INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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NPTEL ONLINE CERTIFICATION COURSE

Unit operations of Particulate Matter

Lec- 19
Transportation of solids (Part-02)

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Welcome to the fourth lecture of week four of the course unit operations of particulate matter, in this lecture we will discuss mechanical conveyors. Now if you remember the third lecture of this week there we have started discussion on transportation of solids and we have discussed screw conveyor in mechanical conveyor category. Now here we will continue that discussion and we will discuss few more mechanical conveyors so let us start with belt conveyors.

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So what is belt conveyor, belt conveyors are most commonly used powered conveyor because they are more versatile and least expensive, so as for as belt conveyor is concerned these are used extensively in chemical plants or in industries one reason is they have good capacity and more over they are less expensive. Now when we consider belt conveyor you understand that it has a belt which move because as the name says it is belt and that belt should convey from one space to another space.

So that is nothing but the belt conveyor, so material put over this belt and that is carried, so you see in this case material will not move, material stay at a position and belt moves therefore it is called a carrier. So product is conveyed directly on the belt so both regular and irregular shaped object large or small light and heavy can be transported successfully, so you see here we have discussed that regular and irregular shaped object.

Now what happens when material moves it can put hindrance while moving when it has different shape, but in belt conveyor as material stay on the belt and belt move we can consider any belt, we can consider any shape of the material. So here shape of the material it is size will not affect in transportation, so belt conveyors can be used to transport product in a straight line or through changes in elevation or direction.

So here we can easily convey material through belt when we are transporting the material on horizontal level or vertically or an inclination anywhere we can send material through belt conveyor. Now here we have some of the applications of belt conveyor, distribution of moulding sends and removal of waste. Fuel supply system of power station, usually when we consider power station coal is the raw material for that and that can be conveyed easily through belt conveyor.

Underground and surface transport of coal, delivery of ores and coke in metal making industries and transport building material, fossil minerals, grains, sand and gravels so you see here we have, here some applications are discussed for belt conveyor so you can understand that it is used extensively in plants.

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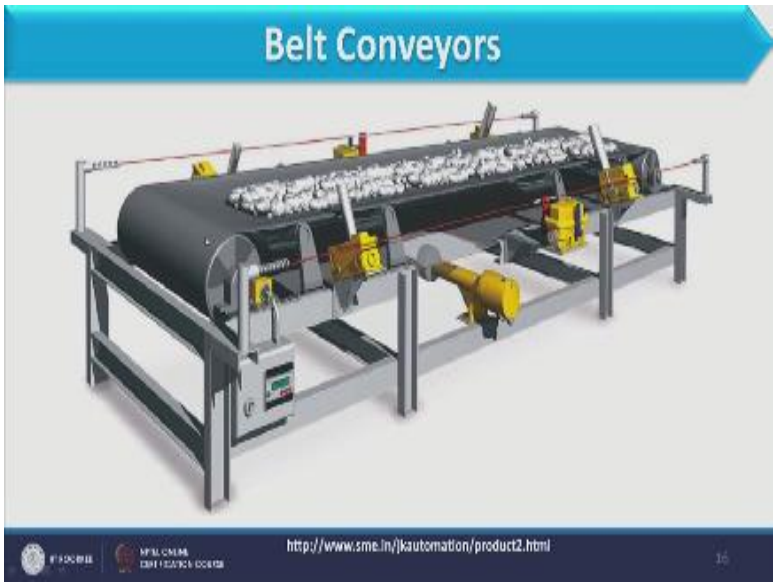

Now if you see this image this image shows a potable belt conveyor, now as for as mechanism of this belt conveyor is concern that we can understand through this potable conveyor. Though in plant usually belts are quite long, so here if you see here we have one roller another roller is at discharge and or we can say head or rare, so these rollers are provided at two ends from where to where belt is used for conveying the material.

Now these rollers are driven by drive so as this roller move the belt move, now belt is basically kept around these rollers you see belt is available around this rollers and from carrying, and from feed and to discharge and the length of the belt is fixed and these length is decided by just twice the distance, length of the belt will depend on the total distance which it has to cover and that should be all most double of that.

Now what happens when material put over here in belt it has a sagging or what we say that material which we put on the belt during continues operation it should come down, so when material is put on this belt after sometime it has come down or sagging occurs in belt so this

problem can be sorted out by putting rollers at definite interval along the length, so from feed end to discharge and continuous rollers are placed in between and they keep this belt straight.

