Introduction to Mineral Processing
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Lecture – 31
Industrial Screening (Contd.)

Hello, welcome back. So, we are discussing that what are the challenges associated while operating the screens industrial screens. So, we had mentioned in the previous lecture about the say difficulty in dealing with the near size particles, however, there are other issues also.

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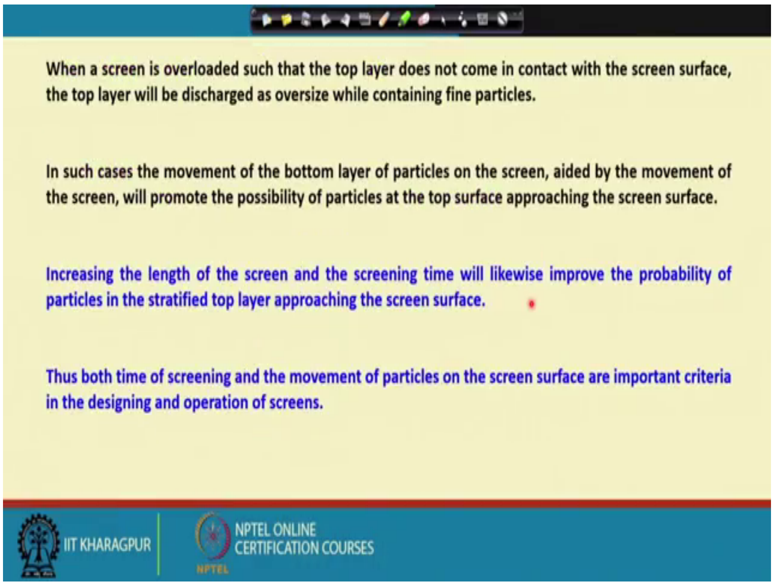

And, I am trying to point out some of them that is when a screen is overloaded, what does it mean, that the screen works well if you have a mono layer of particles, because you are giving the equal opportunity to all the particles to have interaction with the aperture opening and if the particle is smaller than the aperture opening it will pass if it is coarser than that it will retain.

But, eventually what happens when you are loading a particle because if it is only mono layer a particle you have to compromise you have to minimize the capacity of the screen to a larger scale that the economic consideration will not allow you to do so. What we try to do? We try to process maximum amount of material effectively per unit opening area available.

So, for that what happen actually when the particles are fading into a screen surface, there will be layers of particles. So, that is a particle bed. What will happen even if it is too much of overloading, the particle when it is travelling even the top layer or maybe some a few top layers they will just pass through the screen surface without having interaction with the screen apertures.

So, material going in and material going out having no interaction with the aperture so, that means, they are not sized. So, that is why I have written that that when the screen is overloaded such that the top layer does not come in contact with the screen surface. The top layer will be discharged as oversized while containing fine particles.

Suppose, I have got a 100 micrometer opening and even a one micrometer particle which ideally should pass through that 100 micron even having only one interaction with that aperture because it is much finer than the aperture size, but imagine that one micron particle can also report to your oversize if the particle bed is crowded; that means, if you have a thick layers of particles and that one micron particle is basically you are hiding somewhere in the top layer, because it is the entrapped in between the coarser particles void spaces.

So, that one micron particle if it is too much of crowded, the top layer is just going out and along with that even that one micron particle will go out and then ideally we say that these are all oversized particle whereas, actually it is much finer sizes than the aperture. So, what it brings that is called the screen efficiency, that is, how efficiently you have separated your particle based on their sizes.

So, in such cases the movement of the bottom layer of particles on the screen aided by the movement of the screen will promote the possibility of particles at the top surface approaching the screen surface. So, what do you have to understand, to rectify this problem that is how the particle bed at each layer they move, because if the bottom layer moves fast. So, they the particles reported in the bottom most layers they will be sized immediately.

So, then again the next bed is coming to the bottom layer and like that. So, how fast you are your bottom layer is moving and how efficiently your particles they are spread across the width of the screen so that you can use the maximum opening area available of your screen. So, these are all dictated say by the material flow characteristic your screen design and that will try to prevent your say misreporting of particles in wrong streams.

What is another solution that is you can increase the length of the screen, but if you increase that length of the screen; what will happen, the screen screening time we likewise improve the probability of particles. So, what you are trying to do that is suppose I have got a one meter length of the screen and the particle bed is such that that your particle movement at each layer is such that that it passes through the one meter your length without that top layer being reported having any opportunity to interact with my a apertures.

