large lumps and heavy material - coal, crushed stone - stamped steel buckets are used.


a General service　　*b* For wet/sticky　　*c* Stamped steel

Bucke Elevators

They are used when only **direction** of travel required is **vertical**. Buckets are fasten to a chain. Buckets can be suspended from a single chain or for heavier loads two chains are used. Buckets are spaced to prevent interference in loading and unloading.

Material is thrown from the buckets at the top of the elevator so that a spout placed to clear the head sprocket (drive pulley) will receive all the discharge

In the case of elevators for heavy material using over lapping buckets, the buckets are so shaped that the back of one bucket acts as a discharge spout for the next bucket.

Three common types of bucket elevators are there :

Centrifugal - discharge

The buckets are bolted through the back on to a single strand of chain or belt.

Buckets are loaded by material flowing through a chute. The load is thrown out of the buckets by centrifugal force as buckets pass over upper wheel

Positive - discharge :

Buckets are carried on two strands of chain which are snubbed under the head wheel and offer a more positive discharge

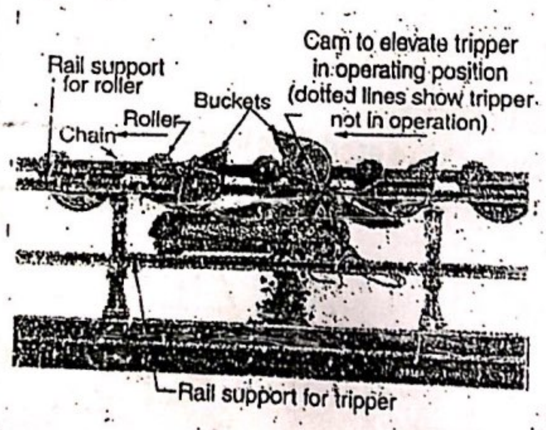
Continuous - discharge

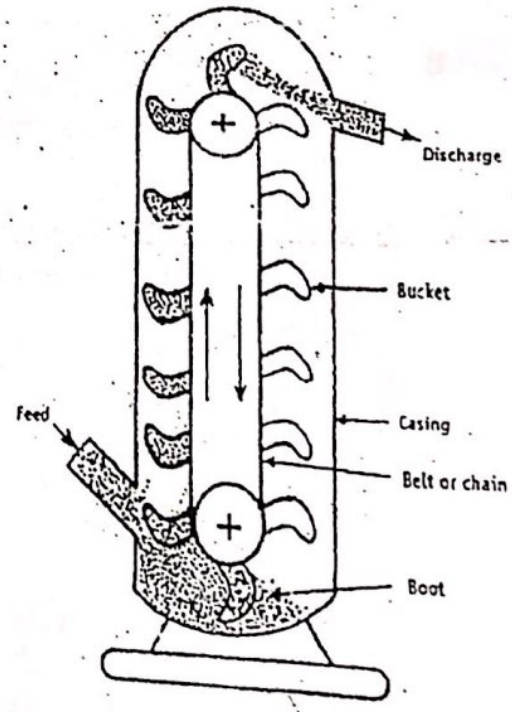
It is built with the buckets so close together that each bucket discharges by gavity with the load flowing over the front of the preceding bucket into the discharge chute.

They operate at much slower speeds than the centrifugal discharge types

Centrifugal discharge types are well adapted to light materials - grains, ashes etc.

Havier and abrasive materials handled in contonuous - discharge types.





Advantages :

(1) Flexible

Applications

for coal, crushed stone, grains

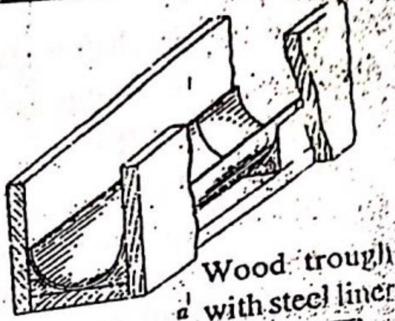
(3) SCREW CONVEYORS

It is mechanical conveyors move materials by a scraping action

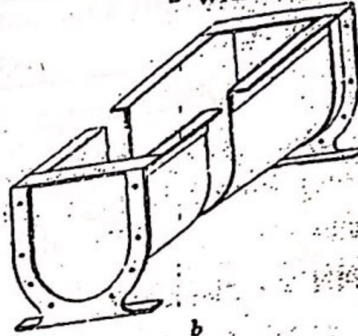
BASIC COMPONENTS :

TROUGH - It is hemisphericle vessel, in which material is kept

It is made up of steel. Fixed length trough may be joined together to increase length. Some time half-round section at the bottom of the trough is made of steel and the straight sides are formed by the wooden



