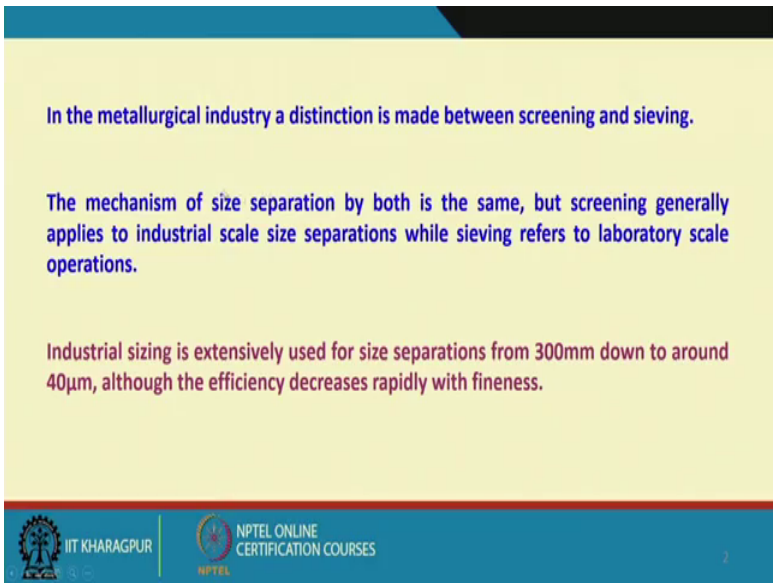
Introduction to Mineral Processing
Prof. Arun Kumar Majumder
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture – 28
Industrial Screening

Hello, welcome to this new week we up lecture series. So, now, this week we will begin with a new topic there is a very important one it is called industrial screening. We have already shown that in crossings or in a crossing operation mostly we go for your closed circuit crossing starting from your secondary crossing stages and there we close the circuit using a screen. So, these are called the Industrial Screens.

(Refer Slide Time: 01:01)



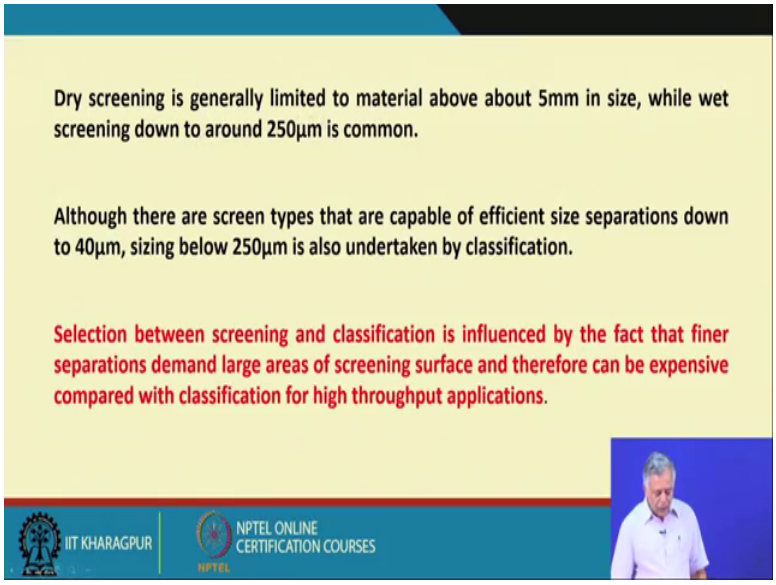
Now, in the metallurgical industry a distinction is made between screening and sieving because when we discussed about the particle characterization we discussed about the size analysis through the sieving method.

So, the mechanism of size separation by both is the same, so essentially they work on the same similar principles. But screening generally applies to industrial scale size separations; that means, this industrial scale screen are operated while using a large much much larger volume of materials per unit time in comparison to your laboratory scale operations. So, when we do the laboratory scale your size analysis, the material it is a medium through which we try to separate based on size that we call it sieve. So, the sieving refers to laboratory scale operation whereas, when we apply the same principle for your large scale operation we call it industrial scale separations.

