Introduction to Mineral Processing
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Lecture – 30
Industrial Screening (Contd.)

Hello, welcome you all. So, we are discussing about industrial screening and so far about the industrial screening we have discussed about the various purposes for which it is used. And, then we have discussed about the gradually and we have started discussion about the surfaces of woven wire screens. So, we will continue that.

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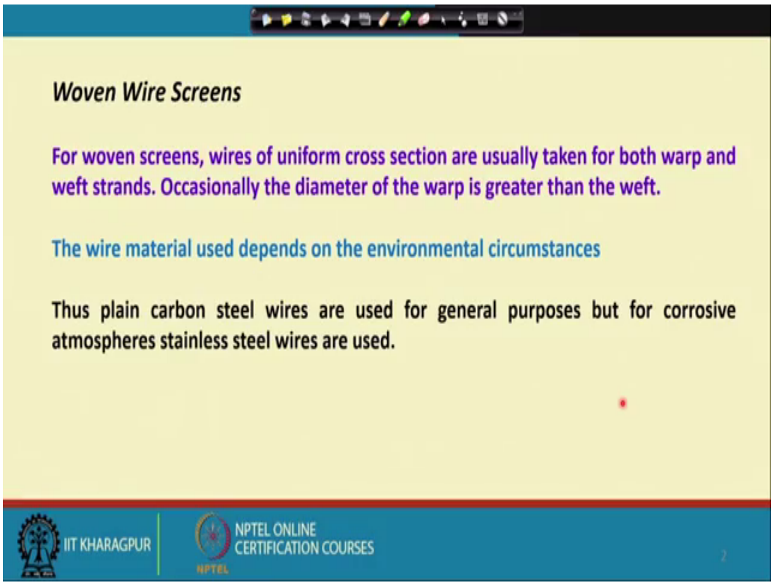

Woven Wire screens will look at the, they are wires of uniform cross section are usually taken for both warp and weft strands; there is a warp, this is the weft. So, basically you have to take uniform cross sections otherwise the aperture sizes will differ and occasionally the diameter of the warp that is what is basically withstanding the maximum load of the particles is greater than the weft.

The wire material used depends on the environmental circumstances which, means that whether your material is your material what you are trying to screen whether that is abrasive whether your water pH is little bit acidic and whether you are having some other because the screens are normally open to the atmosphere. So, whether you have got some nearby some chemical industries or not; that means, you have to prevent your material from corrosion from wire and from damage also because of the stresses coming because of the particle movement. So, plain carbon steel wires are used for general purposes.

But, for corrosive atmospheres stainless steel wires are used; that means, when the atmosphere is corrosive, if your water pH is little bit acidic, if you have some kind of a corrosive atmosphere because of the your surrounding environment if they are producing some kind of your acidic fumes then you have to use the stainless steel wires to avoid frequent maintenance related issues.

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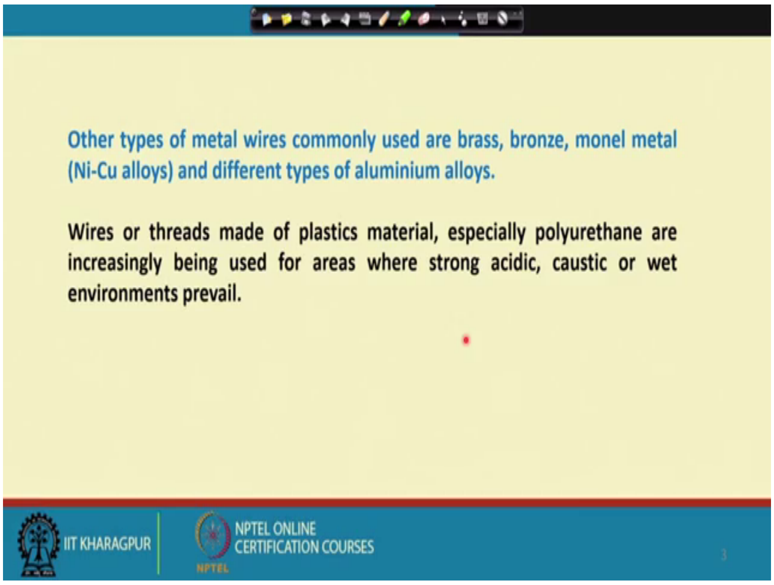

Other types of metal wires commonly used are brass, bronze, monel metal which is a nickel copper alloys at different types of aluminium alloys wires or threads made a plastics material especially polyurethane are increasingly being used for areas where strong acidic caustic or weft environments prevail.