And similarly we have rollers when the belt is returning back, so whatever rollers are using in returning back it has more distance in comparison to the distance we are providing when material is carrying on the belt. Because during returning it does not have any material, so shape of the belt can be maintained through these rollers, so here we have two pulleys on which belt move and we have different rollers which move with the movement of belt. If you want to study about this in detail you can visit this link.

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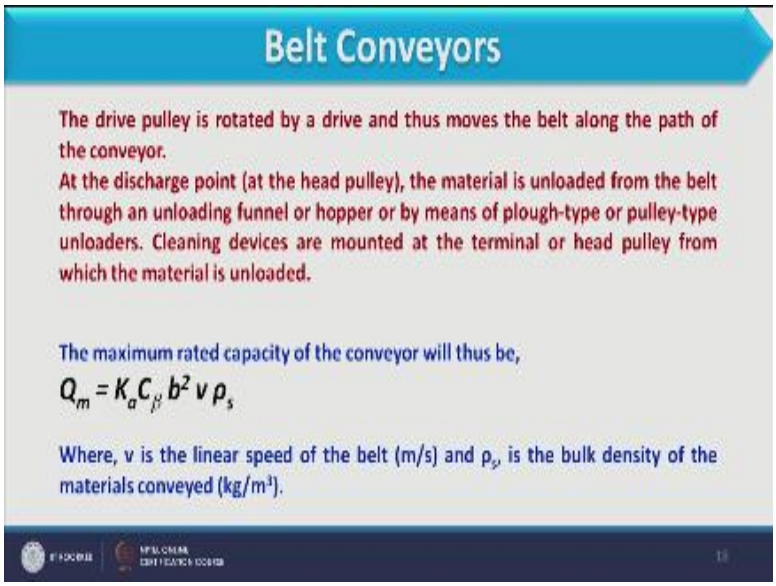

So the drive pulley which is located at two ends of the belt is rotated by a drive and thus moves the belt along the path of the conveyor. At the discharge end we call it head pulley or we call it discharge point also, the material is unloaded from the belt through and unloading funnel or hopper or by means of plough type or pulley type unloaders. Cleaning devices are mounted at the terminal or head pulley from which the material is unloaded.

Now here what happens when material is unloaded from the belt there we have cleaning system also because after continuous operation we have deposition of material on the belt so that has to be cleaning out, how we clean this because, how we clean this at the discharge end we have a mechanism like some rotating brushers are available so that moves over the belt to remove the material, so that can we use for sticky material as well as same type of material.

Now as for as maximum capacity which belt can carry that can be calculate and for that and imperial relation has been proposed and that is Q_m that is the maximum rated capacity of the conveyor equal to $K_a C_\beta b^2 v \rho_s$ where K_a and C_β are constants b is the width of the belt v is the linear speed of the belt that is in m/s and ρ_s is the bulk density of the material. So using this expression we can calculate how much maximum capacity a belt can carry. So value of these coefficient K_a and C_β we can see through this table.

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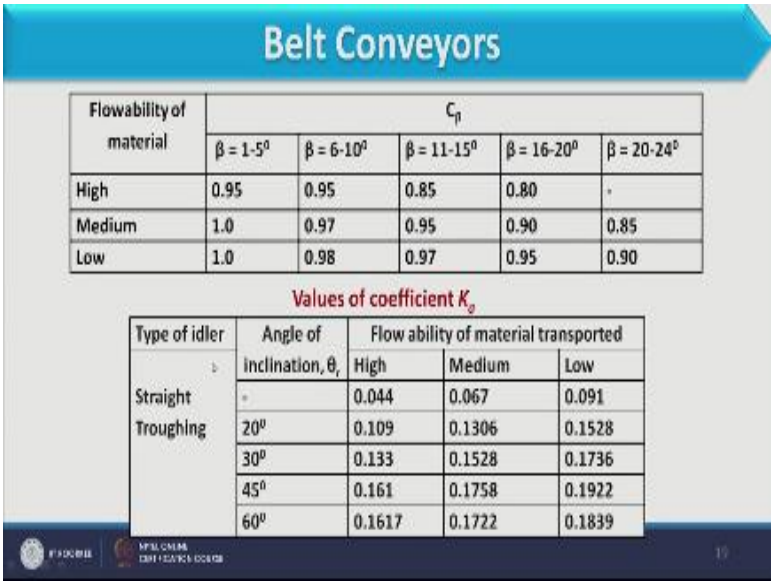

Here we have C_β value for different flowability of material like high medium or low and β angle moves up to 24° β is basically angle of inclination which moves up to 24° so here we have different value of C_β. If you see this table here we have values of coefficient K_a, so this is for

type of idler so straight troughing is there and here we have different angles of inclination, flowability of material transported for high medium and low we can have different value of K_a.