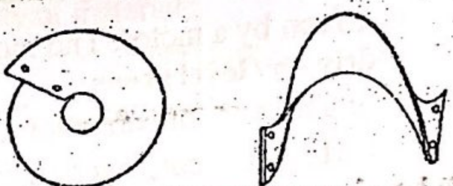
a Wood trough with steel liner



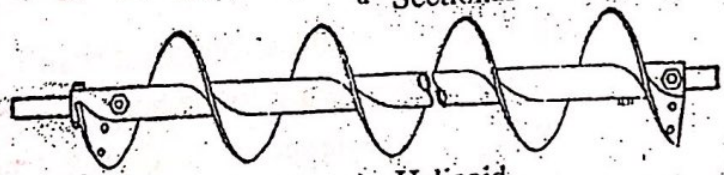
b steel trough

FLIGHTS :

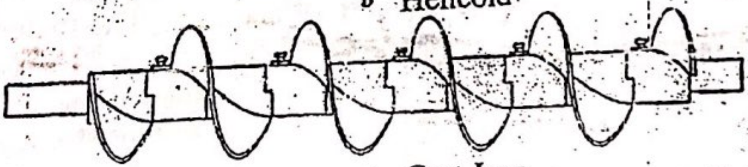
The screw element is called a flight. It may be **sectional, helicoid or spiral**



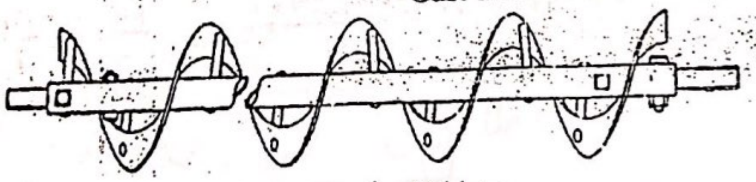
a Sectional



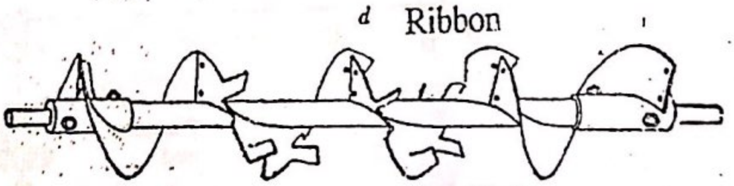
b Helicoid



c Cast Iron



d Ribbon



e Cut flights

SHAFT

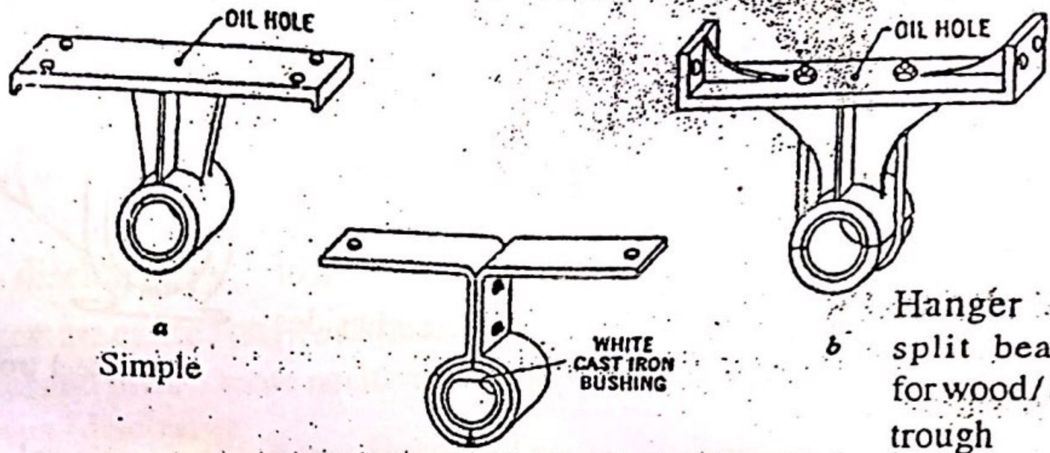
The shaft is standard steel pipe

The flights are welded to the central shaft.

HANGER :

The conveyor element (Shaft + Fights) is suspended with the help of hangers. One hanger is used for each flight. Hangers contain bushings of white cast iron, so no need of lubricant.

Shaft is also suspended by two bearings in the end plates of the conveyor.



a Simple

b Hanger with split bearing for wood/steel trough

c Hanger with Bushing

POWER SUPPLY :

The shaft is driven by a motor, The motor is kept at drive end. shaft is connected to the drive by level greas.

