**Bulk Material Transport and Handling System**
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**Lecture - 29**
**Secondary Crushers**

Welcome back in our discussions on the crushers. We have been talking about how we break things. So, that is as we know in our whole material handling in many times, we need to reduce the sizes of the particles that sometimes it could be a grinding to powders or sometimes from a big rock to a small piece. Now, last class we have discussed about the classification of crushers and the different crushers, we talked about we discussed little bit of charity crusher.

And jaw crusher which are used as a primary crushing, we talked about that how our closed loop and an open circuit and closed-circuit crushers are used. Now, today we will be talking about the secondary crusher which you have seen in some of the flow diagrams of bulk material handling.

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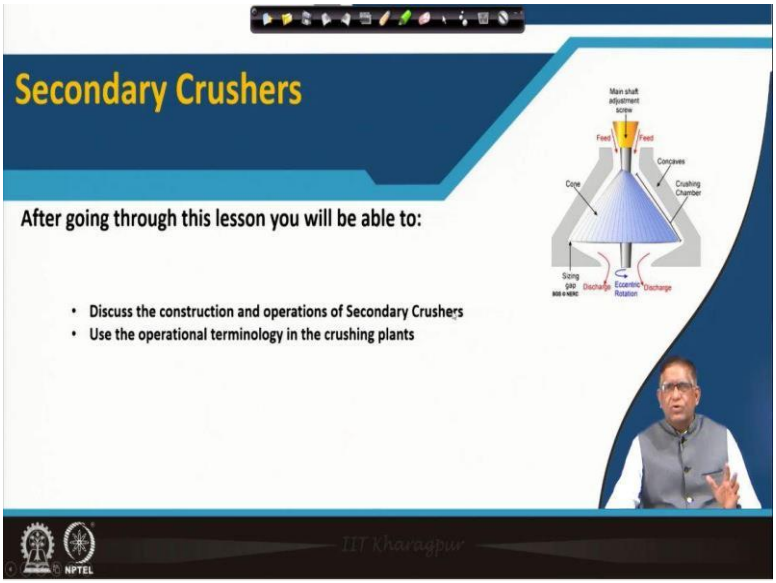


Now, the objective of today's class is to tell you about this cone crusher, which is a secondary crusher along with some other type of secondary crushers. Secondary crushers means exactly when you get a very big size of rock at a from there you directly cannot get it at one stage the very fines. So, they will have to step by step crust so at a some stage we are doing say 1 is to 10 or 1 is that is reducing size from 10 to 1 from 6 to 1 like that.

But in a secondary crushing we take the crust material in the first discuss then you are putting into over here from there again it can go to a tertiary crushing and from there it will be going to milling or grinding for making fine particles. So, now as in this figure you can see we are talking about a secondary crusher which is a cone crusher. We will be discussing about what are the constructional components of it that how the cone is made a movement to inside a concave to concave.

So, that the material get crushed in between and they go get discharged over here. Now, but while in a you are in a crushing plant or in a beneficiation plant, you come across with certain terminology which are used for exactly the describing and then managing the system. So, we will be talking little bit that also.

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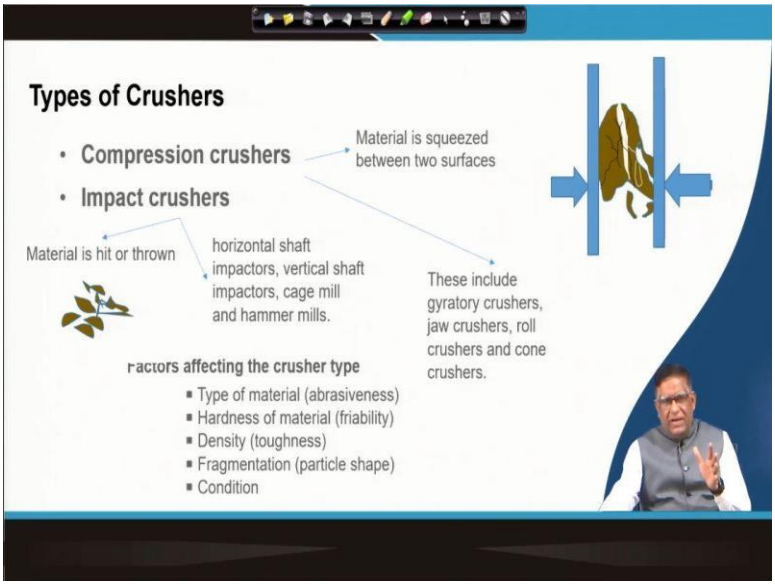


Let us go first, as you have seen that this different type of crushers out of that when we think of this our secondary crushers. It can be of 2 types one is your by compression crusher that is where in a compression crusher your material, this will be squeezed between 2 plates and then when it is squeezed from that you are giving a compressive pressure of it then, what will happen they will get crushed.

And then the crust material will be falling and then you can take it over there or this type of crushers when you are under a compression and then getting an impact where that mainly by compressing you are doing in case of your cone crushers in geometry crushers but other

crushers where the materials are broken by an impact. That is, you have seen sometimes even if you are taking out the in some of the nuts.

If you are taking a chest nut or if you are taking a your even this Acruits. How do you do you hammer it and then break it or (FL: From 03:57 to 04:00) you take out that you crush it? So, that is by impact or pressure when a rock is there in that rock when you give a big impact then they will be shuttering down. So, like that we get an impact crusher. Now there are different factors that will affect this crushing type data.

You will have to select the right type of crusher for the right type of rock mass. And then the whole crusher selection for your secondary crushing will be depending on what type of material you are having you may be having this the materials if they are very highly abrasive there if you want crushers there what type of liner if you are using a very abrasive material to crush by pressing 2 bits into plates there must be proper liner.

So, that abrasive action do not damage the crusher plates. Similarly, the hardness of material if you are having a friable rock then they will very easily get broken into pieces. Then the density of the material, it will be giving sometime very tough sometimes some materials are very tough to break it will not be breaking easily. Then, there will be some that the fragmentations will be depending on that what type of shape or what type of particle you need to find it out.

And then also under what conditions it is working, it is a wet condition dry condition high temperature conditions your low temperature conditions in a confinement in a open type in a one side open type there are different conditions may take place. So, the selection of cursor is also a picture.