Now as for as capacity of belt is concerned that depends on many factors such as width and speed of the belt.

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Friction between the surface of the belt and the solids, angle of repose of the solid material I hope you are understanding what is angle of repose. For example, if this is the belt and we put the material over here it will makes a conical structure. For example, if this is the belt and when we put the material over here the granular material, if we put over here so that material put so that material prepares a conical on this and it will make an angle with this.

So whatever angle of this like if this is the cone the material makes and the angle with of this from the horizontal this angle is called as angle of repose. Angle of inclination of the belt the capacity depends on that how long, how at what angle it is conveyed, it is conveying the material at what angle it is conveying the material. Stickiness of the solid materials, shape, size and specific gravity of the solid.

So all these factor we should consider when we are defining, when we are considering the capacity of the belt. Now here if you see this image shows conveying of material to high point to elevated point so for such purpose conveyor, for such purpose belt conveyors are suitable here you see in this type it is collecting the material and you see here when we consider this is material prepares a cone on ground and when we consider this particular angle this is called angle of repose.

And when we have to convey the material from one point two different point as shown in this figure like here this is one conveying belt, this is conveying belt and this is also conveying belt so from same source two different discharge point we can use different belts and they are working very effectively.

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Here we have few images like you see it is transporting the material at slightly upper position it is conveying the material at upper position and if you see this image here in this case it is already mountains or hill area so here belt conveyors can be installed effectively with a structure. Now here if you see in this we have that hemispherical kind of roof is there so this is because, this is

so this can be used for worse weather conditions. So sometimes we provide roof over the belt and sometime material moves in open environment. So here we have some images for detail you can refer these links.

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Now we will discuss the Apron conveyor, now what is apron conveyor it is similar to belt conveyor but in belt conveyor what happens a continuous belt is there which moves over the, we can say drive pulleys which can move over the drive pulleys however what happens in apron conveyor it also has the drive pulleys but instead of belt some, instead of belt metal sheets are available and they are connected to each other.

So they move the material is stayed on the metal sheet not on the belt, because belt material, because material of belt will not be as hard as metal sheet. So apron conveyors that we have discussed it is similar to belt conveyor except solids are carried in moving turf we call it apron and they are made with wood or metal sheet instead of continuous flexible belt. So what is apron, apron is a load carrying element of apron conveyor it may be made of different configuration such as flat open, flat closed or corrugated with or without side walls.

So you see apron is basically the metal sheet or sometime it is prepared with wood also, so we have a rectangular sheet and these are connected side by side to prepare a chain of metal sheets, so you see sometimes we use a plane metal or that flat metal sometimes you put corrugated metal sheet on which friction will be there and material will stay on it even heavy material can stay over this. Now in apron conveyors sometimes we use side walls and sometimes we do not use.

What is side walls, it is for example if this is the apron conveyor here and here we have side walls, if you consider this is the apron conveyor up to this much width so here we have walls so that is basically the side walls it moves with the apron. So apron conveyors horizontal and inclined are widely employed in chemical, coal processing and metal making industry and also in thermal power plant, so you see they are used in different plants and they are used to carry the items not only the raw material.

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Now when we move the material through apron conveyor what happens because it is stayed on the metal sheet we can carry out different operations over here and these are hardening, tempering, cooling, washing, painting, assembling all these operations can be carried out on

apron conveyor which is added advantage of apron conveyor. Unlike belt conveyors, apron conveyors can handle heavier lumpy or abrasive material like ore and stone extra.

Because it is prepared with the metal sheet not with flexible belt, now as for as length is concerned the maximum length for this apron conveyor can be up to two kilometer, and they provide large through put capacity that is more than 2000 m^3/h due to high strength of hauling chains and use of intermediate drives. So here in this case, we use intermediate drives also in belt conveyor drive pulleys are available at two ends only.

But in apron conveyor we can install intermediate drive and because of these drives as well as the metal sheet it has more strength in comparison to belt therefore, it can have more capacity in comparison to belt conveyor. So apron conveyors are having appreciable weight of apron and chain and consequently their higher cost and more careful maintenance is required, so this is the disadvantage of apron conveyor.

Because of these metal sheet it has more weight and as for as cost is constrained high cost involve in this in manufacturing of these kind of conveyors and it requires careful maintenance, so that is the disadvantage with apron conveyor.

