ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF AGRICULTURAL ENGINEERING

AI3601 POST- HARVEST TECHNOLOGY

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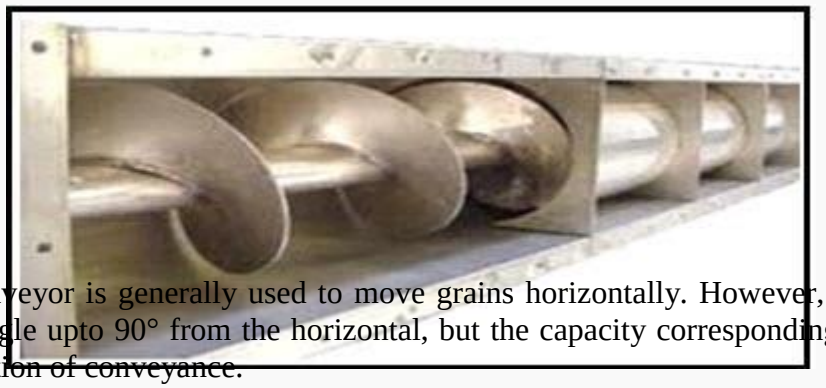
Screw Conveyor

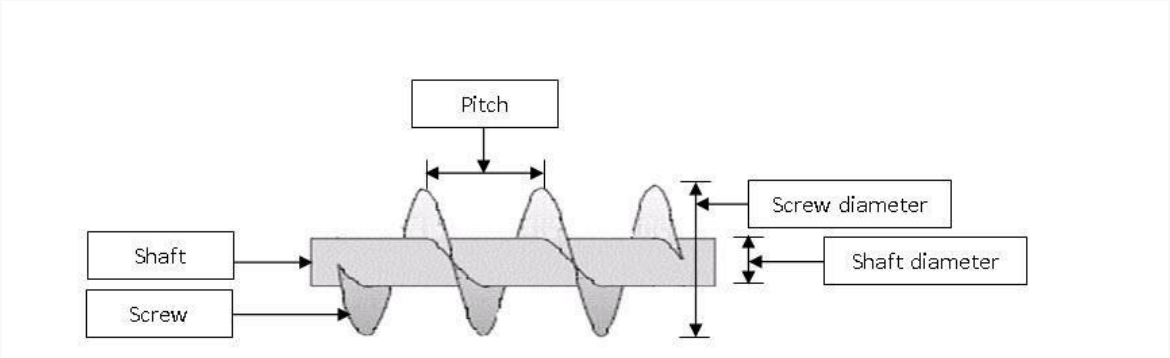
The screw conveyor consists of a tubular or U-shaped trough in which a shaft with spiral screw revolves. The screw shaft is supported by end and hanger bearing. The rotation of screw pushes the grain along the trough. The screw conveyor is used in grain handling facilities, animal feed industries and other installations for conveying of products generally for short distances. Screw conveyor requires relatively high power and is more susceptible to wear than other types of conveyors. The pitch of a standard screw which is the distance from the centre of one thread to the centre of the next thread, is equal to its diameter.

The screw conveyor's driving mechanism is simpler and no tensioning device is required therefore, the initial cost of the conveyor is lower than any other conveyor with the same length and capacity. The main parts of a screw conveyor are, screw blade, screw shaft, trough, inlet and outlet gates, bearings and drive mechanism.

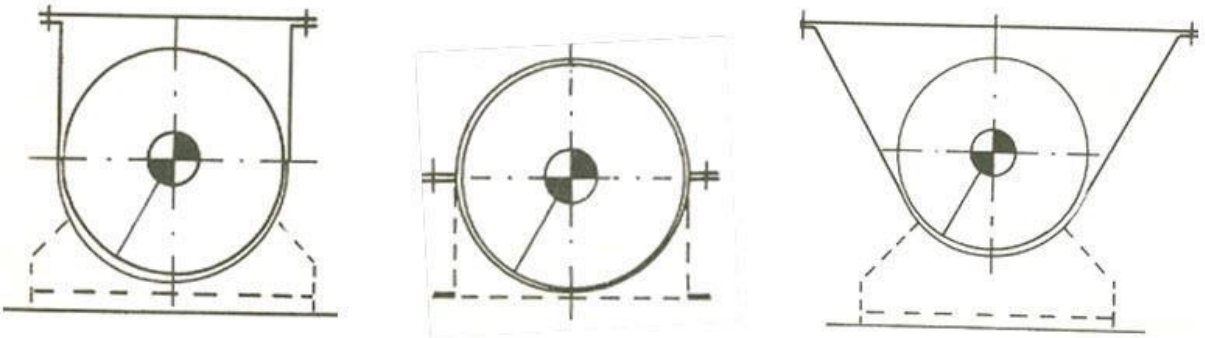


The screw conveyor is generally used to move grains horizontally. However, it can also be used at any angle upto 90° from the horizontal, but the capacity correspondingly reduced as per the inclination of conveyance.