So, these days the wires are even made of plastic materials. So, the material selection for your even your wire material that is very crucial part that what it is made of and there is no fixed rule for that it is dictated by the environmental conditions, the surrounding environmental conditions it is your material that is in the sliding form what you are say such processing through the screen surfaces, what is the characteristic of that and then what type of particle you are processing and what sizes, what is the abrasive characteristic of those particles this will all determine that what type of material you should use for making the woven wires.

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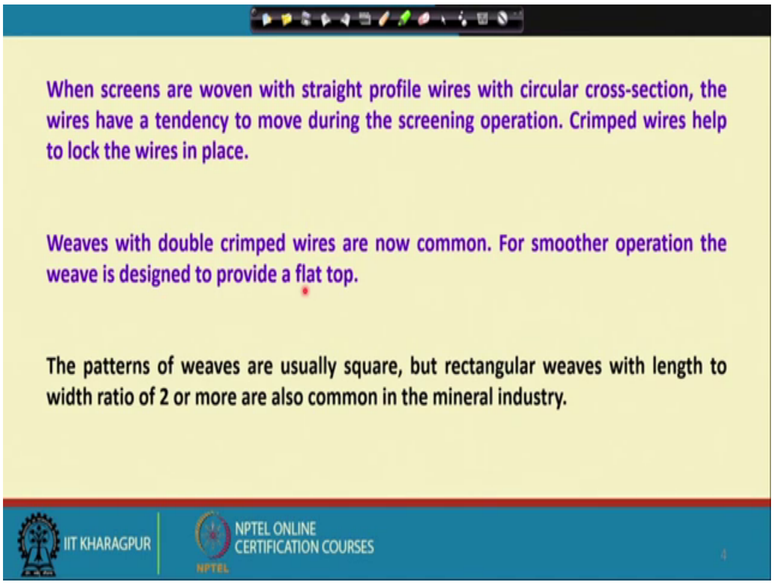

When screens are woven with straight profile wires with circular cross section, the wires have a tendency to move during the screening operation. Crimped wires help to lock the wires in place; that means, if you are having your straight wires like this and say woven like in your horizontal and your sub article directions and so, what will happen when the particle tries to flow; so, that there will be some displacement of the wires. So, you will have your aperture of various dimensions. So, your screen efficiency will be hampered. So, for that what we should do that is the joints, that is, wires the intersecting points between the 2 wires which is going to in the horizontal direction and the vertical direction that should be crimped.

Weaves with double crimped wires are now common, that is, to further prevent it from say the lateral movement or vertical movement of your wires. These days the double crimped wires are also used. For smoother operation the weave is designed to provide a flat top; that means, the surface should be flat. The patterns of weaves are usually square; that means, the apertures are normally square, but you can also use the rectangular weaves, many a times we use rectangular weaves with a length to width ratio of 2 or more which are very common in the mineral industry.

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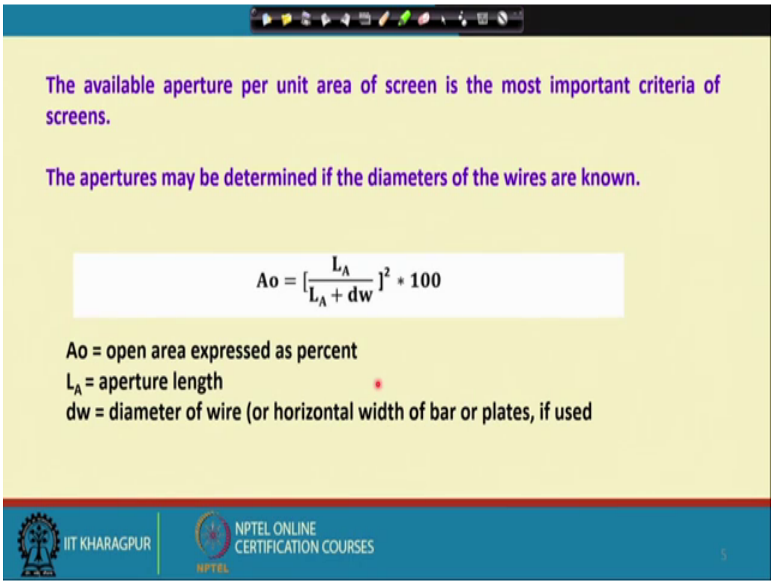

