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Unit 4 – Topic 6

Bucket Elevators – Pneumatic Conveying

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 device 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 elevators 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 elevators

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 centrifugal discharge type is most commonly used for elevating the grains. Bucket elevators with belts are used in food industries for vertical conveyance 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 quiet.

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 buckets 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 characteristic 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 designed bucket ele3vator driven at the correct speed will make a clean discharge. If the belt speed is too low, the discharge of the grains becomes more difficult, with too high speed the buckets are not fed well.

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

The bucket elevator's capacity can be calculated by the following 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

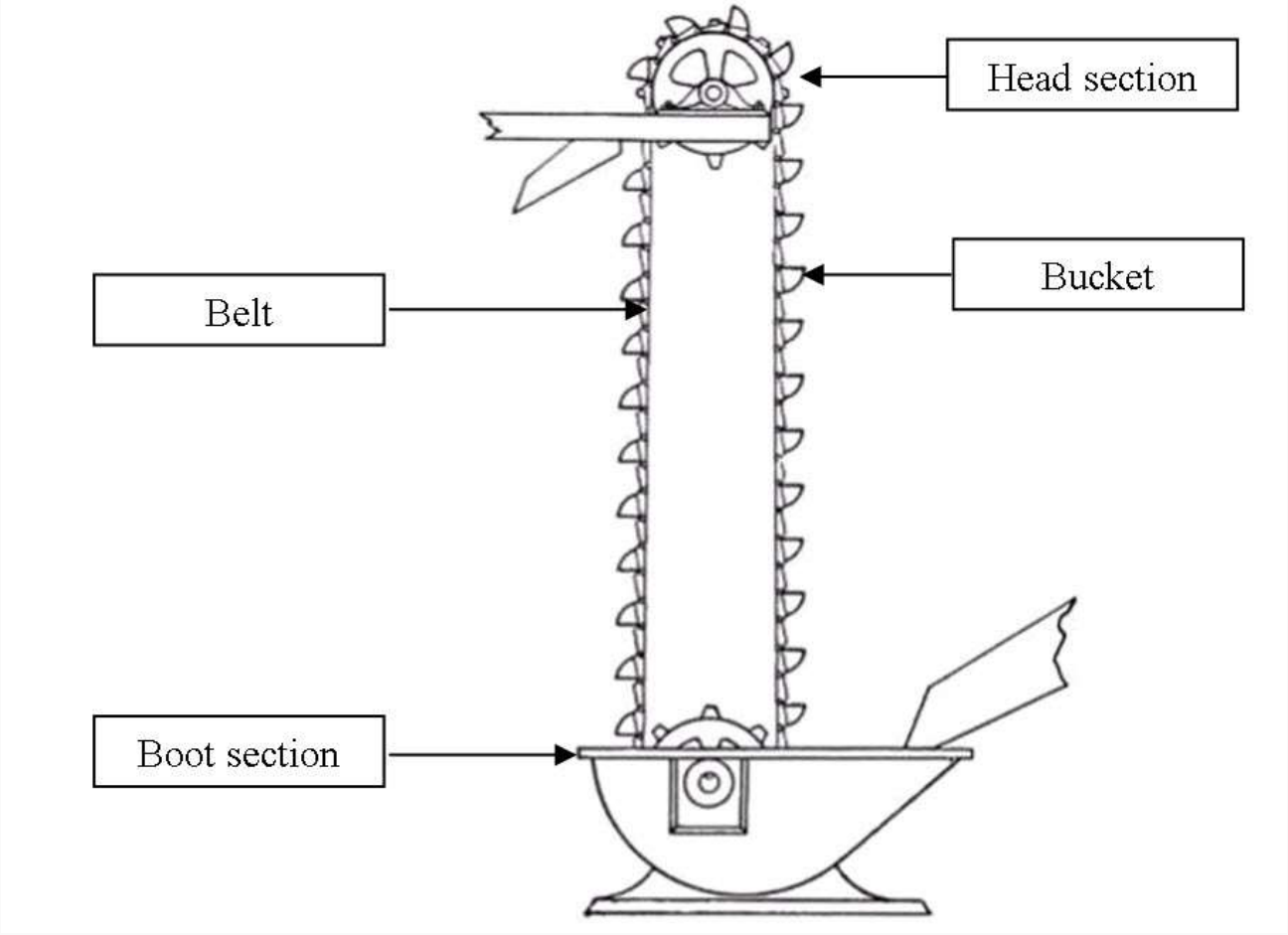
- elevator legs

- belts for bucket elevator and

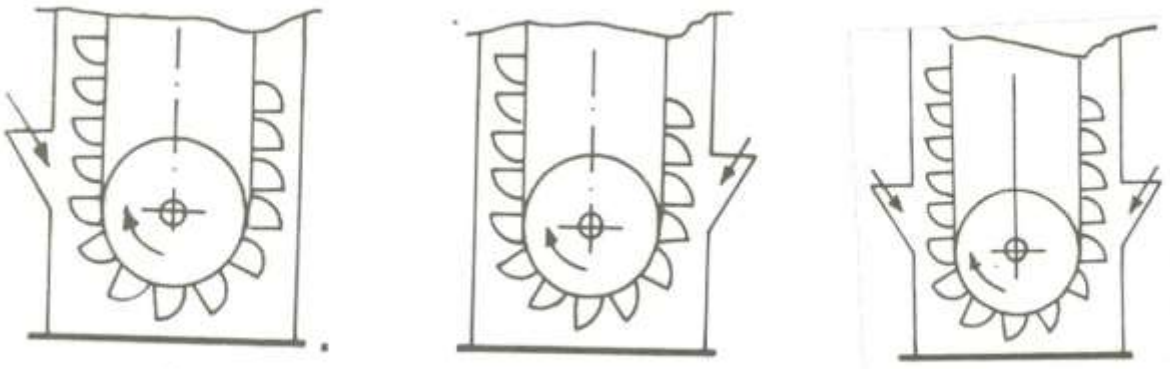
- buckets.

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 discharge 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 up going and down going trunk. Service and inspection openings are needed as it requires adequate maintenance.

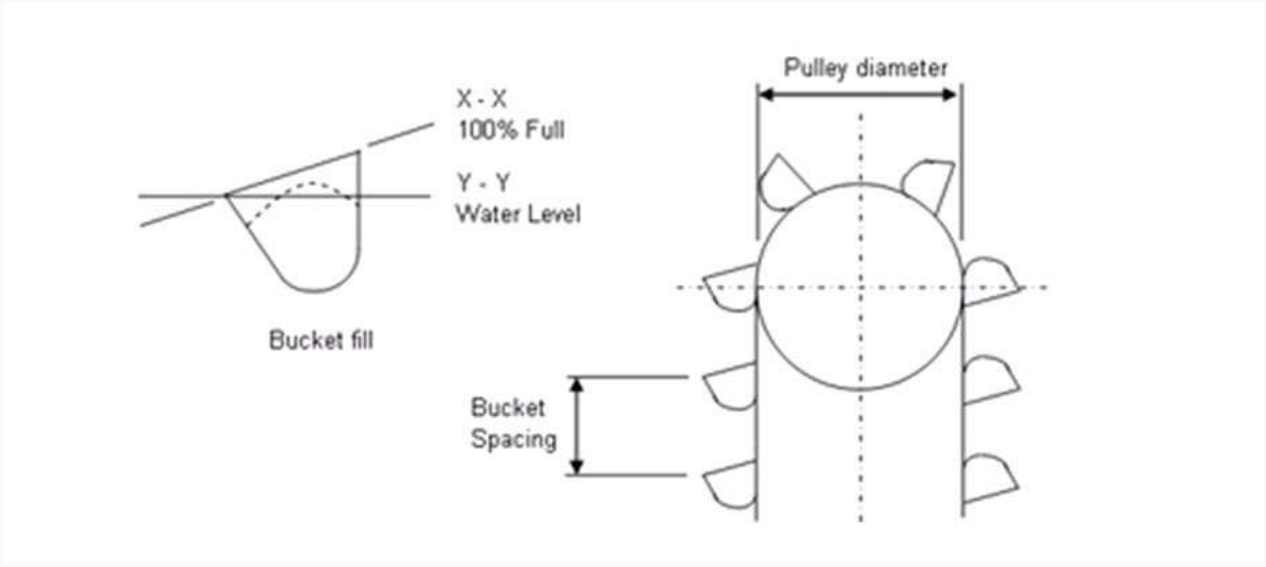
Elevator Belts

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 elevator belt has no support between the drive and the return pulleys, therefore, cross stiffness of belt is very important. Most conveyor belts consist of synthetic fibers like polysters and polyamide and built up with synthetic rubber or PVC. To increase tensile strength of belt, several layers of fibers 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 pulley and the belt causes wear in the underside of the belt. The back falling product is caught and crushed between the belt and return pulley. Extra forces are also exerted on the belt by rigid buckets while passing over the head pulley.