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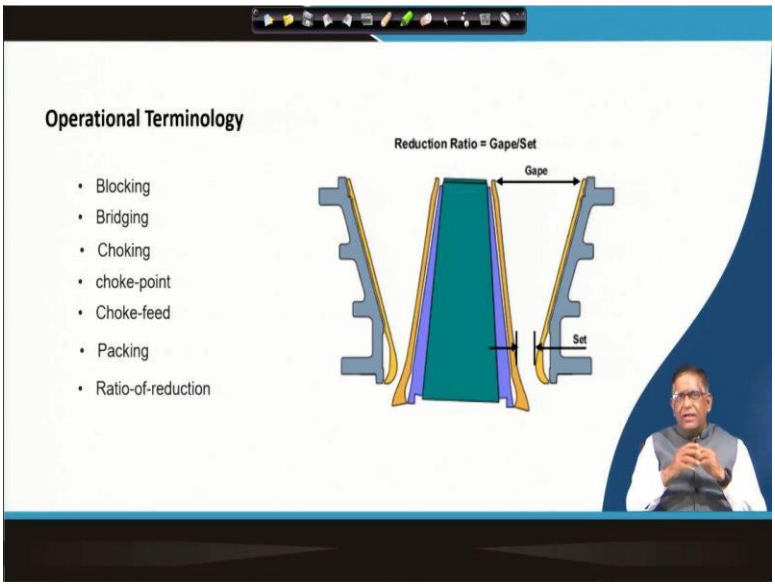


Now, in basically you have seen in the gyratory crushers last time we have discussed that the material is fed into that is where it is coming inside at that time that is the gape will be determining in your feed size, how much big size of material you can take and then you find out after it is crushing it is in a gyratory crusher, they will be giving (()) (06:06) gyratory motions with the eccentric shaft;

It will be moving or in case of your jaw crusher they will be giving a impact moving like that from that keeping it to the or you can give it in the that is depending on where the pivot point is there black type or dots type we have discussed last day. By that exactly when they are giving your if it is a fixed plate if your this plate is coming over here then what will be the main gap which is there that is called your set.

Then the gap and set ratio that will be giving you the reduction ratio. But some of the terminology which you will be coming across in selecting or in operating with a crusher is that blocking, bridging, choking, choke point, choke feed, packing and the reduction ratio. These are the terminology very often you will be finding.

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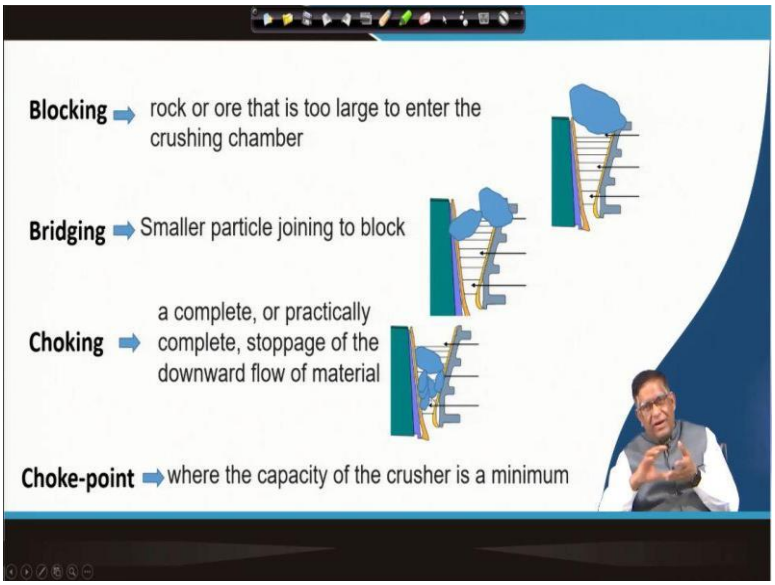


So, let us see what they mean. The blocking means your rocker ore is too large and the enter crushing chamber it cannot come. So, that means then what will happen if any particle comes which is a very big then rest of the things it is it cannot it will be going as a spillage it will falling outside and all. So, that is why in any crusher you will have to see the feed size which is coming over there will have to be done.

So, now you know operationally exactly in real life what will you do it? How will you have it? Suppose you are having the crushers hopper the material are dumped right there the truck is coming and they will be giving the material over there. So, in that case what will happen? That when you are a truck is loading the material then if a big boulder come your crushers will get. So, to avoid that what is done, we will be using at the receiving section a grizzly.

Grizzly is nothing but a hopper where the hopper side walls are not plate but there will be rails. They will be fixing just like you will be having you may be knowing about the cow catcher in many of the gates you find out that some roller pipes are there with a gap. So, that the cow will not go inside because his leg will go, I do not know whether the animal lover will be telling it is a having a cow catcher is good or bad that we do not know.

But thing is that that system is a grizzly that means if you are keeping any rock is allowed to put on that grizzly only that between the two rails whatever the gap that material will go. So, you allow that thing to go to the crusher that whatever the oversize will be coming you take it out separately maybe you again do a breaking or you just you can, if you go to any mines of iron ore mines you may see that when the material is being dumped to the crushing plant.

Then this oversized material to break it down on the grizzly itself there will be your hydraulic rock breaker. They will be having a rock breaker with an impact and hammering action they will break this oversize. So, that it becomes smaller and they will come it. So, but sometimes this blocking may come with a bridging the smaller particle also can block the flow of the material to your crusher.

How? Because, these two things or sometimes the particle they can come in a zigzag manner and they form a bridge. So, this type of problem may occur. If it is there then you can by creating a vibrator or putting something you can easily do it. Depending on the problem how it comes you will have to observe and then in the field you will have to solve the problem. Sometimes, it becomes choking or a complete or partially complete stoppages of the downward flow is getting blocked.

Because hold the material is getting stuck over there, that is a choking. Now, when a choking takes place there will be a choke point where the capacity of the crusher is minimum. Normally if the wherever if the crusher is not giving a enough force to crush over here that may be the soaking point in that crusher. Depending on the design of the cursor descending of the curve what it is there the choke point can be a different. Some many times while maintaining while designing these points need to be looked into.