Industrial scale screens that is industrial screens are mostly your continuous mode; that means, the material going in and material going out and you have to have a automatic system for that discharge and the product collecting systems. Whereas, in a laboratory scale sieving process you use you try to separate the materials which are retained my manual means. So, these are the basic difference between your industrial scale screening and your sieving operations. Industrial sizing is extensively used for size separations from 300 millimetre down to around 40 around, 40 micrometer. Why we limit it at 40 micrometer? Because below that it has been observed that the efficiency of a screening operation reduces drastically. Even with this size range that is 300 millimetre down to 40 micron micrometer the efficiency decreases rapidly with the fineness of the material why it decreases what are the precautions we have to take these are all that issues which we elaborated in this under this topic.

And what are the various types of screens who use for different purposes that will also be discussed in this your lecture series.

(Refer Slide Time: 04:00)



Now, whether we use again the wet screening or dry screening that depends on many factors that is whether my your screen overflow and underflow product will be utilized into a wet say separation processes or my client wants a dry separation. So, dry screening is generally limited to material above about 5 millimetre in size. So, within that range even will limit the dry screening up to 5 millimetre in size; that means, even though my downstream processes could be wet, but still we go for dry screening when the sizes are in the relatively coarser size range; that means, they are bigger than your above 5 millimetre in size, while wet screening down to around 250 micrometer is very common.

So, the industrial scale although there are industrial screens available which can deal with up to 40 micrometer even these days the screen manufacture some of the screen manufactures they claim that they can even screen down to say 20 to 10 micrometers. But as because the efficiency decreases rapidly with the fineness so that means, the cost of your say screening process increases rapidly with the fineness of the material as well as the efficiency decreases. So, the common size range what we use in industrial scale screening there is up to 5 millimetre size we go for dry screening because of the particle mass they have their own probe say actually you do not face the material flow related your problems because the screens are generally at an angle so that means, they are at a gradient. So, the material they travel through the screen surface because of their own mass so we can use the dry screening.

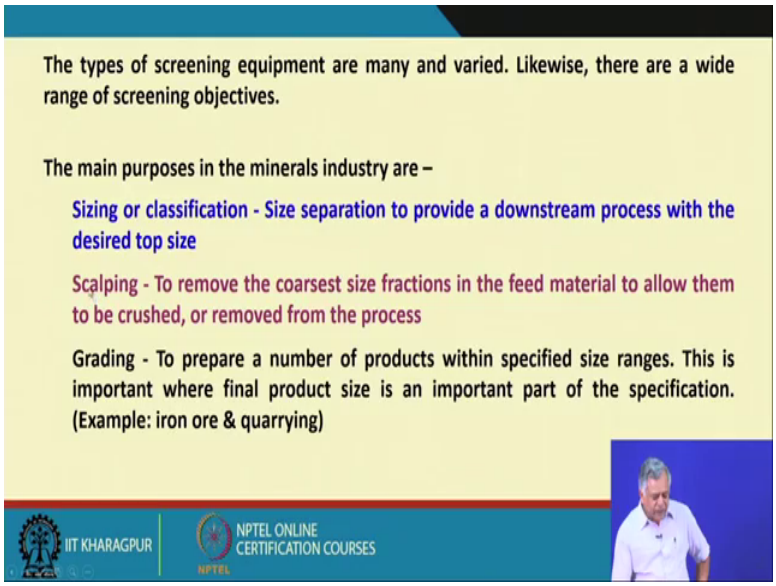
While for relatively finer particles for particle transport and when they become more finer they try to get adhere to each other and form agglomerates and that drastically reduces the screening efficiency because they no longer remain a single particle and that is why your screening operation becomes inefficient. So, the water when we add water into that that water helps in the flow ability of my material through the screen surfaces and as well as it in the dispersion of the my particles. Although there are screen types that are capable of efficient size separations down to 40 micrometer sizing below 250 micrometer is also undertaken by classification. That means, there is another set of device work based on the principle of your setting velocity principle that is your movement of solids in fluids based that is not a screening operation that is called we call it classifier which will be dealt with in another set of lectures within few weeks time.