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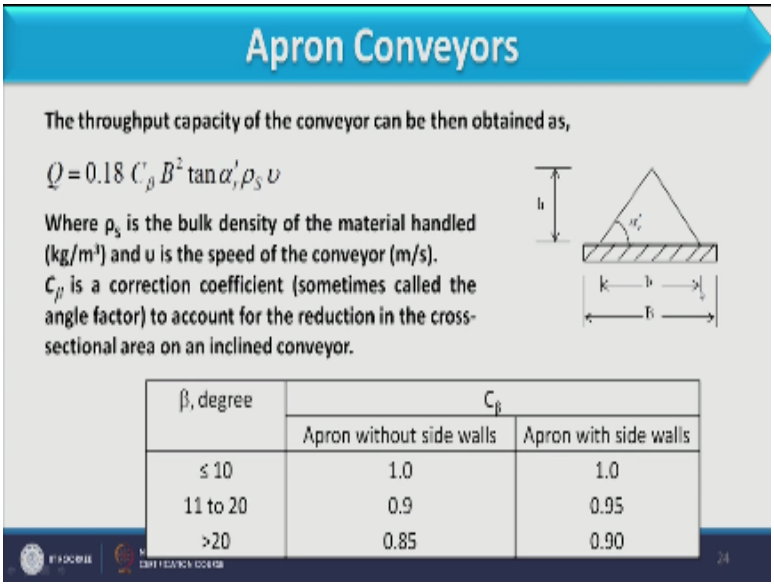

Now as for as throughput capacity of conveyor that can be calculated by an empirical relationship, here we have the relation as 0.1 it $C_\beta B^2 \tan\alpha_r' \rho_s v$, now if you consider the apron what is B, B is the total width of the apron, b is the parameter where which is the width of cone, parameter b is basically the width made by solid material on the apron. So here you see α_r' is nothing but the angle of repose and h is the height of cone which is made with the solid material.

So this type of apron is without wall, and when we consider this equation ρ as over here is the bulk density of material which we have to convey, v is the speed of conveyor m/s, C_β is the correction coefficient we call it angle factor which depend on angle of inclination, so here you see C_β value we have to see from the table otherwise other parameters we can collect from the apron itself.

So β is basically angle of inclination which can be greater than 20° and C_β value for apron without side wall and with side walls are given like this, so you see apron with the side walls has more C_β value in comparison to without side wall because when we are using side wall more capacity, more material can be put in the apron, so therefore capacity will increase therefore it has more value.

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So these images show you the apron conveyor if you see the first image it is apron conveyor now these are basically the metal sheet which are connected with each other and that is move through this drive, so if we are considering this particular image it is without wall however in second image you see this is basically the apron conveyor with an inclination and here we have the side walls.

So side walls will be the static section whereas belt, whereas apron conveyor moves over here, so here this side wall is not moveable with apron so and if you considering apron these aprons are corrugated type of, so material which we put over here that will not displace from its position because they can stuck with this corrugates. So here these are without side wall and this is with side wall apron conveyor for more you can refer these links. So that is all about the apron conveyor.

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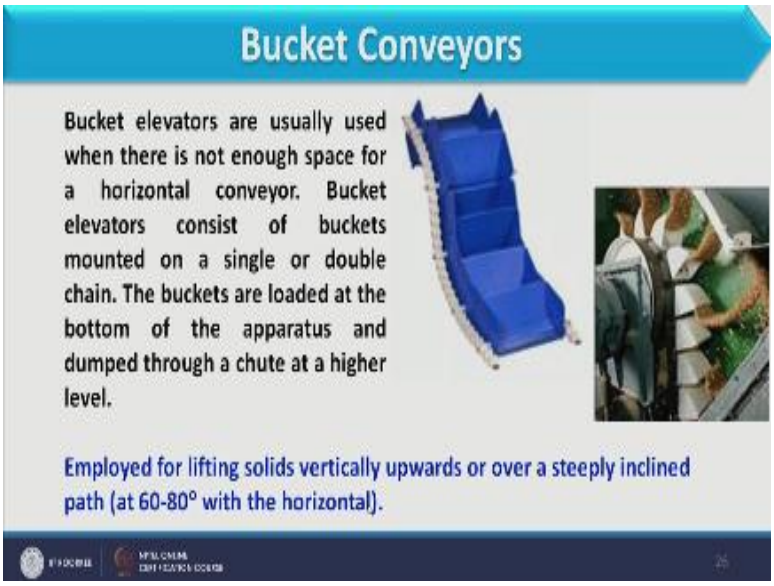

Now we will discuss the bucket conveyor, now what is bucket conveyor, bucket conveyor is basically the conveyor of the shape of bucket it takes the material and then dumped to the other side, so these are specifically used when we have to drop the material from one flow to another flow or when we have to transfer the material vertically, so bucket elevators are usually when there is not enough space for horizontal conveyor.