Very important issue for this woven wire screens are the available aperture; that means, what is the available aperture per unit area of screen, is the most important criteria of screens. Because, your screening efficiency will largely depend on how much of the aperture area you have created or you have provided per unit length or per unit area. So, the available aperture per unit area of screen is the most important criteria of screens, but how do we calculate this available aperture area.

So, the apertures may be determined if the diameters of the wires are known. So, when you know the diameters of the wire and we said at the beginning that the diameters of the wire this should be identical. They may differ from your say what is in the vertical direction or what is in the horizontal direction, but they have to be fixed for say for all the screens whatever you are making. You should not change it frequently because what will happen then your aperture area will be different and you cannot control your product quality.

So, for a square opening if we say that the L A is the aperture length, what does it mean? Now, suppose I have got a square opening like this. So, this is the opening area, what is your aperture length? And, suppose the thickness of the wire is d w. So, what is the available area, what is the available aperture area? So, A 0 if we denote it, A 0 is the open area expressed as percent. So, it should be L A, that is, how much is the say length L A by L A plus d w whole square so; that means, it is what is the say area of a square that is your area square that is your length square. So, that is, L A square divided by L A plus d w whole square. So, this will give you d w is the diameter of wire of horizontal width of bar or plates if used and L A is the aperture length. So, using this formula if I know the d w that is the wire thickness we can calculate that, what is the available aperture area.

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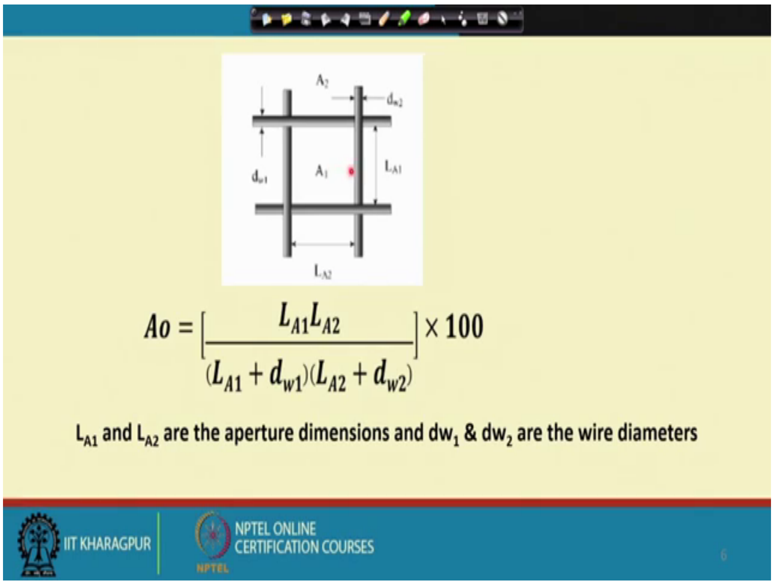

If you look at this figure this is what a basically woven wire I am trying to show here you say this is a rectangular opening and this is what is now you say that you have got different wire diameter for the your say wire which is in the horizontal direction their diameter differs from your the diameter what do you have in the vertical direction of the wefts. Now, if L A1 is the length of the opening of the aperture in or the width of that aperture and L A2 and L A1 is in the vertical direction that what the aperture you are giving is. So, what is the length of this that is the open area? So, what will be the opening open area? So, A1 will be this is the open area. So, that is L A1 into L A2 will be the area inside this.

Now, the aperture area is basically what you have to take because it will be there will be another screen here there will another aperture here. So, normally the 50 percent of each wire width is be used for each aperture. So, if the d w2 is the width of this wire and if the d w1 is the width of this wire, so, what will be the length of this if I go up to this 50 percent of that? So, it will be L A2 plus d w2, because half of this and half of this will give you d w2 and this one will be L A1 plus d w1, because half of this and a half of this.