So, as a very important thing that although there are screen types that are capable of efficient size separations down to 40 micrometer, but sizing below 250 micrometer is also undertaken by classifiers. So, whether I will use a screen or whether I will use a classifier that is another size separation device that depends on many factors which we will discuss in due course of time. Now, as this topic is related to all industrial screening we will discuss only the various issues related to this topic.

Selection between screening and classification is influenced by the fact that finer separations demand large areas of screening surface. So, what happened? Now, when you have a finer, relatively finer particles finer particle means you are generating more new surface areas. So, when you are generating more new surface areas, so naturally your screen surface area requirement also will be more.

So, when you need a huge surface area of screen many times because of your limitation of the land or maybe because of the cost of that your screen and the maintenance the mechanical means of we are operating those screens larger dimensions of screens become economically not viable. And therefore, it can be expensive and because of that we have an alternative method of size separation that is called the classifier and normally the classifiers are used when you deal with relatively finer particles and at the same time you want a very high throughput; that means, high capacity and as well as you do not want to spend much money.

(Refer Slide Time: 09:57)



The types of screening equipment the screens are not only used for the size separation purposes it is also used for many other purposes and even the size separations are being performed for various other reasons not only to control the your product quality of the your combination circuits.

That is why it is written here that the types of screening equipment are many and varied likewise there are a wide range of screening objectives. Why do you need to screen? So, there are various purposes for that and depending on the purpose we use different terminologies for the different screen types. So, when we know that this is the terminology for that screen so that means, we know the objective of that screen. So, we can speculate that what will be the basic design features of that screen or what is that we should control much. I will give you an example I will give you some of your screening objectives.

So, the main purposes in the mineral industry for using the screens are first is sizing or classification that is you need size separation the size separation to provide a downstream process with the desired top size.

At the beginning of this lecture series we have I have said that mineral processing operation is basically first we comprises of first you liberate and then you go for separation and then you go for your product handling. So, when the particles are liberated you have to collect them at the liberated state for effective separation. So, how do we know and these are being controlled by the proper control of the sizes. So, that the main control is being done through by effective utilization of a screen. So, your screen selection, screen effectiveness play a vital role in the overall process efficiency of a mineral processing operation. Because most of your downstream processes they can accept a particular side of it that is the courses size of feed even they are also having a limitation of accepting a bottom size limit of a feed material otherwise their performances will be hampered. So, size separation to provide a downstream process with the desired top size.

This is another terminology we use it scalping the scalping screens when we say scalping; that means, the objective of my screen is to remove the courses size fractions in the feed material to allow them to be crushed or removed from the process what is the meaning of this. If you remember we said that the crusher says for example, the jaw crusher. I said that the jaw crusher has got a gape size if you remember that. So, suppose gape is 1 meter so that means, it can accept maximum size of particle very close to 1 meter normally that is around 10 percent less than the gape size. So, around 0.9 meter of a particle that is the maximum size of a particle it can accept, but jaw crusher being a primary crusher the materials are directly coming from my mines, we call it run up mines ore.

There is no guarantee that not even a single particle will be coarser than 0.9 meter. So, in that situation to protect my crusher from getting choked or from getting blocked, so what do we do? We use a screen which will ensure so that is the before the crusher we use a screen and that guarantees that whatever is coming out from through that screen that is finer than 0.9 meter and the screen what is being used for that purpose that is called the scalping screen. So, that is why it is it into remove the courses size fractions. That means, if I have any particle coming from a mines it is around 1.5 meter. So, they will be retained on the my scalping screen.