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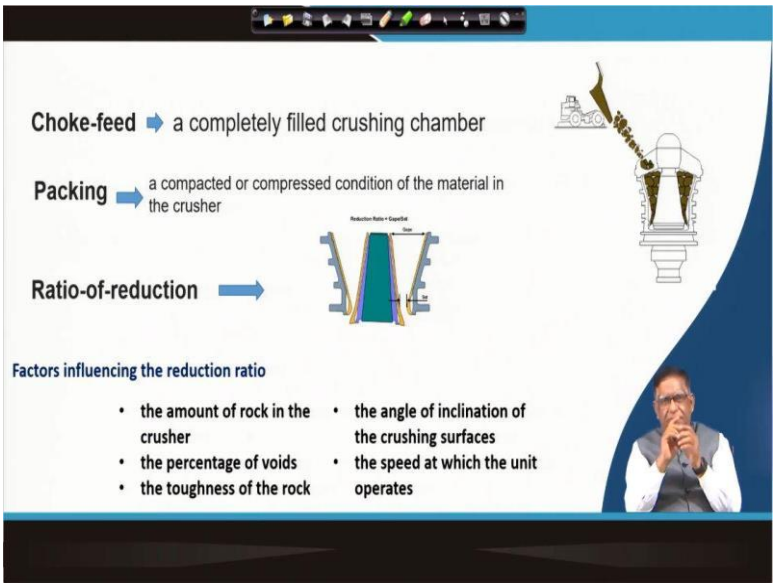


Then other thing is that how you are feeding the material to the crusher as I said that could be by a grizzly or there could be say when a truck is loading the whole material over there this is

a gyratory crusher you can see over here. Now, when the material is coming you are giving a choke feed that the material can get fill the whole crusher and it is by that and then when it is moving the material is pushed that is a choke fit take.

Sometimes, this in a such a get the compacted and inside that it get packed, that is also an issue and the reduction ratio as I have already told you. So, this type of terminology are very important in your designing or in the operations and in the practical field. Now, that reduction ratio that is how will you decide because your run of mine whatever is coming out of the mine that material may be having a different type of fragmentation depending on your blasting.

So, many a time when you are that mine to bill concept is now it is very common that is you design your blasting in such a way that your reduction ratio required in the plant in the crushing plant is not very big. That means you already get a fragmented one then your energy required in the plant will be less and that is why it will be much cheaper. Now, the amount of the rock in the crusher how much it will be coming.

It will also it will have to you will have to see that what is the percentage of voyage. When your material is fed into the crusher there whether they are getting is a very compact packing they are getting or there is some bridge is there. So, in between void is coming depending on that the reduction ratio as well as the energy that will be affecting. That is your what type of toughness of the rock.

That will also, will affect your selecting that what should be the reduction ratio and the angle of inclinations. And that exactly what is this angle of the gyratory crusher or jaw crusher what angle you are keeping over here that is also a and also the speed at which that operation is going on. That is if it is a jaw crusher at what is the blow per minute it is giving or if it is gyratory crusher how many times in per second it is giving the gyration. So, those are the factors that will be effective.

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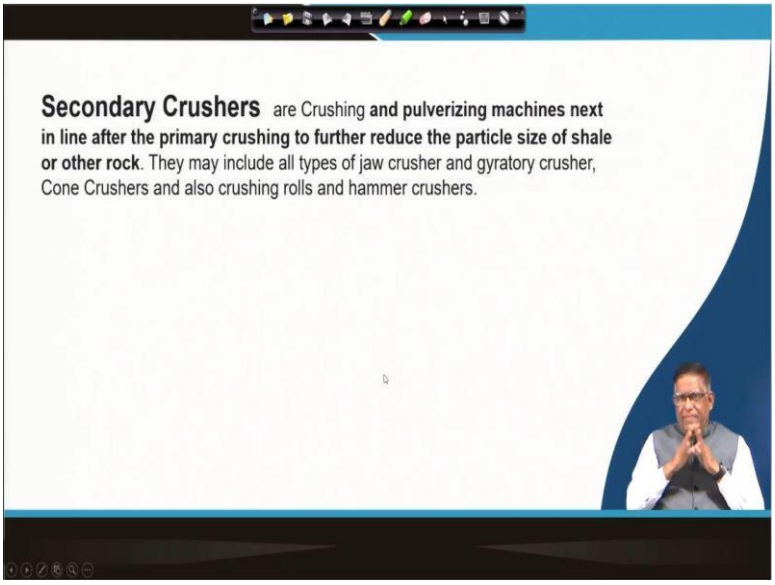


So, telling about this which is a very general things and all of you must know.

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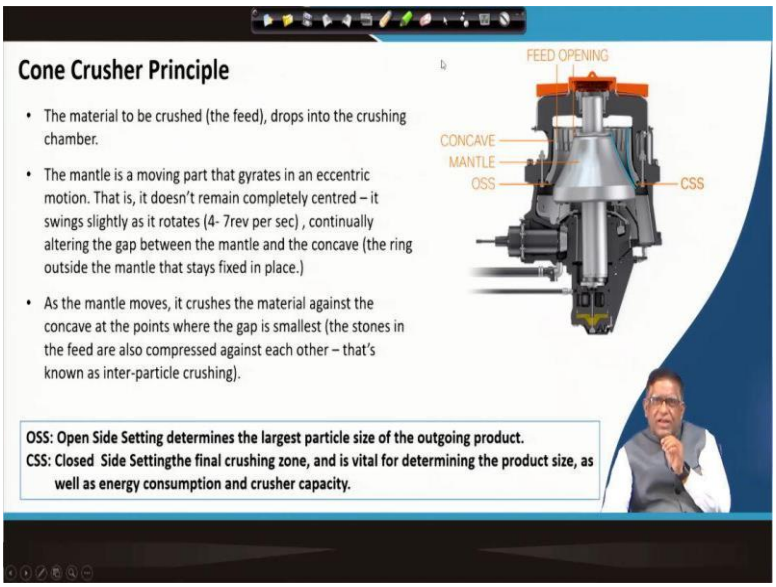


Now, let us talk about this is the Cone crusher which is for secondary crushing you are using. That you know that is here the whole operation will start you will have to get the feed will be coming through this chamber. You can see this chamber is made by this concave shape over here and this cone is there. Now, you may see that here this angle exactly this depth is less but in case of directory cluster this depth is more this is the difference of a gyratory crushers and the Cone crusher.

Both are having a mantle; this is also a mantle but the here the mental height is less in case of Cone crusher. And that is your open side setting that is exactly because of the eccentricity it will be moving like this. So, when it is moving in this the gyration is also here you can find

here how this was getting opening but here it get closed when and then when it will be rotating and during the rotation time once it will get open and then it will get closed.