So, what will be the area for that? So, that is L A1 plus d w1, that is the your length here from here to here that is L A1 plus d w it should be actually the d w1 and then this is L A2 plus d w2 that is from here to here. So, the A 0 should be the area available here that is L A1 into L A2 divided by L A1 plus d w1 multiplied by L A2 plus d w2 and you have to express in percentage. So, that is multiplied by 100.

So, if I know the wire diameters and if I have a screen and I know the wire diameters or maybe we can measure it physically, the wire diameters and then we can measure the opening that how much what is the dimension of the length and the width of the your available aperture and then we can calculate that what is the available aperture area we are having.

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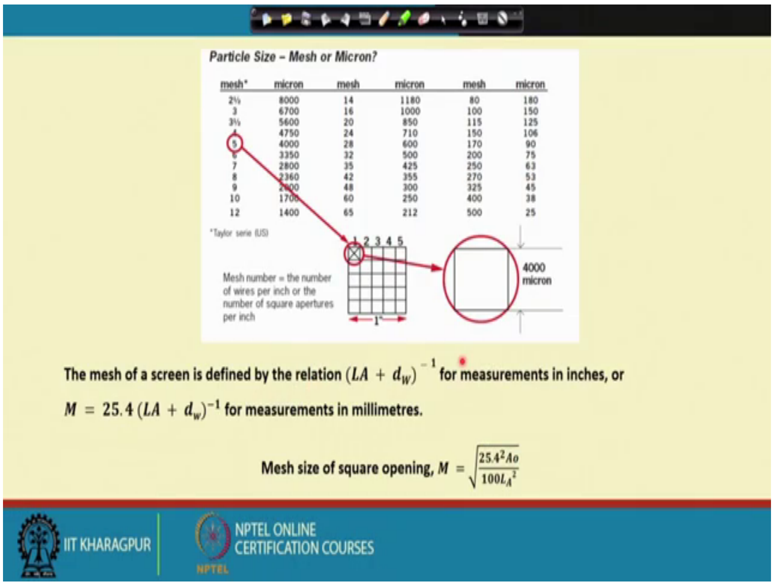

Now, let us see that we are discussing many times about the size with a unit called mesh. Now, these days we try to use it with directly with a micro metres or metres or millimetres like that meters we do not have any screen in that length so, but it is also conventionally being used that is one unit it is called the mesh. Now, what is that mesh? So, mesh is basically of a screen is the defined as what is that your how many numbers of holes are there per unit length.

So, in terms of, mesh of screen is defined by the relation one by L A plus d w; L A means is the opening a opening length plus d w is the wire thickness. So, 1 by of that for measurement in inches that is per linear inch how many open say apertures you have.

But, if I convert it into millimetres, so, 1 inch is equal to 25.4 millimetres. So, M will be the mesh 2 millimetres conversion will be 25.4 divided by L A plus d w for measurements in millimetres. Mesh size of square opening will then be we can easily calculate that for a square opening will be the say the mesh size. So, it is expressed as 25.4 square, A 0 divided by 100 L A square, wire formula will you get it.

Now, this is the formula for same mesh or same mesh size for a mesh your square opening and you just put this value L A plus d w and you replace it with the equation that is L A plus d w is equal to say M by 25.4 and then you replace it you get this value. So, you can easily convert it into this form. So, the mesh of square opening M is square root of 25.4 square A 0 divided by 100 L A square.

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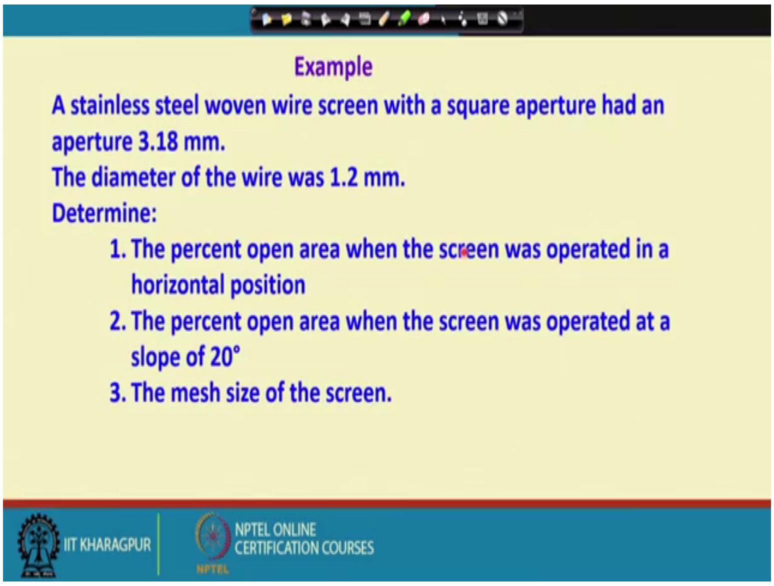