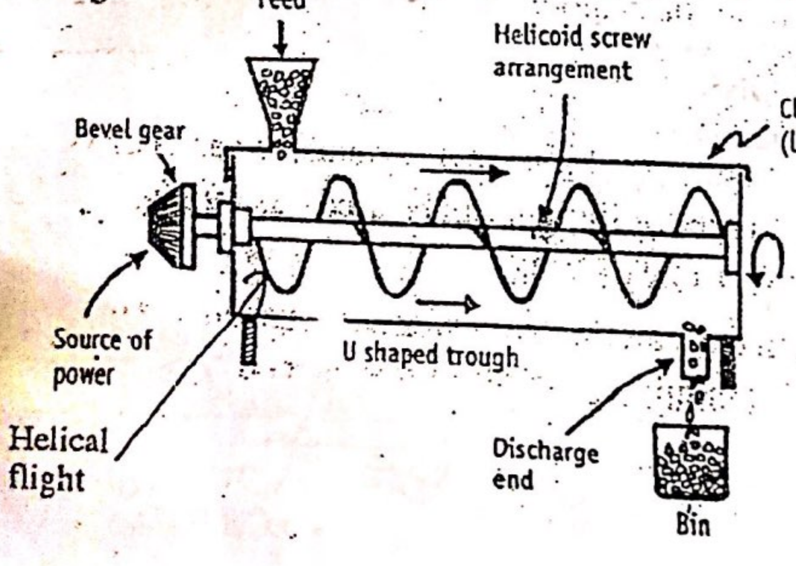
BOX ENDS : The ends of conveyor is know as **BOX-ENDS**

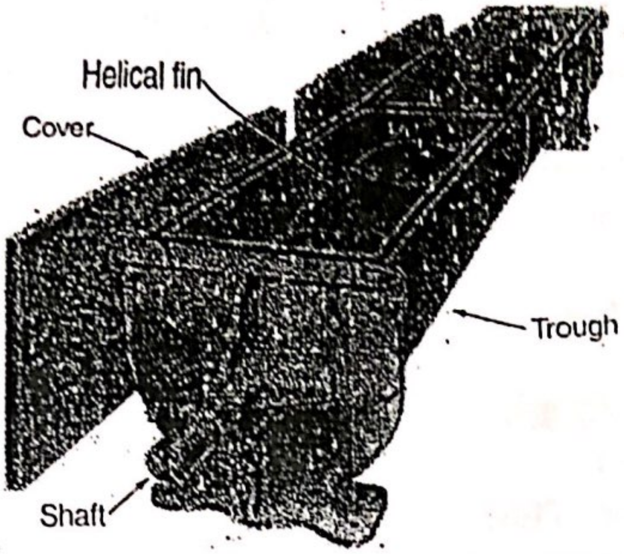
Drive end is different in construction from the discharge end.

WORKING :

When power is applied the drive rotates the shaft and hence flights. Flight is rotated round an axis and nearer to the bottom of the trough

Feed is introduced by plain spouts. As the flight moves the material also moves forward along the path of sections. The material is received using open-end trough.





ADVANTAGES

(1) Can transport material horizontaly, vertically (Up or Down) or inclined positions
(2) Easy to operate and occupy less space (Compact)
(3) Constructed from variety of materials
(4) Operated at positive and negative pressures
(5) By insulating the casing temperature can be loweral or raised
(6) It can be made dust free
(7) Economical
(8) It also perform mixing operation

DISADVANTAGES :

(1) Operates at low rotational speeds
(2) If large, combersome handling
(3) If rotated at high speeds there is problems of abrasive
(4) Power consumption is more

APPLICATIONS

(1) For finely divided solids and pasty mass
(2) Varieties of materials - light, heavy, Abrasive can be handled
(3) By changing types of flight it can be used - as mixing and dewatering

(4) PNEUMATIC CONVEYOR

In this system the material is transferred in suspension in a stream of air. Vacuum cleaner is familiar example of this method..

COMPONENTS :

- **PUMP OR FAN / BLOWER - EXHAUSTER :**

  To produce the stream of air normally cycloidal type pump is used

DUCTS :

CYCLONE : (RECEIVER)

- For separation of large particles

BAG FILTER :

For removing the dust

FEEDER

DISCHARGING DEVICES

DIFFERENT TYPES :

- PRESSURE SYSTEMS
- VACUUM SYSSTEMS
- COMBINATION OF PRESSURE AND VACUUM SYSTEMS
- FLUIDIZING
- BLOW TANK

PRESSURE SYSTEMS

Material is dropped into an air stream by a rotary feeder. Air from blower passes below a feeder.

A mixture of air and material Flows along the ducts, reaching the collector (cyclone) where the material drops to the base of the cone, while the air continues to discharge to atmosphere through the bag filter.

It is used for free flowing materials. Air is supplied by positive - displacement - blowers.

In this system material conveyed from one receiving point to several delivery stations.