Now based on that whether that carries a good amount of your wanted material or not or that is a waste material you will take a decision that weather we will throw it out from the circuit or we will try to break it by some other means on top of the that scalping screen. So, that it becomes finer than 1.5 meter and it should be finer than 0.9 meter. That is why it is relative that the scalping screens are used to remove the courses size fractions in the feed material to allow them to be crossed or removed from the process. So, what is that another idea it gives us when we said this scalping screen? That means, it has to be robustly built because it has to handle the larger sizes relatively larger size of the particles. How it is being feed to that screen? There will be certain your stresses or say forces acting on that screen surface. So, if it is not robust rebuilt the screen will break down so that means, the screens when we say scalping screens; that means, they are robustly built, they are of relatively bigger apertures and then the downstream screening stages and there are many other issues like from which mine it is coming whether that carries what moisture also that carries clays also all sorts of thing we can speculate when we say that there is a scalping screen.

Then there are screens we call it grading screen. Grading screen means to prepare a number of products within specified size ranges. Because many a times as I had also mentioned earlier also like iron ore industry, the iron ore industry it is typical to Indian iron ore industries like Indian iron ores are in general are of very high grade it is more than around 60 percent of Fe, but still the metallurgical industry that is your for blast furnace utilization of these iron ores there is a requirement of size that is they require in between minus 40 plus 10 millimetre size that is called the lamp. Anything coarser than that that is not acceptable anything finer than then 10 millimetre they are not acceptable directly to be utilized in the blast furnace operation because of various certain other reasons. We will discuss that part when we talk about iron ore beneficiation towards the end of this lecture series.

So, the screens what are being used to give you that your discrete sizes of product that is called the grading screen. Even for queering industry it is only you what do you need that is you have to cross the query product and then you have to screen you have to size it to different discrete size ranges. The different size range product they are utilized for different purposes and they have got the different value. So, your value of your material lies not on the purity of the material what do you have mined yeah that is required, but on top of that what is the requirement that it should be properly sized and the screens what do we use it for this purposes we call it grading screens. That is why it is written that grading screens are used to prepare a number of products within specified size ranges. This is important where final product size is an important part of the specification like in your iron ore industry the iron ore particles which are finer than 10 millimetre below 10 millimetre sizes they are called fines, although that is also being used for iron ore by blast furnace operation, but you have to enlarge the size again by some other processes called sintering or pelletizing or very fine particles.

But you cannot directly feed it to the blast furnace. So, the lumps they have got a different value definitely because you do not need any further processing you can directly charge it. So, it will give you the much more higher value than below 10 millimetre particles. So, your entire iron ore related your business will depend on how much of material you could generate out of your mind material and the size range of 40 to 10 millimetre size.

(Refer Slide Time: 20:46)

Then the screens are also used for media recovery like it is called magnetite media recovery, we have not discussed it probably we will not discuss in during this course, but this is a very important operation in coal preparation or coal washing and in some cases in diamond processing where we use a artificial medium like what you use an artificial medium for particle breakage in a ball mill or in a tumbling mill. So, there we use artificial the very medium that is called very fine magnetite particles for having a suspension so that we can increase the density of my fluid medium, artificially. So, that I can have a separation based on density.

So, when we want to recycle back that media we use a screen that is called a media recovery screen. So, what it gives me the idea? That when you are saying that it is a media recovery screen so that means, it is a very fine screening operation because the suspending media has to be very finer in nature. So, the design, the purposes are different and there I my your main purpose of screening is to have a solid liquid separation is not a solid solid separation using a liquid medium or a fluid medium, it is a solid liquid separation, so that means, the screen is being used for your solid liquid separation

Then there is called a dewatering is the purpose is to drain free moisture from wet slurry. What does it mean? Most of the mineral processing operations we have seen that starting from your grinding operation, your even screening operation, even for your say your separation processes they are mostly wet processes. So, whatever free moisture; that means, you cannot get it dry solids with the screens, but say suppose I have got 60 percent 60 percent water or 60 percent your say water in my slurry by volume or say by wet slurry.