This is an example through which I will show you that, how to calculate this opening area and the mesh size of a screen. The question is a stainless steel woven wire screen with a square aperture, what we are saying that it has got a square aperture had an aperture 3.18 millimetre; that means, the length of this or the say the square aperture the length is equal to width, that is equal to 3.18 millimetre. The diameter of the wire is 1.2 millimetre. Now, if I ask you to determine the percent open area when the screen was operated in a horizontal position.

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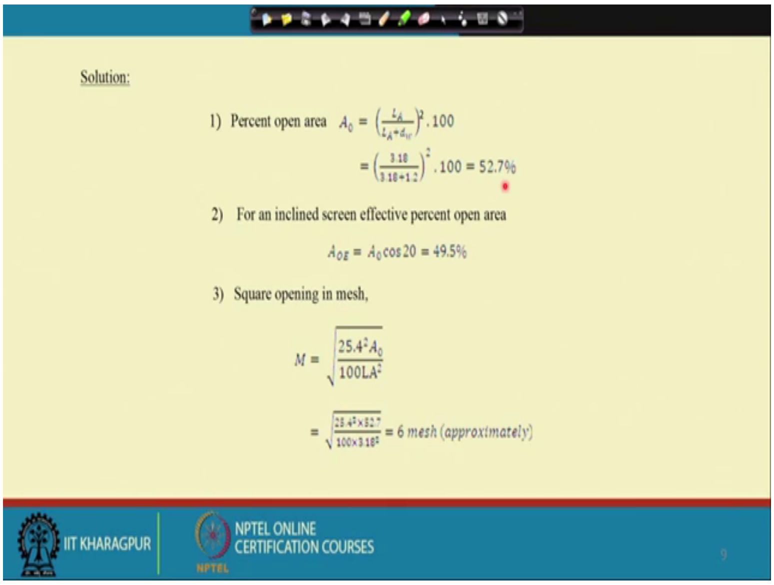

So, what I have to do, percent open area A 0 is equal to L A by L A plus d w whole square into 100, that is the formula I have seen and it is very easy formula because how much is the opening area and what is the total area it has consumed, divide by that into 100. So, L A by L A plus d w whole square into 100; L A is that is the length of that square aperture is 3.18 and your d w that is the wire thickness is 1.2. So, we can write 3.18 divided by 3.18 plus 1.2 whole square into 100. So, that will give you 52.7 percent. So, that is the opening area when the screen is in horizontal position.

Second question is, the percent open area when the screen was operated at a slope of 20 degree. So, what will happen because when it is at a slope and the material is falling like this, you are not getting the entire area? So, it is actually you have to make some correction with the angle. So, what is that correction you have to make? Now, here for an inclined screen effective percent area that is equal to A 0 cos theta. So, it will be A 0 cos 20 and you put the value of A 0, 52.7 and get the value of cos 20, multiply it you will get 49.5 percent. Now, you see that when the screen is at an gradient. So, your available aperture area reduces.

So, now, when the aperture area gets reduced, why should I have a screen in an inclined position? But, there are other advantages that you can use the gravitational force for material transport, because the material has to flow over the screen surfaces. So, when it is at a gradient because of the gravity the material will automatically start flowing, but if it is horizontal, it is very difficult for the particle movement. So, normally the industrial screens therefore, although we know that the available your aperture area will be reduced, but still we try to operate it at a gradient normally.

The third question was that is what is the mesh size of the screen? That is, if I convert this into a mesh size what will be the mesh size of the screen? So, this is a square opening. So, if you remember the formula that is M is equal to square root of 25.4 square A 0 divided by a 100 L A square. So, put the value of a 0 is 52.7 and L A is 3.18. So, when you put it you get approximately 6 meshes. So, that is how we can convert it from the opening or vice versa, that is, if I have mesh we can calculate the each in a millimetre or in micron that, what is the conversion?