Bucket elevator consist of buckets mounted on single or double chain so when we see that bucket conveyor it looks like here you see different buckets are mounted like these are bucket, these are mounted with the chain these are connected with the chain and this can be used to transfer the material vertically like this also, we will discuss these conveyor in detail now these conveyors are employed for lifting solid vertically upward or over a steep inclination when the angle of inclination is 60 to 80̊.

So when we require very high angle of inclination or we have to transfer vertically we should use bucket conveyors. Now we have different types of bucket conveyors and working of these bucket conveyors are different.

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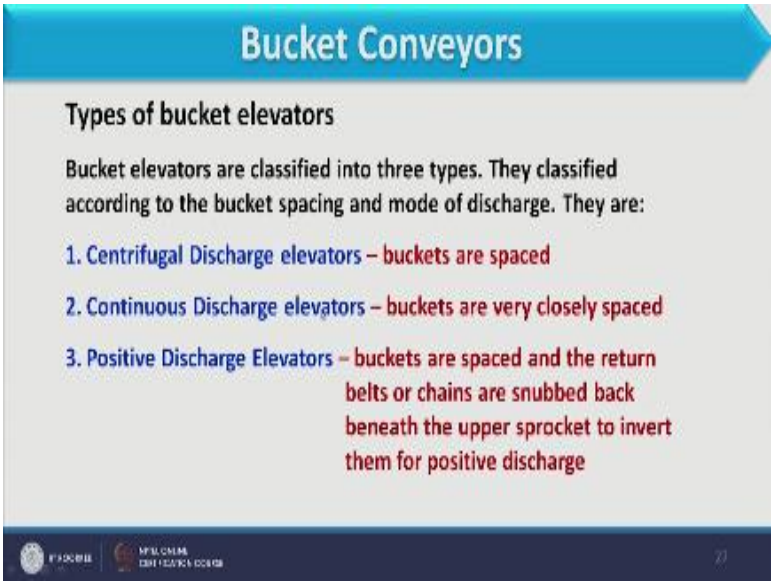

So let us discuss what are the types of bucket first is centrifugal discharge elevator, second is continuous discharge elevator and third is positive discharge elevator we will discuss details of one of each, so here we have centrifugal discharge elevator.

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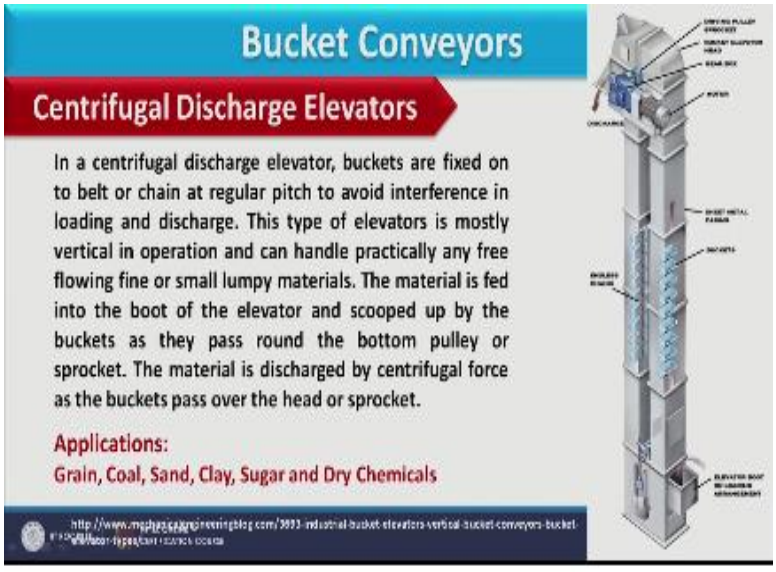

So if you see here we have different buckets which are mounted on endless chain if you see this side here we have chain and over which these buckets are attached so what happens it takes the material from this it is basically loading point it takes material on each bucket and these are

transferred vertically and at this point the material when it is returning back it drops them it discharges the material to the other side.