And then it will get open this will get close. Like that exactly it will be doing in every rotation by that the particle is giving the compressions over there which will be more than the breaking strength of the rock and then the things will be breaking. So, here the mantle is the moving part and gyrates in an eccentric motion just like the gyratory crusher. That is does not remain completely cantered.

The eccentric means it is not always staying in the centre that is why it is the gap between the mental and the concave that will be going on varying. And that will be allowing your bigger size particle when the gap is getting that is your gate is getting open that size of particle will be going down. And that it rotates about 4 to 7 revolution per second as a result that gap between the machine and the concave will be changing.

And the material is getting pressed and open pressed and open like that, they will get crushed, as the mental move it crushes the material against the concave at the points where gap is smallest. That is the stone is the fit and then compressed against each other. The stone there are already the rock is there two three different big size rock they can get compress each other there will be some attritions also and then they will be breaking and falling down.

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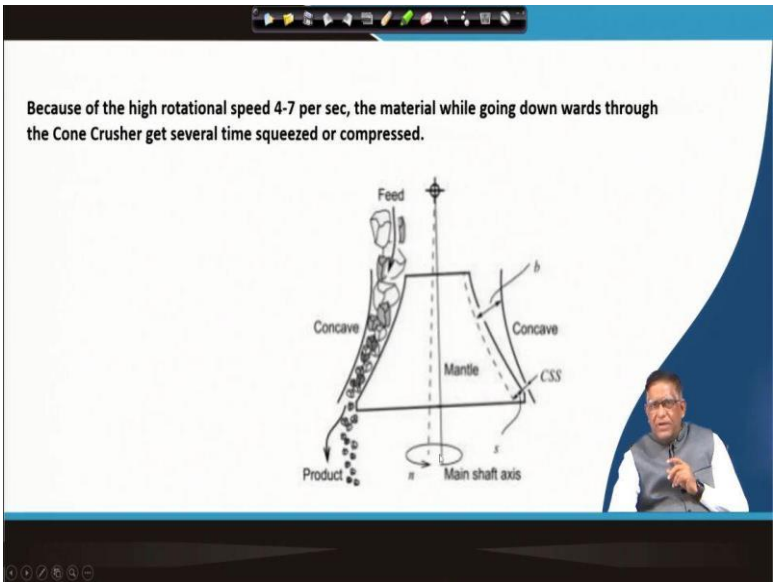


So, now you know that this in your cone crusher, the basic thing is you are getting that is your mantle it is rotating over here but the rotation is not about a centre it is going eccentric.

Because, of this eccentric movement that your closed set or at open set. Wherever it is there the material will be flowing like this getting this bigger particle is coming it is getting slowly getting pressed over here that pressure goes on continuously increasing the material breaks.

While breaking their material to material attrition is also taking place and the compressed force is also coming up by this way your crusher will break.

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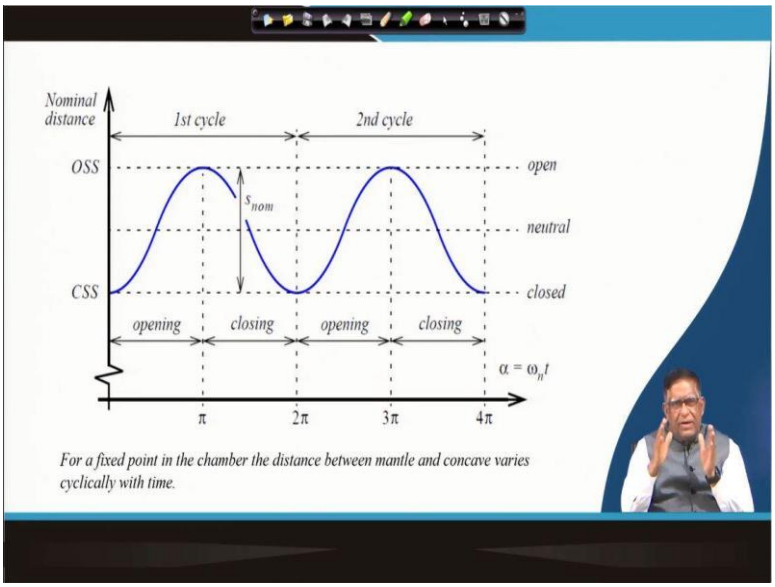


Now, you can see little bit more analytically what is happening. That when it is rotating at that time the material is moving from your that at the bottom side once it is closed after some time it will get open. That means as you see here this one when it will be rotating depending on it is going 90 degree then it is going again 180 degree 270 degree and 360 degree. During this 360 degree operation once this, your open set this will become close and this side will become open.

So, as a result this when it is rotating like this you are getting the at any point if you take in between your concave and the mantle that space is taking as a sinusoidal way. So, this is where exactly the mantle and the concave their distance it varies. And whenever the distance become more, the pressure is less but whenever the strain is making small that means that rock is getting pressed and that will be giving your whole classic energy to it and it will break.

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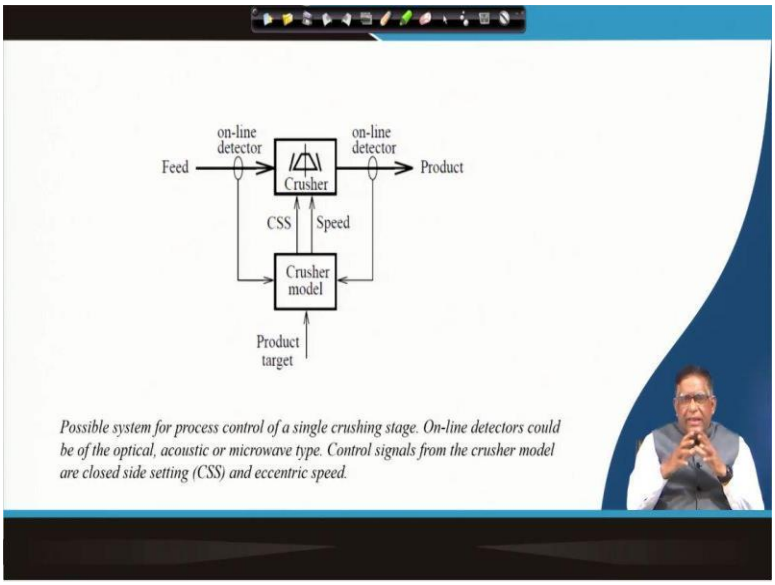


Now, then what we learn from here that the whole this crushing system, it is working the crusher your feed is coming and then your product is going in between to control that how will increase the efficiency of it. To increase the efficiency of it we must know that all those phenomena the blocking is not taking place pecking is not trapping that happening or bridging is not happening.