So, there I can increase the length from one meter to 2 meters. So, that these particles when they are living the one meter size they are again having another one meter to travel. So, that by that time your bottom layers are already cleared that you have decided that whether I will be coarser or finer than your aperture sizes.

So, that is how you can increase the length, but when you increase the length what you are trying to do, you are trying to increase the retention time of the particles on the screening surfaces. So, to prevent overloading to prevent the misreporting of the particles normally the fine particles miss placement in the oversize you have to increase the length when the length you cannot increase you have to reduce the feed rate; that means, you have to compromise with the capacity of the screen.

So, the both time of screening and the movement of particles on the screen surface are important criteria in the designing and operation of screens. So, you should have a good knowledge about the material flow characteristics. So, what is the probability of my materials, if they are sticky particles their flow characteristics are different, if they are angular particles they are flow characteristic is different, if they are a very fine particles their flow characteristics are different, if they are coarser particles their flow characteristics are different.

So, what is the size range of that particle we will be trying to your size into an industrial screen that knowledge I must have, otherwise I cannot design a screen which suits that those material and for those material at what rate I am feeding I will be feeding what is the capacity I am looking for. So, to match that capacity how much of the screen surface area will require so that your all the particles will have at least some time to have interaction with my apertures, that means, how much is the retention time of the particle you are trying to give based on the material flow characteristics and how accurately you want that sizing operation that also your influences your design criterions. So, screen design is a very challenging area. Apparently, will looks very simple, but it is it is very critical issue that how do I design my screens and to minimize the or say misplacement of the particles or to improve the screening efficiency.

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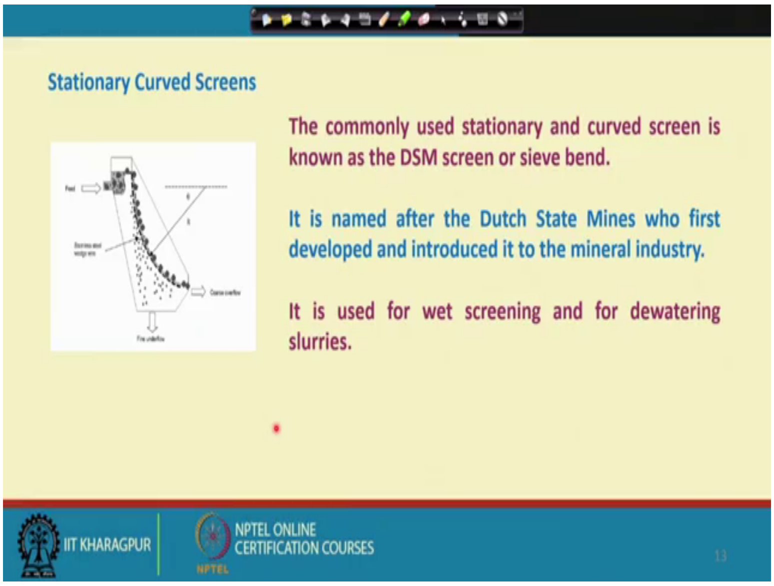

Now, I would like to show you some of the screens. This is a stationary curved screen. So, this is the stationary screen and this is a in curvature. So, when it is at curvature, what happens even the apertures at different locations they are having different apertures I would like to show you that what is that angle you have to calculate and then you have to correct it with up your cos theta side that is what I have shown you that when the screens are a 10 gradient, how much is the aperture area, but as because it is curved.

So, at each position because of this angle will change, what have to do if I want to separate a particle at say suppose 100 micrometer with this curved screens. So, I have to adjust the openings at different particle or along the path of this curvature considering that your theta at what angle it is.

Why it is curved? What is the advantages of that having curvature. So, the curvature is again we are trying to do that is the material which are basically say when you have a very coarse and very fine sizes that is we want to have we want to minimize the residence time of the particles here at this stage; that means, the particles which are much finer than my aperture size they will immediately pass through. So, they will reduce the load or my total material flow rate. So, what will happen? The near size particles now I want to increase that their residence time at this location. So, that they can finally, decide that whether I can pass or I can retain.