The screw basically consists of a shaft and the screw blade or flight. The flight is a continuous one piece helix, shaped from a flat strip of steel welded onto the shaft. The serew shaft is usually a jointless tube with thick sides and a high tensile shtrength to reduce the weight. The thickness of the steel strip helix decreases from the innter edge to the outer edge.



Troughs of screw conveyor have different shapes. Most commom is U-shaped trough. In an enlarged or flared trough the side walls become wider at the top. This type of trough is usually used for conveying non-easy flowing materials which may have lumps. The tubular trough is completely closed with circular x-section and mostly used for conveying materials at inclination or for vertical lift.



For operational reasons, some gap is provided between the edge of the screw blade and the trough walls. Due to this gap, it is not possible to completely empty the trough of a horizontal screw conveyor. If the screw conveyor is used to convey different materials, mixing of products is possible. Also, when the kernels are pressed between the serew edge and trough walls, they can be damaged. During conveyance, the kernels are also subjected to continuous friction with the trough walls. Screw conveyor may be designed for clockwise or counter-clockwise rotation. The change in direction of roatation does not affect the capacity.

The capacity of screw conveyor is influenced by the screw diameter, inclination of the screw blade, speed of the blade, shaft diameter and cross-section of loading. The theoretical conveyance capacity of the screw conveyor can be calculated by the following equation.

Capacity ,

Where,

D = screw diamter, m

d = shaft diameter, m

p = pitch, m

n = rpm

The power requirement of screw conveyors for horizontal operation may be determimined by the following equation.

Where,

Q = conveyor capacity,

L = conveyor length, m

W = bulk material weight,

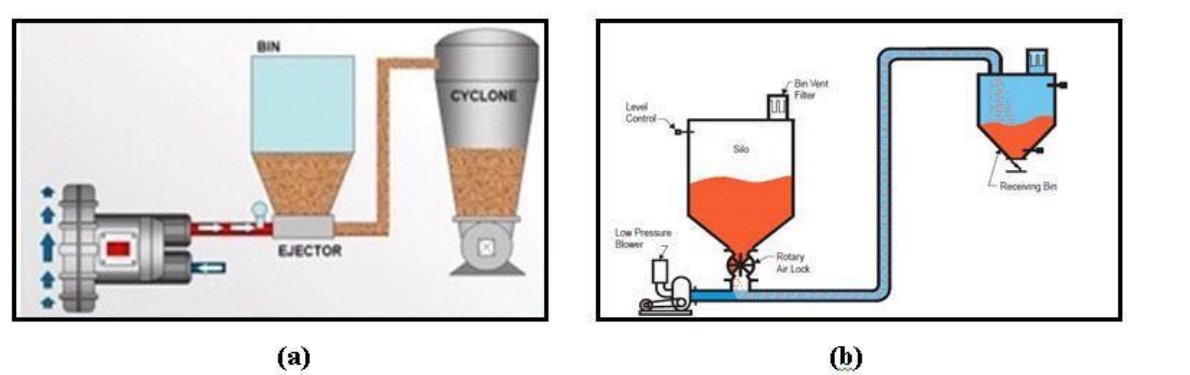
F = material factor

Screw conveyors can be operated in an inclined position. In this case, the material will be conveyed upward. The capacity of inclined screw conveyor decreases than the horizontal operation. Loading and discharge of a screw conveyor can be take place at sevaral places.

The product supply should be regular to avoid overfilling and congestion in a screw cpnveyor. To regularize product flow an adjustable opening at the feeding point should be provided. The product can be discharged either at the end of the screw or the intermediate discharge can be achieved through an opening in the bottom of the trough.