It will have to smooth all the time the crushing should take place and the material should flow. What is most expected is? That whatever the material is coming it is going down that from your entry point to the exit point, the material is flowing. At what speed it is flowing then only will be knowing that how much exactly material you are getting and cutting. So, that is why if you need to detect that is, how you detect the feeding system?

There you can have your online detection system for knowing what is the size and then how much quantity of material coming. And then in the outside that where it is going there you are finding what is the size and how much material is going. A material balance will have to be maintained. If there if the total quantity of material totals meter cube which is coming over there definitely the whatever is going out the meter cube will increase.

You have studied about the rating just formula and all that thing that when it is getting crushing more surface area and more volume is created. But if we know that the weight will remain same so by a study, we can find out a correlation ship that if our crushing is this much is happening that same material will have to go but by that how much volume has increased for that you will know that exactly your size reduction has taken how much.

So, like that your data to be collected from the system and there whenever you make these things that by sensing it you can sense the things by putting a sensors of your that is by visual sensors. You can take the image and that image you can process and then you can have the online way system in the feeder and then also that feeder is there the feeding side also a richer side also a feeder for the subsequent program that is your transport mechanism.

So, what are the parameters you will be detecting and from that you can develop what is called a crusher model. So, this is done in the industry you get a little bit of interest of it then you know that what is that physics and how the engineering is done over there.

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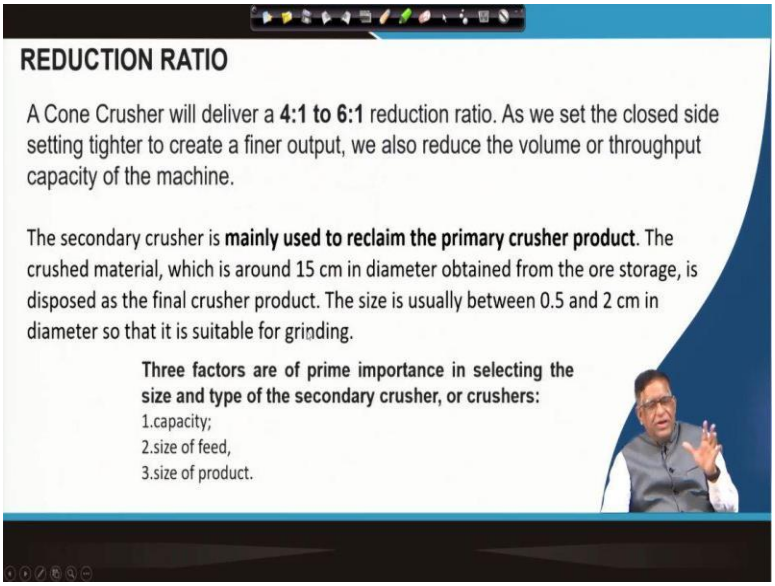


The most important thing is there, a cone crusher will be delivering at a 4 is to 1 or 6 to 1 reduction ratio. Now, as the set closed side setting tighter to create a finer output. If you are having a very small that means you are increasing the; that your that increasing the reduction ratio and you are trying to get a uniform material over there. So, what basically it is doing? It is whatever the primary crusher did their material you are reclaiming taking it over there.

And then you are giving a secondary crushing product. That depending on your processes required depending on your mineral you are using this can be different you can have that your secondary crust product may be your 0.5 centimetre or it can be 2 centimetre, it can be 5 centimetre depending on in what type of processing you can do it over there. So, in the real life plan we will be talking about what is the capacity?

What is the size of the feed? And what is the size of the product? And for that what will be monitoring how much energy is consumed how much time has taken. If your energy consumption should be minimized your time required should be optimized and the matching with the subsequent operations should be compatible then your cluster selection is proper and you will be getting economic life.

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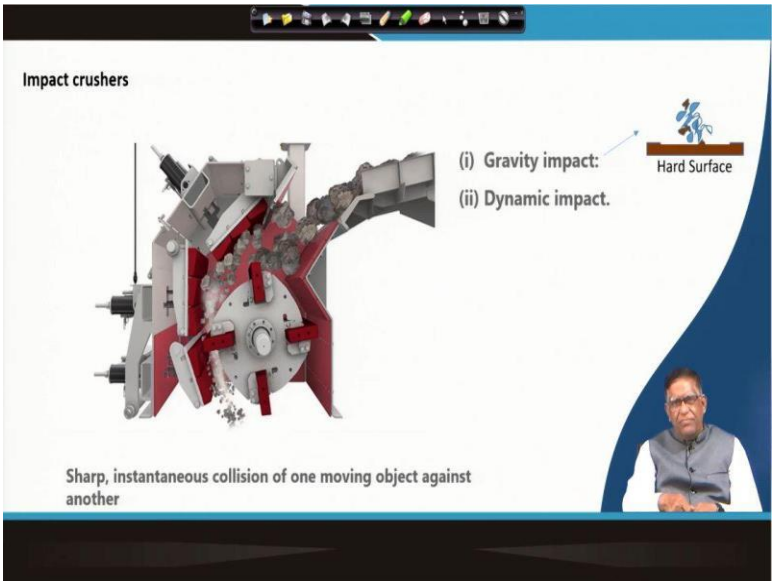


That is cone crushes we have said then there are other type of crushers you may be hearing about that what is called your that impact crusher. Now, impact means if you are having a rock and then you are having a hard surface by gravity if this rock comes and it falls on that rock then what may happen this rock will get shattered. That is exactly as a gravity impact you have got. But sometimes this impact can be dynamically all the time you give.

That is that impact crushers I think I told you last time you can do an experiment with the at your home allowing different type of rock and then put and then you find out what is its crushability your particular rock whether that is your the limestones in a different mines or that coal from different mines they may have a different type of crushability. Now, if a system if you are need to reduce the size, how will you determine that the crushing by a gyratory crusher or a cone crusher.

Or a by an impact crusher will be having a crushing product at least cost for that in a laboratory experiment is necessary. And you can create your own experiment at sometimes you can find out take out two three different rock and you find out which one is easily

crushable just by a gravity making them to fall and they will break or where we have to do a hammer? And in the hammer also some rock how much energy will have to be given?