So, the commonly used stationary and curved screen is known as the DSM screen that is Dutch State of Mines screen or sieve bend popularly it is known as sieve bend. It is named after the Dutch State Mines who first developed and introduced to the mineral industry. It is used for wet screening and for dewatering slurries also. So, many a times it is mostly it is used for dewatering slurries because what happens, you are trying to use this gradient so that the material flows very fast and your water immediately when it gets the apertures it just passes through that and you are having a dewatering and that you do not have to worry about the as how the slurry you will flow. So, you may not need a pump because in many cases like one example is it is being used in coal preparation plants where you try to use the gravity force the in place of pumping, you are using heights.

So, ever is if your material is coming from a certain height that is in the slurry form. So, you can have this sieve bend located somewhere and then you can directly feed that slurries there and because of your gravity it will say naturally try to flow and then you have a solid liquid separation. So, this is why you have it is typical your shape, but it depends on it is again driven by the material characteristics and the purposes for which you are trying to use it.

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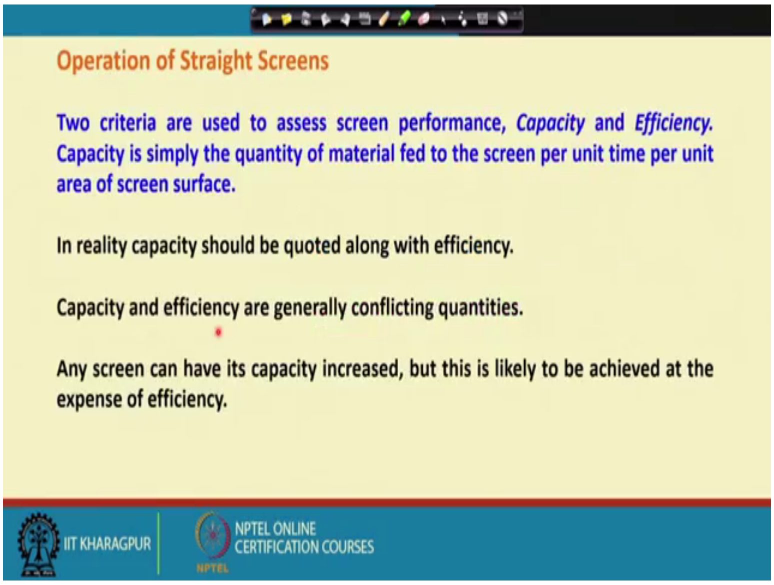

If I look at the straight screens, how do they operate and what are the parameters that influence the capacity or the efficiency. So, two criteria are used to assess screen performance that is how do we assess the screen performance; one is the capacity, another one is the efficiency and it is 2 for most of the your processing equipment. So, what is the capacity the capacity is simply the quantity of material fed to the screen per unit time per unit area of screen surface; that means, let me repeat it that capacity is simply the quantity of material fed to the screen per unit per unit area of screen surface; that means, if I want to process 500 tons of material per hour how much of screen surface area we actually require.

So, more the surface area means more the screening time and so, lesser the capacity or the more the investment is required more land space is required. So, we try to have an optimized your screen surface area by having many other means like your vibration by your gradient or even by you are having curvature like that. So, let me repeated again their capacity is the quantity of material fed to the screen per unit time per unit area of your screen surface.

In reality capacity should be coated along with efficiency like it has got like your similarity with if you remember the great and recovery type of relationship like if we want better great you have to compromise with the sacrifice little bit with a recovery. So, here also if you want to increase the capacity your efficiency that is your effectiveness of screening effectiveness means what is that at desired size I wanted to separate that you have to compromise. So, they are normally inversely related that is why I am saying that conflicting quantities and this is again the challenge to the mineral processing people that is how do I optimize both that is I want a efficient screen at a maximum capacity.

So, that is why, I have read in that any screen can have it is capacity increased, but this is likely to be achieved at the expense of efficiency because when you increase the capacity you are basically increasing the bed height, we call it bed depth. So, you have got many layers multiple layers of particles. So, there is a chance that your some of the layers which are in the relatively on top of the bottom layers they may just pass through they may report to the oversize and they may carry significant amount of relatively finer particles so; that means, you are compromising with the quality of your product.