So, this is how we can use this for simple formulas that. So, now, if I want to increase the say suppose your capacity of a screen without changing the dimensions of that that is your external dimensions. So, what do we have to do? We have to increase the percent open area. So, how do I increase the percent open area that is a challenge that is, can we have a reduction in my wire thickness can I use a better material for the wire where even is in place of 1.2 millimetre if I use a 1 millimetre thickness wire, but that will give you the sufficient strength to withstand those your say wear and tear related issues. So, there we can go for some replacement of the materials and we can change the wire thickness.

So, this is how we can basically increase the percent open area that is one of the solutions. There is another solutions are like how these apertures are being basically oriented, that is, whether they are in the square your say spacing you have or what kind of spacing you have. So, let me see if time permits we will discuss that also.

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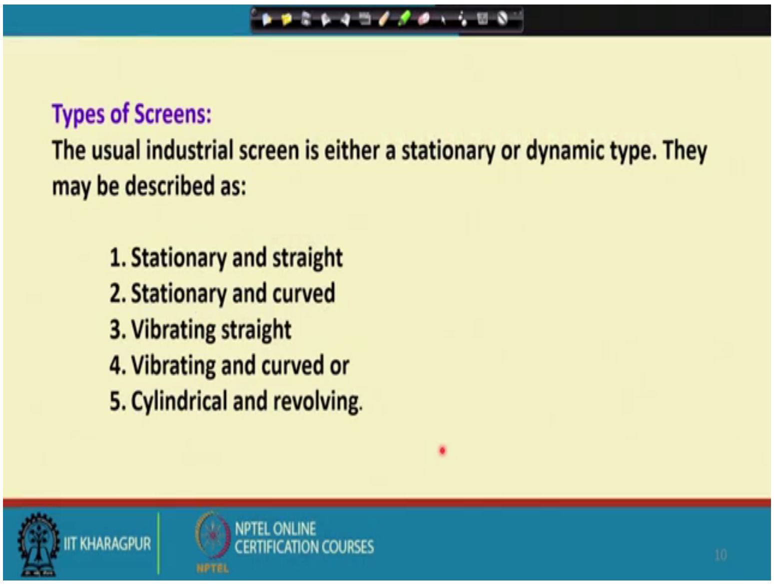

So, now what are the different types of screens? So, we have discussed about the screen surfaces so far and you have seen that for robust screen that is for grizzly you have a different material for using and you use a different type of a your design. For medium sized particle separation, we normally used woven wire screens and even for that we have to know that how much is the percent open area and how the percent open area will change if I have your square aperture or if I have a rectangular aperture. So, that is what we have discussed that is how we can calculate and we have also discussed that how we can convert the micron to mesh or millimetre to mesh or vice versa.

Now, let us discuss some of the various types of screens what we use. So, the usual industrial screen is either a stationary or dynamic type, that is, your screen could be stationary or it could be dynamic also; that means, you may be vibrating that also or me may be shaking that also. So, depending upon that screen type you can categorize them as stationary and straight; that means, they are stationary screen and they are straight screens.

Number-2: stationary and curved they may be stationary, but the screen may be curved like this. Then the screen may be straight but, they may not be stationary they may be vibrating and these are all basically the designs will the screen type we will again depend on what sort of material you are trying to say do sizing and that at what rate and how much of accuracy or precision you are you are looking for.

Then, vibrating and curved even it can be curved and it can be vibrating or cylindrical and revolving that is it can be cylindrical type and it can be revolving. So, that is one varieties of screen are also there, we will discuss briefly about some of them.