What should be the size of the hammer to give a rock? Say if you want to break a rock a granite that what should be the size of the hammer to fall it from and then how many times the blow will have to be given. If you take a coal what should be the size of the hammer and how many times the blow will have to be given? You can design number of experiments and you find out what is the specific energy required by a different method.

If you want to give a pressure then how much exactly energy you have to press to break it over there. So, that impact or in a dynamic one if the rock is moving your feeder is giving the rock into a chamber in which this is a plate with that you can see here is the hammer plate. And this is your plate fixed plate this rock will be coming and giving an impact over here and while it is coming at that time this will be rotating.

These rotations will be giving also an impact over here and then they will be getting broken and that small pieces will be getting. So, this as because how robustly you will be designing those of who are who are mechanical engineer your job will be that exactly how you will design this component and rock. Now, for doing that exactly the how you will be allowing the chamber to operate that is the designing part of the mechanical engineer will do as a material handling engineer you will have to select the right type of equipment.

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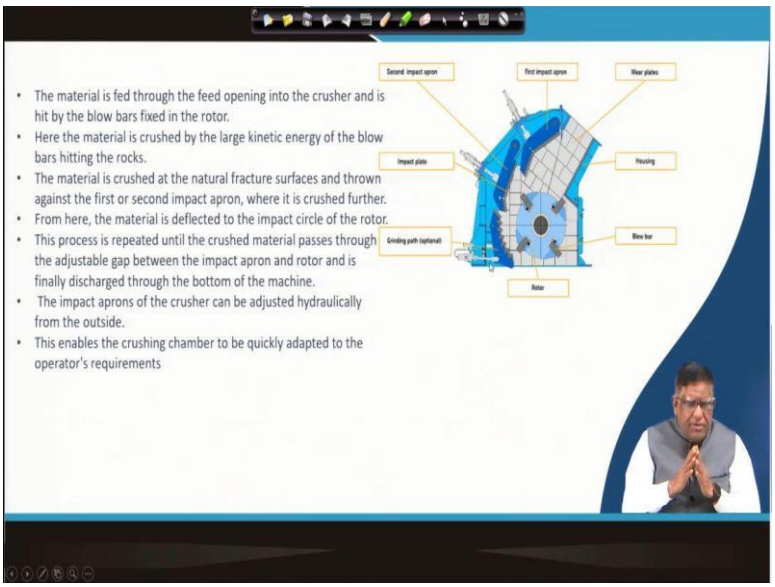

That your chamber that where the impact will take place how will be having this your impact apron these are impact apron which are there and this is (()) (25:30) has created such type of machines where you can have that exactly depending on that what velocity what size of material is coming you can push these things closer to this. Because, when the material will be coming a big size material has come over here it will get stuck.

And this rotation will be giving a impact over there and it will go. And then there could be number of them that they will be giving is repeatedly over there and then they will get a more finer or a grinding will take place. So, this is the way in a by feeding at one point how much time it is having a retention time over here. That means when the time is at the time a batch of material is coming over here and the same batch of material is going over here.

The time which is taking over here is called a retention time. Depending on that retention time your that feeder which is feeding the material over there that feeder belt at what speed it will be coming will have to be compatible. So, that is when you will be studying in a field this need to be matched. So, designing of that your crusher will also require that to design how the feeding is taking place.

Now, this is a yours the rotor which is rotating over here in a crusher it can be a vertical rotor it can rotate like that. And also, it can give his hammering actions or it can be in a trough where that is your the hammer is in a horizontal shaft and rotating over there and they will be giving. There are lot of different design is possible you will have to do.

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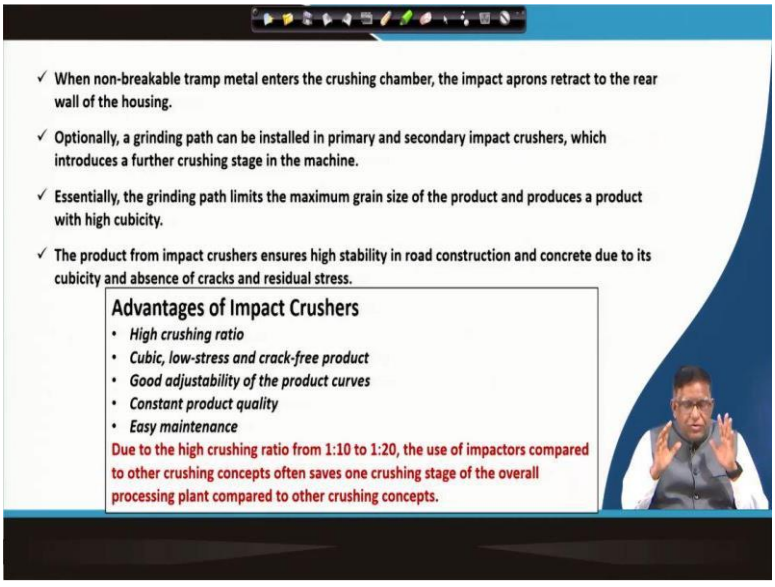

So, you have seen that the impact crusher has got a different way and the cone crusher does a different way. But what is there because it is a impact is given additionally and you can change the blow you can change the pressure as a result you can get a high reduction ratio. And then sometimes when you are giving a pressure in a cone crusher and breaking the fine product, they may be coming with some crack under the pressure inside a crack will get developed.

Now, that when that final product will be coming out, it may be weak now depending on what type of operations you are requiring outside. If your product whether there should be residual stress in the finished product is good a crack inside the product is good for the subsequent process or not that will be telling your because normally as you are doing an impact over there whatever is coming because of the brittleness and all it will get shattered.

And that they will break and they will not remain any acid will crack much as it is done in case of your cone crusher. Now, we can have a good adjustability and the products that we are processing engineer they do a lot of things that how it is we adjusted with their subsequent operations and then the product quality can be maintained. Particularly that if you are to do the shipping or screening actions afterwards.

That our required size the retention of the required size that may be increased more these are the sum of this. Now, one thing is there it can give go to the reduction ratio 1 is to 10 to 1 is to 20.