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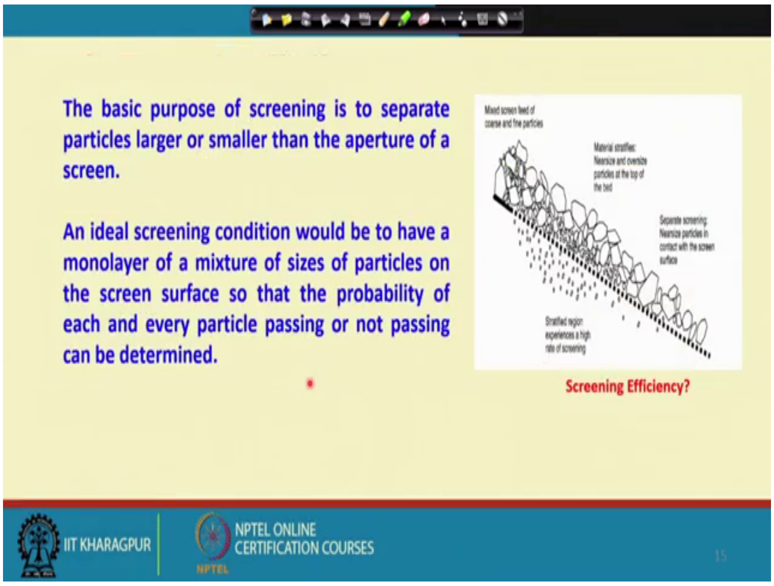

So, if you look at this is your straight screen, but this is at a gradient, what happens. So, the basic purpose of screening is to separate particles larger or smaller than the aperture of a screen, but the problem is suppose my screen is 2 meter wide. In that case what will be my feeding system that will ensure that my material is equally spread along the width of the screen. So that means, what is my bulk material handling system that has to be synchronized with my screen your width I with that to ensure that the material is well sprayed into the surface.

So, when actually the materials are poured into the screen surface. So, initially these particles are basically I call them that they are confused particles initially because they do not know that what for I am here. So, it takes some time it is analogous to your in a fluid mechanism is called the hydraulic jump; that means, if you have an open channel if you try to pour some fluid at certain flow rate. So, initially the flow will be disturbed. So, it will not be stable and after reaching start after travelling certain distance then it will have some kind of your steady flow behaviour.

Here, the particles they are basically a confused and then that is why initially even though you have got significant amount of finer particles, because they are not oriented properly you may not have very good separation of the fine and coarse particles that is up to certain distance and after that the particle will be reduce themselves and you get the maximum efficiency of separation at this position. And, then here it is basically you have got extended that length to handle to tackle the near size particles; that means, if you have any near size particles you are giving them more opportunity to decide that whether I will pass or I will retain. So, this one we call it stratified region experiences a high rate of screening. So, this is a stratified layer, this is a separate screen near size particles in contact with the screen surface, then these are the near size particle and these are the near size and oversize materials.

So, an ideal screening condition would be to have a mono layer of a mixture of sizes of particles. This is what I have already explained on the screen surface so that the probability of each and every particle passing or not passing can be determined this is the point which I have already discussed. So, now, the challenge here is that is you may argue that why should I need these portion, but it has been and this is my question also too many screen manufacturers, but what we have observed that if we reduce this length your screen efficiency gets reduced.

So, this is again a challenging area for research that you can think of say designing a better screen surface that is without changing the total unit area available, total area aperture opening area available that is how we can increase the capacity of my screen without say compromising with the quality of my product.

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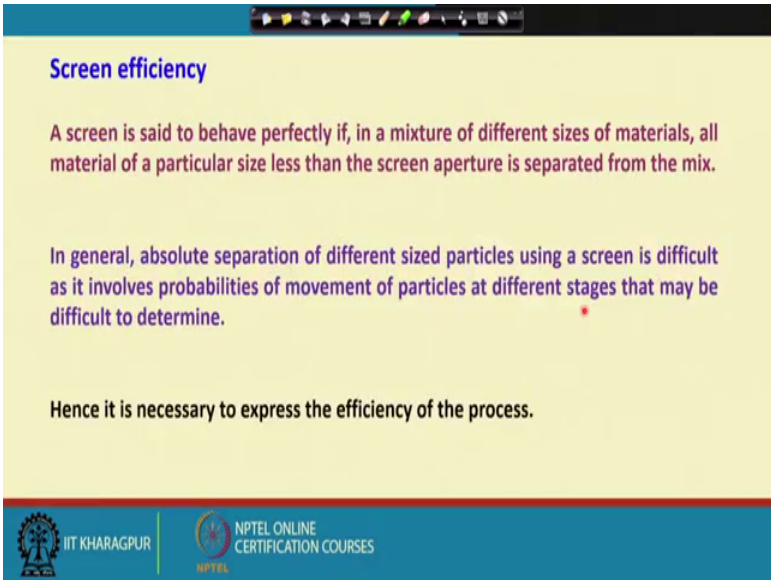