So, it has got 60 or 70 percent of water by wet in my slurry, slurry is the mixture of solid and liquid. So, water is very precious and then I cannot use that, your that much of your say particles having that much of moisture contained or say water contained for my say in uses. So, what do you want need to do? We need to recycle back or regenerate that water for my further processing we want to recycle back. So, what do we do that is we use a screen because the particles are relatively coarser and the fluid is you know as a free flowing material. So, we need to use a screen and my material retains on the top of the screen although it will have some moisture adhere to the surfaces may be entrapped, may be entrained, into the in between the particles and, but most of the free moisture I can free water I can drain it out through the screen surfaces and by using a screen and the purpose for which it is being used it is called the dewatering screen.

So, when we are saying that it is a dewatering screen so that means, we have to use large volume of water and that means, that my screen surfaces have to be protected from my corrosion related issues, and then the what kind of your material collection system should be there to collect my water, and then what should be my material collecting system for your the material which got retained on top of the screen because they are also having some a good amount or it is a good percentage of moisture. So, that will tell us that what the circuit that is your dewatering screen means.

Then there are screens which are being used for desliming. Desliming means to remove fine material normally below 0.5 millimetre. Like we had discussed that even during the crossing stages that when we have a clay particle; that means, you have got your rod of mine ore, but they are having a your clay material percent clay material which are getting area to the surfaces of my bigger particles and eventually when we try to break them into a crusher. So, this clay particle they got stuck into the surfaces of my crossing surfaces and because of that my impact gets weaker and my material breakage efficiency as drastically reduces.

In other situations even for separation purposes that is I want a separation in between two particle classes based on the differences in the density or maybe on size or maybe based on their surface chemical properties. So, there I am using a fluid medium and I want that separation to happen at a size of say suppose your, at a range of your say around 0.5 millimetre to 2 millimetre size ranges. But there if I have very fine particles say suppose at around 40 micron particles which are not at all required for my as a product, but if they are coming they are getting mixed along with my water. So, what will happen? This particle will be suspended particles and they will unnecessary increase the viscosity of my fluid medium. So, and my viscosity of my viscosity is nothing, but the resistance to flow. So, my flow ability of my material inside my separating vessel will drastically be hindered and because of that many a times it is required that you try to separate out those ultrafine particles before we send it to any process either for size separation or for separation based on density or based on surface chemistry based processes like froth flotation or even for magnetic separation or for some other separation.

So, the screens which are being used for that that is called desliming screen. So, desliming screens when we are saying that it has to handle a much more higher proportion of material in the overflow in then in under flow and then the screen sizes apertures should be very fine because I want to separate at very fine sizes and then I will need also water because the disliming is done in to again in a slurry form mostly. So, you need to design the material screen surface based on that.

Many times screens are used for trash removal usually to remove wood fibres from a fine slurry stream. Like the as I said that when the material is coming from a mine many times he use wood in support and then when you are mining many times the wood are also being mined and then they are broken to a finer sizes in the crossing stages if they are not taken out from the circuit path by some other means. And then this will give you a fibrous product, and then when the you were try to have a separation in the form of a slurry that is for fine particles and then you want to separate them at a very fine sizes that is below their liberation sizes then these wooden fibres they again create a lot of problem with the flow ability of the material, with the separation efficiencies and all this. So, there we use again a screen to separate these wooden fibres because we try to use the shape base we try to have a separation promoted by the shape. So, that is called the trash removal.

So, these are the in general the various purposes of your screening operation starting from sizing or classification, scalping, grading, media recovery, dewatering, desliming, trash removal and we will continue this discussion in the next lecture.

Till then, thank you very much.