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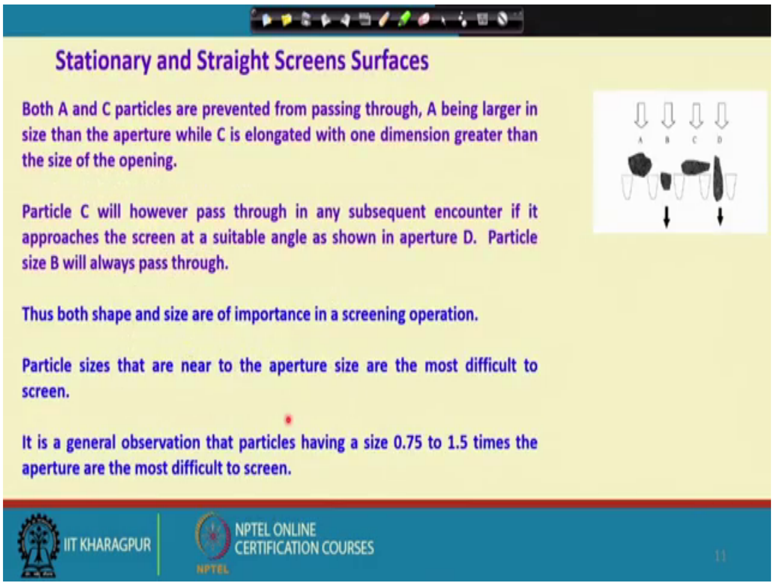

Now, stationary and straight screen surfaces, if you look at you see that this is a schematic of a stationary screen and a straight screen. Now, these are tapered like what we have shown it in grizzly. So, this is just a schematic representation of a grizzly screen let us assume that. So, this is tapered for the free flowing to improve the free flowing characteristic of my particles, but now you see that here the particle A and particle C, they are prevented from passing through, because A is the larger particle in size than the aperture.

So, no way can it pass through, but look at the C is elongated in one dimension greater than the size of the opening. Now, what will happen this particle the C even it can pass through if you change its orientation, that is, if it is falling inside the screen aperture in this pattern, then they will that particle will eventually pass through.

So, the question comes, that whether this particle will pass or retain that depends on it is orientation. So, what we have to do, that is we have to give the maximum chances of this particle to change it is orientation so that it passes through. The particles C will however pass through in any subsequent encounter if it approaches the screen at a suitable angle as shown in aperture D; that means, there is no guarantee that it will say continue to report in the your say as oversize materials, it is dictated by the material property. So, the screen has nothing to do it is the material shape. So, that is where the shape factor is coming into picture. Particle size B will always pass through because it is finer than the aperture.

So, what I try to show here that is the both shape and sizes are of importance in a screening operation. So, it is not only although we are trying to separate particles based on size, but you cannot ignore the effect of your particle shape. So, whatever what is the elation learnt that when we have if you know that your particle are having elongated your type of shape majority of your particle, then you have to do something you have to change the design of your screen so that this elongate particles you are giving maximum opportunity to have close interaction with the aperture to decide finally, that whether it will pass or whether it will retain.

That means, you have to give them equal operate. How you can do it? One way is to lift them up. How you can lift them up? That is, you can lift them up while vibrating the screen surface. So, the particle will be lifted and when they are falling they may change their orientation and then they may pass through, but when you have this type of particles it is very difficult to have a consistent product quality.

Particle sizes that are near to the aperture size are the most difficult to screen. Although ideally the particles which are basically smaller than the aperture size they should pass verses suppose my aperture size here is 25 millimetre and I have a particle of 24.9 millimetres. So, whether that particle will pass or will retain? Although ideally it should pass because it is finer at that 25 millimetre, but these are the particles which takes much time to finally, decide that whether I will pass or not and it also depends on how you have measured that 24.9 millimetre because we said that we have discussed that your definition of particle size is not well accepted there a various your definitions.

So, what is that size you are referring to that 24.9 millimetre. Now, it is a general observation that particles having a size 0.75 to 1.5 times the aperture are the most difficult to screen. That means, if I have an aperture of 100 micrometre, it is the particle size in between 75 to 150 micrometre. These particles will take much longer time in this to decide their whether we should report to the oversize fraction or undersize fraction and this is the near size materials which create lot of trouble.

So, the screening efficiency largely depends on that how effectively you are able to say your size these near size particles. So, because these are the most time consuming and otherwise what will happen sometimes they may report to the undersize fraction, sometimes they may report to the oversize fractions and there suppose the relative percentage and the total your say population if they are significant like 40 percent, so, what will happen, you will have some kind of inconsistency into your product size either as oversize or undersize material and your downstream processes will be having lot of problem in say maintaining a consistent product quality through their processes because your feed rate will be changing. We will continue this discussion we have to discuss many other things related to screen.

So till then, thank you very much.