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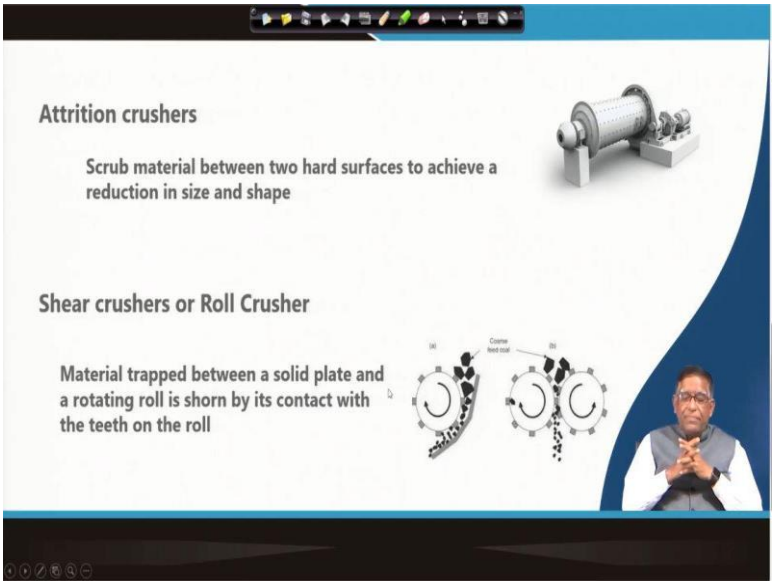

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So, these are the possibility over there. Then the next type of this year after that we have some of the attrition crushing in which I told you earlier also in the introductory classes that if you get a ball mill or a rod mill the material along with a ball mill if it is rotated inside a ball mill, they will be starting we are giving a lot of attrition will take place and the fine products will be coming.

But this your when you are telling about this your crusher secondary crushing can be done by two rolls. If your material is coming, we are having these with some of this impact fit and then the material is just, these two will be rotating over there and they will get cut over there. That break broken over there sometimes this rotating roll a cylinder with the having some of that impactor fixed over there.

And this is the that your should through which it is coming that the material is fed they will get crushed and then the product will be coming out.

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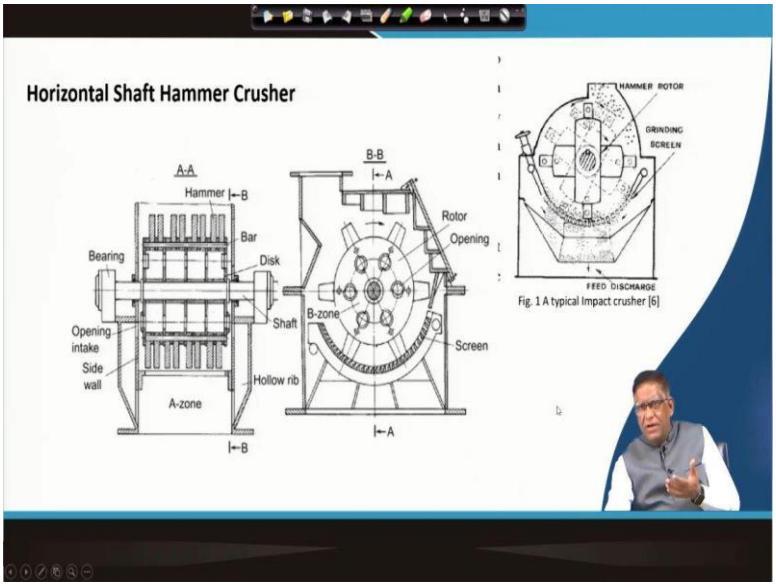


So, the other thing is that your that in the impact pressure, we said that it can be horizontally this is placed over here you can see that this is rotating like this material is coming from here and this cylinder is horizontally it is just rotating over there. The material will get crushed and from here the material will be dragged down to over here to get reduced that it can fall like this.

So, there are different designs different makes are available you will have to charge and find out.

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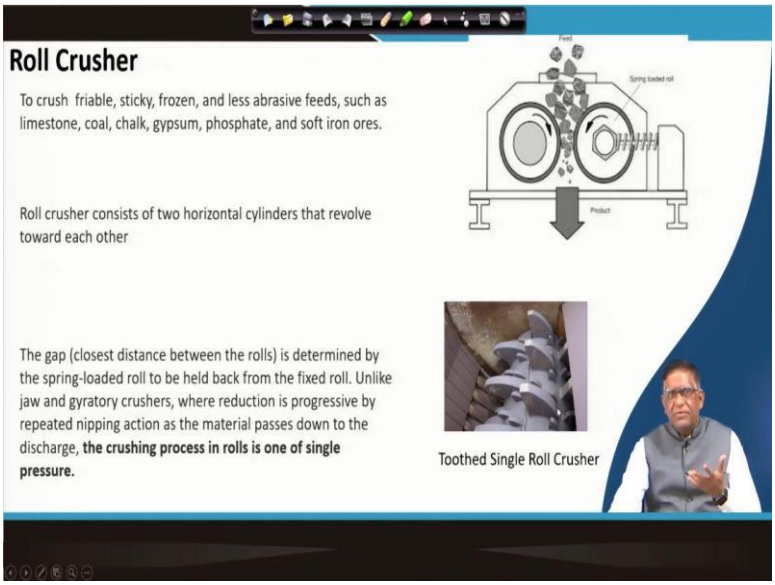


That this roll crushers which I said that it could be only straight roll or the rolls will be having this type of your that is your impactor by which when these 2 rolls will be rotating from the opposite directions and then they will be giving that impact inside the chamber they will get broken.

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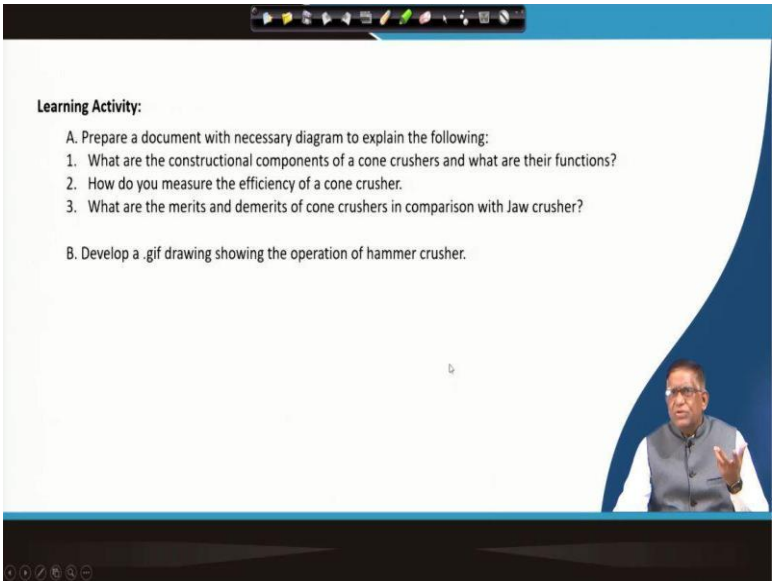


So, there are different way we can do this secondary crushing's and then their operations but you will have to learn how to manage the handling system and your learning will be there when you take some learning activity. I wish that you prepare a document with necessary

diagram to explain what are the constructional components of a cone crushers we have discussed little bit.