Pneumatc Conveyor

The pneumatic conveyor moves granular materials in a closed duct by a high velocity air stream. Pneumatic conveying is a continuous and flexible transportation method. The material is carried in pipelines either by suctuion or blowing pressure stream. The granular materials because of high air pressure are convayed in dispersed condition. For dispersion of bulk material, air velocities in the range of 15 – 30 m/s is necessary.

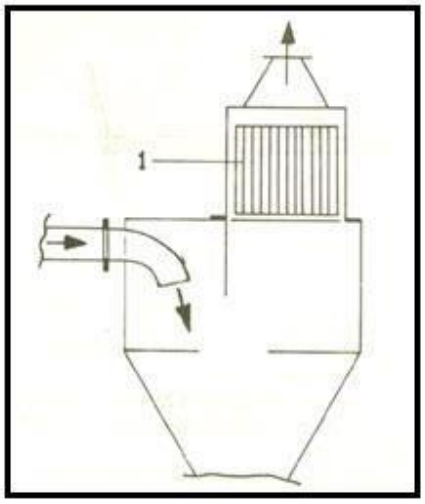


(a) (b)

The pneumatic conveying system needs a source of air blowing or suction, means of feeding the product into the conveyor, ducts and a cyclone or receiving hopper for collection of product. There are three basic systems of pneumatic conveying. These are pressure or blowing system, suction or vacuum system and combined push-pull or suck blow system.

In blowing or positive pressure systems, the product is conveyed by using air pressures greater than the atmospheric pressure. The selection of air mover is the most important aspect of the design of a pneumatic conveying system. Two factors, supply air pressure and the volumetric flow rate of air should be considered in designing.

For separation of product particles from air, air-product separators are used. Cyclones are mostly used to collect the particles. Cyclone is a device which removes the bulk of the product particle from the conveying air stream by centrifugal force. In some cyclone, a fabric filter is attached to remove residual dust and fine product particles from the air stream.



a) Fabric filter

b) Cyclone separator

Separation of product particles from air

The volumetric flow rate of air depends on the necessary air velocity and pipe or duct size used in the system. In pneumatic conveying systems, fans and blowers with high voulmetric flow rates and lowe pressures to positive displacement compressors producing high pressures are used.

Bucket Elevator

A bucket elevator consists of buckets attached to a chain or belt that revolves around two pulleys one at top and the other at bottom. The bucket elevator is a very efficient deivce for the vertical conveyance of bulk grains. The elevator can lift the materials between few meters to more than 50 m. Capacities of bucket elevators may very from 2 to 1000 t/h. Bucket elevators are broadly classified into two general types;

1) spaced bucket elecators and

2) continuous bucket elevators.

The above two types are further sub divided into various classed.

The spaced bucket elevators are further classified as;

a) centrifugal discharge elecators

b) positive-discharge elevators

c) marine leg elevators and

d) high-speed elevators.

The continuous bucket elevators are classified as;

a) super capacity bucket elevators and

b) internal-discharge bucket elevators.

The spaced-bucket centricugal discharge type is most commonly used for elevating the grains. Bucket elevators with belts are used in food industries for vertical converyance of grains, its derivatives and flours. Bucket elevators have high capacities and it is a fairly cheap means of vertical conveyance. It requires limited horizontal space and the operation space and the operation of conveying is enclosed in housing, thus it is dust free and fairly quite.

In a bucket elevator, the conveyor belt with buckets runs over pulleys at the upper and lower ends. The top pulley is driven pulley while the lower pulley is return and tension pulley. Buckets are usually made of steel or plastic and are bolted onto the belt. The bucktes may be enclosed in a single housing called leg or two legs. The return leg may be located at some distance from the elevator leg. The housing or legs are also made of steel are welded or boltyed together and are dust tight. The curved hood is designed for proper centrifugal discharge of the grains. The boot can be loaded from the front or back or both . The product flow is discharged either by means of gravity or centrifugal force.

The bucket elevator's capacity mainly depends on bucket size, conveying speed, bucket design and spacing, the way of loading and unloading, the bucket and the charactesistic of bulk material. Bucket elevators with a belt carrier can be used at fairly high speeds of 2.5 to 4 m/s. The speed of the belt depends upon the head pulley speed. A properly deisgned bucket ele3vator deriven at the correct speed will make a clean discharge. If the belt speed uis too low, the discharge of the grains becomes more difficult, wioth too high speed the buckets are not fed wel.

In elevating of grains the discharge from bucket elevators is a combination of centrifugal and gravitational discharge. Part of the bucket conetnts is projected by the centrifugal force, the rest flows out by gravity.