Now, we are talking about screening efficiency. What is this screening efficiency and can we quantify it? This is what I am going to talk now the screen efficiency is; that means, a screen is said to behave perfectly if in a mixture of different sizes of materials all material of a particular size less than the screen aperture is separated from the mixture. In simple terms that is it is based on common sense that I have got an aperture of a 500 micrometers.

So, ideal condition, ideal screening condition what I want? Suppose, I have got a mixture of particles consisting of particles finer than 500 micrometers and coarser than 500 micrometers, even an ideal separation process all the particles which are finer than 500 micrometers they should ideally report to the undersize fraction and particle coarser are than 500 micrometer they should report to the oversize fraction I do not think that there is any controversy in this. But, in general absolute separation of different sized particles using a screen is difficult as it involves probabilities of movement of particles at different stages that may be difficult to determine.

Now, what are the issues now issue is that that the size what we are talking 500 micrometers, 400 micrometers, maybe 600 micrometers. We have also measured this in a laboratory with the similar principle like with the CV that is fine. So, there is no say question about the similarity in the definition of size, it is doing the same job. But, what is the fundamental problem? The fundamental problem is in a laboratory sieving what we have done we have taken reasonably very less quantity of material so that I will have a mono layer of particles. So, I am trying to give because that is an idealistic situation and we are giving a sufficient amount of time like we give 10 minutes, 15 minutes and if they are very finer sizes even we go for 30 minutes time for the particles to be separated based on their sizes. So, that is an ideal condition.

So, why cannot we reproduce that into an industrial screen that ideal condition? The reasons are we need to have higher capacity; that means, we need to process much more quantity of material per unit time. So, in that case what is happening? When we are trying to process much more quantity of the material on the screen surface and with the fix you are available surface area or aperture area. So, at the end because of that we are not giving the retention time of the particles what we had given it into the laboratory sieving process that is number – 1.

Number – 2, now the particle movement how the particles will be your travelling across the screen surface as well as the cellular say actually the longitudinal direction. So, that well determine that whether the particles will be given a chance or any there any probability of all the particles to have interaction with the apertures to finally, decide that whether I am finer or coarser.

So, and then the material shape because if I have a different material shape and what is coming from the mine site because the time when you did the sieving operation the particle shape may be different, now what you are dealing with that shape may be different and then in a laboratory we may have processed a dry samples, but when it is coming from the mine you may have some moisture and you have to run your screens all throughout the year, at a different environmental conditions.

During the rainy, during the monsoon season you may have more of your moisture and that moisture will create additional problem related to your particle agglomeration related thing or say particle size enlargement processes. So, it is the absolute separation of different sized particles using a screen is difficult. As it involves probabilities of movement of particles at different stages that may be difficult to determine; that means, or in simple terms I will say that have we given the equal opportunities for all the particles, whatever you have fade onto the screen surface to have a close into avid interaction with my aperture and that whether it will pass or not and then how many times they are given these opportunities, because if they are very close size range they need multiple your opportunities because you have to give opportunities to change their orientation.

So, if they are moving while they are moving maybe in the horizontal direction maybe if you are lifting them. So, they may have a chance of your changing his orientation, that to finally, decide that the separation is based on the actual size. So, therefore, it is necessary to express the efficiency of the process. What is trying to say that there will be some misplaced particles or there will be some particles which are finer than the aperture size, they will report to the over sized particles and there is a possibility also the relatively coarser particle because you have been safe that that may report to the your underflow.

Or, if there is some damaged portion of the your screen surface, because we are dealing with large amount of surface area and in a continuous mode and suppose, we are trying to say that this is 100 micron aperture, but because of the damage of the wares and that position that has become 200 micrometers. So, even a coarser particle coarser than 100 micrometer they may pass through and they may report to the undersized fractions. So, how do I quantify this? This will be the topic of our say your next part of this lecture. Till then, thank you very much.