Buckets

As per the requirements, buckets are made of different materials and come in various 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.



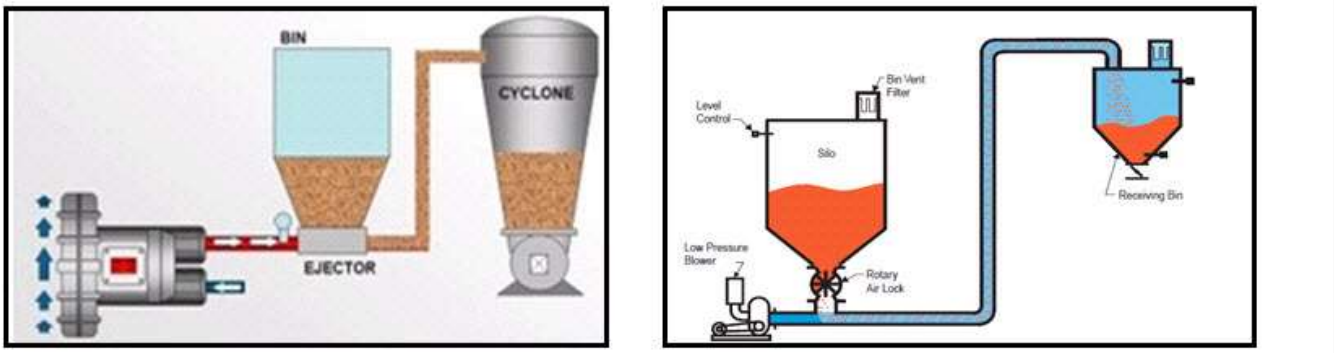
For centrifugal discharge the resultant of product weight and the centrifugal force should preferably be directed towards the lip of the bucket. The buckets should have a wide open mouth for digging and discharging the product. The conveying capacity of the elevator also depends upon the number of buckets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

The capacity and discharge of each bucket is influenced by the previous bucket, hence the distance between two successive buckets is important. Therefore, compromise between the following factors is required 1) the

design and content of the buckets, 2) the shortest distance between successive buckets without any mutual influence, 3) for centrifugal discharge 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.

Pneumatic 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 suction or blowing pressure stream. The granular materials because of high air pressure are conveyed in dispersed condition. For dispersion of bulk material, air velocities in the range of 15 – 30 m/s is necessary.

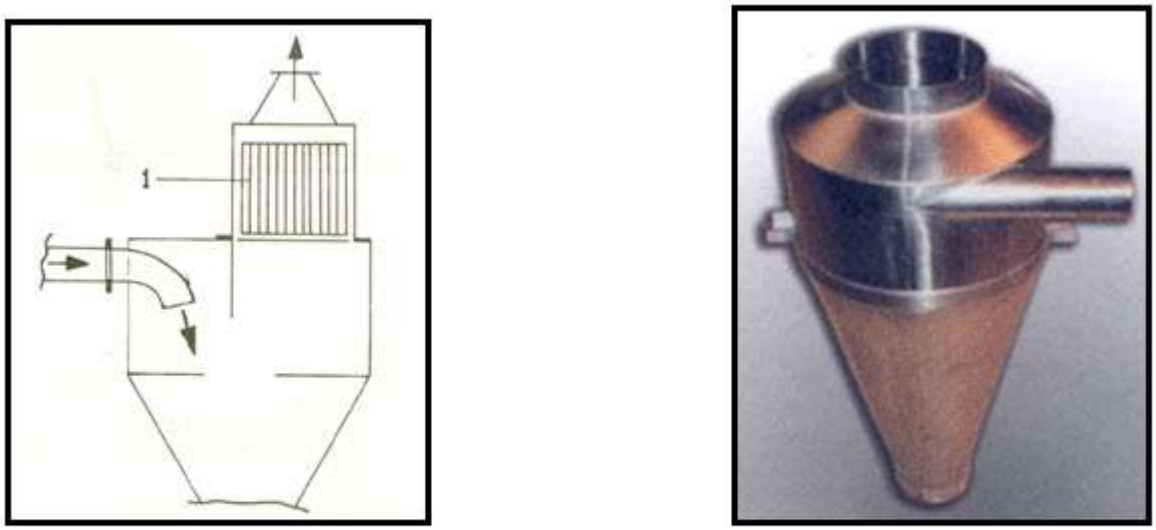


(a) (b)

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 volumetric flow rates and lower pressures to positive displacement compressors producing high pressures are used.