The bucket elevator's capacity can be calculated by the follwoing equation.

Elevator capacity,

t/hr =

$$m^3/_h = bucket\ capacity, m^3\ X\ number\ of\ bucket\ per\ meter\ of\ belt\ X\ belt\ speed, m/\min X\ 60$$

$$\frac{Capacity, \frac{m^3}{hr} X\ material\ density, kg/m^3}{1000}$$

The main parts of a bucket elevator are;

- elevator head and boot section

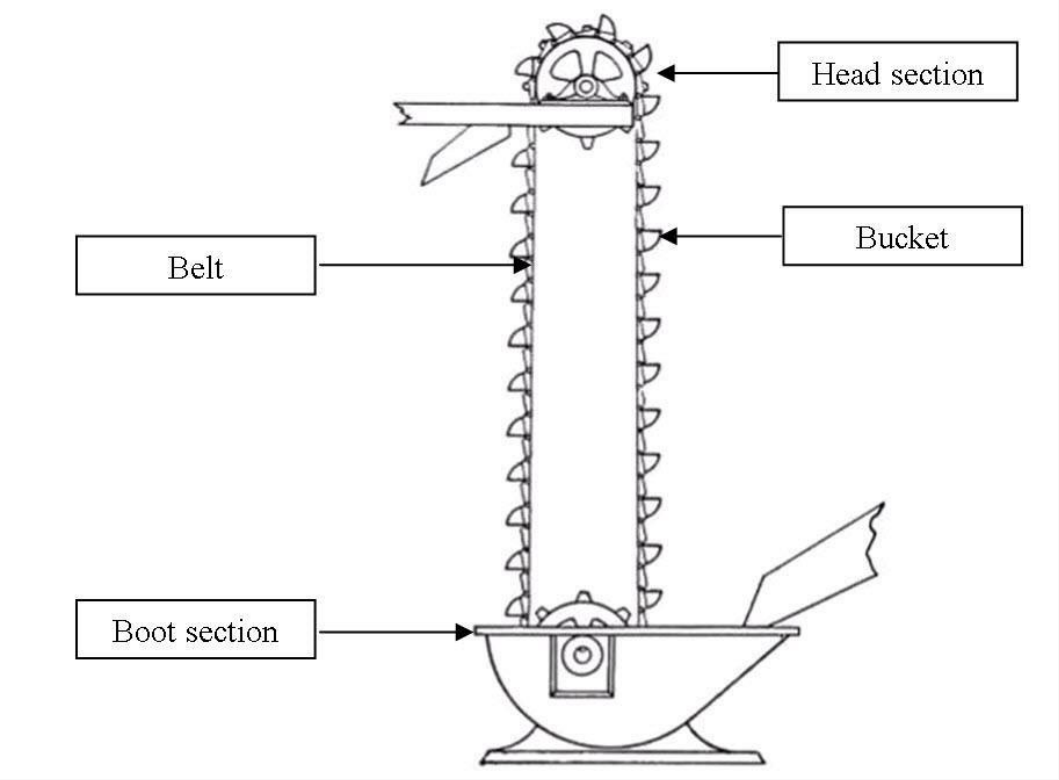
- elevator legs

- belts for bucket elevator and

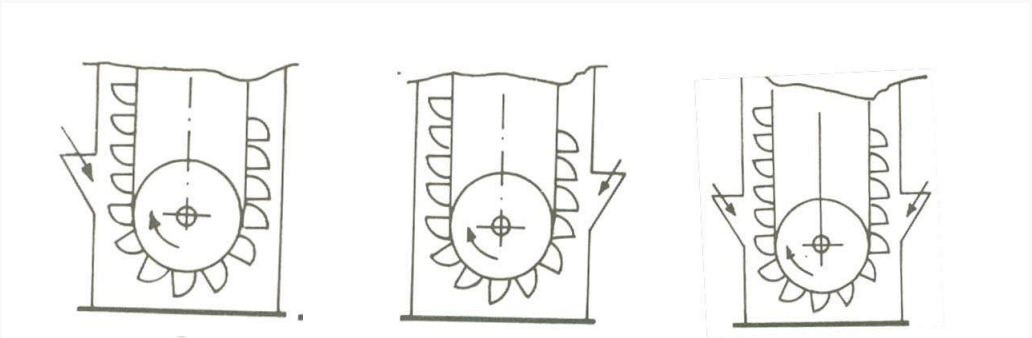
- buckets.