But by listening to the class and then they not do you will have to do by yourself at least draw a free hand sketch then only you will be able to do it. And then after you know the component you yourself will ask what is the function of the mantel? What is the function of the concave? What is the function? Why the gap should be there? How we design that how much the gap will be there? How the eccentricity is coming?

We are get eccentric stuff that what are the drive component of the eccentric shaft? Whether we will be giving a hydraulic drive or electric drive with a gearbox and then how the bushing will be made? Those things a little bit of more mechanical detail you can do it by your self-studies under preparing this document. How do you measure the efficiency of a cone crusher? That is how much your input energy and then how much is the product you are getting you make some.

What are the different indicator that industry? They say is the key performance indicator that how those key performance indicators are measured you need to find it out. What are the merits and demerits of cone crushers compared to a jaw crusher? Or another work you can do if you are interested is this when I see those gif that exactly there is a freely available that your software's are there you download it how to develop a dot gif file which will be giving your you make it over there.

Draw the sketch very simple pencil sketch and over there and then how you see that this can be given the animations it will be going on doing over there. So, those are the today students should develop your own gif at least for one item you do it will be a good interesting learning exercise and you can do it over there.

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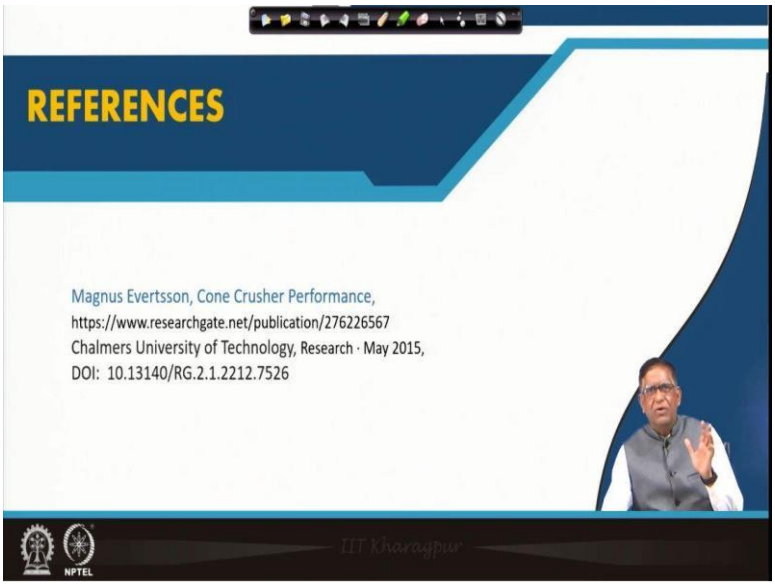


There are many books and the normal text books that will is book on mineral processing engineering. Then there are number of open that is public domain articles and of that internet information's are there. I request you learn those keywords whatever has been given in this. These are you take one or make a list of at least 10 or 15 phrases as a keyword. Make that you do not take a lot of time our topics we have got lot of different topics to be introduced for your learning.

And you make for every class at least seven keywords you pick up and for that seven you read at least seven articles in seven days in a week for all this and then you find out yes. This one is important interesting do a little bit of another 1 or 2 hour study of that whatever the minimum you study that is the best things with the minimum study you prepare one document that will be sufficient for your learning exercise.

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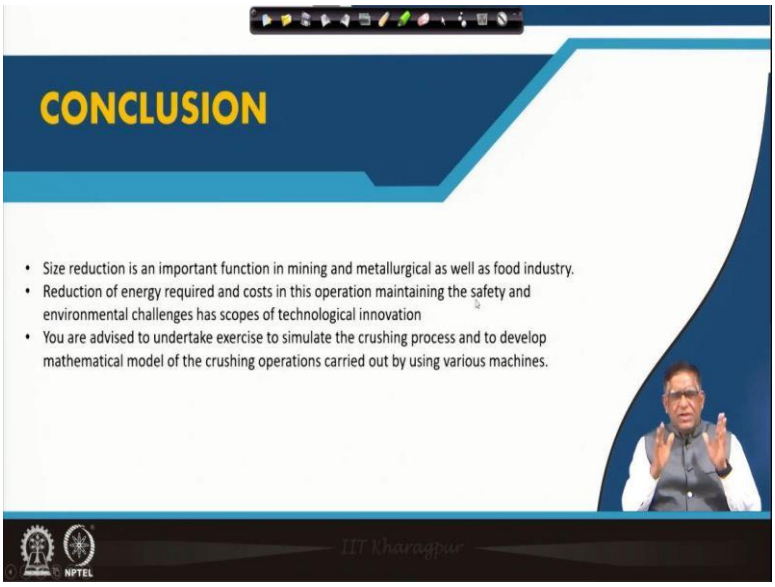


So, size reduction is an important function in mining and metallurgical as well as in the food industry. And reduction of energy required, that is a poor reduction energy is required and cost of this operation maintaining the safety and environmental challenges. The scope of technological innovations are plenty you can innovate new things new way of doing things. But for that you will have to see find out how exactly that your everywhere it is crushed whether it is if you go to atta chakki there also the things are crushed.

And then whether you go to any that your, even you do a different type of crushing for taking out the juice that is also in food industry different type of handling and crushing takes place. You are advised to undertake exercise to simulate the clashing process and to develop mathematical model of crushing operations carried out by using various machines. I do not know how many of you will be really interested.

But yes, the simulation and model development for predicting the problem that if some of you are mechanical engineer you may think of what will be the tribological aspects of this crusher operations where the friction we are will be taking place where you need to lubricate the mechanical engineer may look into a crusher in a different point of view. As a processing engineer you will be looking into a different fold.

That is as a mining engineer you need to manage you will be looking into that how the cost benefit is coming. So, depending on your interest take the things I have just introduced this thank you very much.