So in this way the centrifugal discharge elevator works so when it discharges the material it has centrifugal election that is why it is called centrifugal discharge elevators. Application of these elevators are to carry grain, coal, sand, clay, sugar and dry chemical but specifically when we have to transfer the material vertically. For details you can refer this link.

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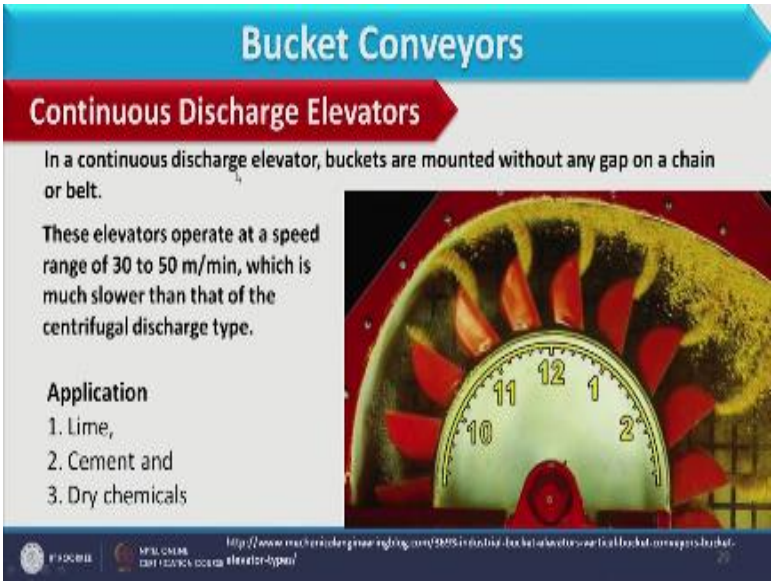

Here we have continuous discharge elevators now what happens in continuous discharge elevator that buckets are mounted without any gap on a chain or belt, so you see when we are considering centrifugal discharge elevator their belt their bucket are mounted while keeping some distance

between two buckets, but here buckets are continuously attached one by one, so when we it carries the material and it discharges the material to other end.

Therefore, it is called continuous because these are attached very close to each other so material can be transferred continuously. These elevators operate at a speed range of 30 to 50 m/min which is much lower than that of centrifugal discharge type. Application in lime, cement and dry chemical plants there we can use such type of elevators. For details you can go through this link.

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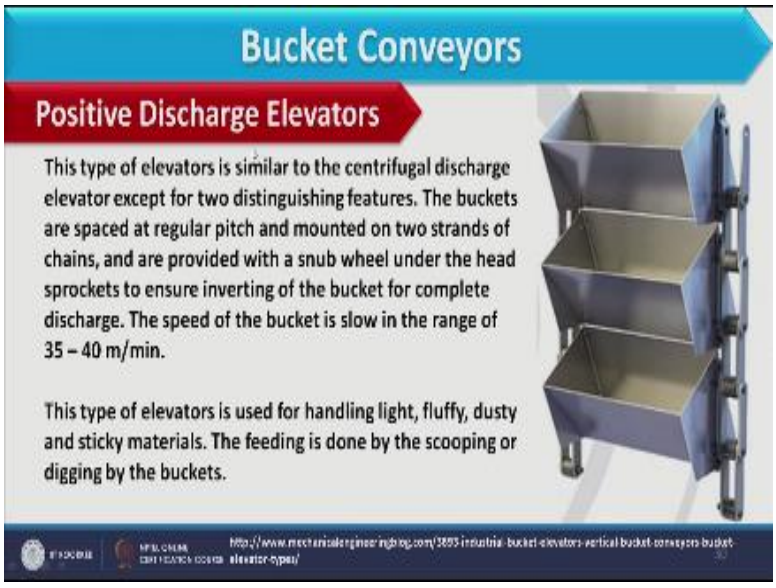

Further we have bucket conveyor and that is positive discharge elevator, now what happens in these elevator if you consider these bucket these are rectangular buckets and here we have this chain kind of structure, now these buckets are attached with these chain now what happens when

it has to discharge the assembly is like that it will be, this section will move to this side and it can may completely inverted to the side where we have to discharge and therefore it is called as positive discharge elevator.

Because it is completely invert to the discharge side, so this type of elevator is use in handling light, fluffy, dusty and sticky material the feeding is done by scooping or digging by the buckets. So for more you can refer this link, so you see here in this particular lecture we have discussed belt conveyor, apron conveyor and bucket conveyor all these are used as a carriers. So here we are stooping discussion on mechanical conveyor and that is all for now, thank you.

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