Head and Boot Section

The head section should be of the proper shape and size with smooth counters. The discharge side of the head should be shaped so that material thrown from the buckets may not deflect into the down leg. When the product is not thrown well clear of the buckets into the dischage chute, it will fall in the down leg. This is called as “back logging”. The back logged material has to be re-elevated, thus it reduces the capacity of the elevator. To avoid back-logging, an adjustable cut off plate is provided close to the lip of bucket.



Bucket elvators boots should be of bolted assembly to allow for proper maintanance and replacement of pulley, shaft and other accessoris. In the boot section, the loading chite should be located at such point that the pick-up of the product by the buckets takes place above the centre line of the return pulley.



Bucket feeding section

Elevator legs

The up and down moving string of buckets in bucket elevators are enclosed in elevator legs. The elevator legs stop the emission of dust. These legs are constructed as all welded, bolted or riveted. The strings of up and down moving buckets can either run in a common leg or in

separate legs. With double legs, a balanced pressure can be obtained by ducts connecting on different levels of the upgoing and downgoing trunk. Service and inspection openings are needed as it requires adequate maintenance.

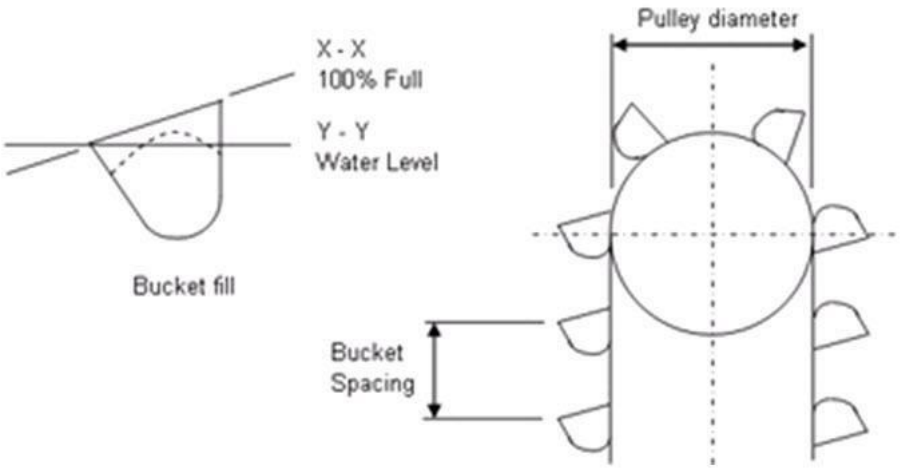
Elevator Belts

In a normal operation of the bucket elevator, the loads exerted by the elevator height, product weight, weight of bucket belt and idle tension and the digging resistance are taken by the belt. The bucket elevatyor belt has no support between the drive and the return pulleys, therefore, cross stiffness of belt is very important. Most conveyoor belts consist of synthetic fibres like polysters and ploymide and built up with synthetic rubber or PVC. To increse tensile strength of belt, several layers of fibres are put together to build a carcass. Such carcass is able to withstand very high tensile forces with minimum of stretch.

During continuous operation, elevator belts are susceptible to various mechanical stresse3s which may cause wear. The friction between drive pully and the belt causes wear in the underside of the belt. The back faling product is caught and crushed between the belt and return pulley. Extra forces are also exerted on the belt by rigid buckets while psssing over the head pulley.

Buckets

As per the requirements, buckets are made of different materials and come in veroius shapes and sized. The shape of the bucket is very important for filling and discharge. Digging in of buckets in the elevator boot and the centrifugal discharge at the elevator head influence the shape of buckets.



For centrifugal discharge the resultant of product weight and the centrifugal force should preferably be directed towards the lip of the bucket. The buckets should have a wide open mouth for digging nd discharging the product. The conveuying capacity of the elevator also depends upon the number of buckets per metre belt length.

The capacity and discharge of each bucket is influenced by the previous bucket, hence the distance betwen two successive buckets is impornttant. Therefore, comprosime between the following factors is required 1) the design and content of the bucjkets, 2) the shortest distance

between cussessive buckets wothout any mutual influence, 3) for centrifugal disrhagte the appropriate belt speed and diameter of drive pulley. In general, the spacing would be from 2.0 to 3.0 times the projected width of bucket.