Bulk Material Transport and Handling System
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Lecture - 19
Principles of Blending and Reclaiming

Welcome students to this discussion of our stacking, blending and reclaiming. In last two classes we have discussed about different type of stackers and also, we learnt about that how we compare different type of stacker, how we select it for different purposes. Today we will be discussing about this another important thing about blending. Because when you are forming a stockpile, we are keeping the things together at one place.

Then there are two words we introduced in between that is your what is homogenization and blending. Homogenization means if you are having a heap of bulk material if you take any sample from any location if the compositions and then the ultimately the quality of it, it remains same everywhere then it is a homogenized. Now in case of your mining or in many times when you are getting the say rice product from different fields many a time the same rice quality will not be coming.

But when we are placing it over there it is a same type of rice coming from different fields then it should be when you take any sample from anywhere it should be giving the same quality that we can do it as a homogenizing by keeping the things in a particular way. And then your another thing is that when we blend. In a blending, we do that is exactly for certain processes. For example, you may be having some if you are living in north India, you might be knowing there are different type of dals, moong dal and masdoor dal.

These two types of dal they mix together and cook. Now depending on the proportion of these two there could be a different taste. Similarly, you may be saying in Indian cooking that past furan that when they mix different type of spice to make one. If any of the ingredient are changed then the taste of your curry will be different. So, the same thing is there in our bulk material when we blend. For example, we will be talking about today about how ore blending is done.

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And then for that blending purpose how different machinery are used, how that whole your operations need to be planned. Now of course it is a big subject. Today I will be just only introducing in such a way that you should be able to define the objectives of the blending in the bulk material handling and you should be able to explain the basic principles behind and then you should be able to explain how reclamation and stock pile operations are planned. So, that you can take some learning activities some mini projects in this area of expertise.

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So, let us first say what this blending of ore is? We will be talking this stocking, blending and reclaiming basically for the mineral industry it is very, very essential. And the blending is a process whereby in a mine a group of mines served by a common mill then send their ore at a different time from different locations. But when they will have to be fed to the mill, they will be fed in such a way that the concentrate which they will be producing as they have end up in a beneficial plant.

It will be giving a value which or that concentrate will be acceptable to the metallurgical plant where they need to go. So, ore blending is the process responsible for combining ores with various grades and contaminants in a systematic process. Because the ore contaminant means gangue material there could be different gangue material may come into different ore. But when you are processing in the or concentrating in the beneficiation plan, they will have to take care of it.

Then it is a blending of existing or according to the production index before ore dressing to make the mixed ore properties more convenient for production thus improving production efficiency and reduction of cost. Now here many things are involved in blending basically when you are talking of different size that which size index is necessary over there, also when you are thinking of say when you are going to reject some of the material.

Suppose you are having number of the test locations from where the ore is coming. Now at a time if you are not having very good quality ore then your many of the poor quality ore will be rejected in the tailings it will be going. But things that if you are having some very good quality ore then some of this rejected material also can be used. So, there is a two type of cost saving is there. One is those which you have rejected exactly they have not given any return.

And there were a huge cost for mining it and then bringing it to your plant and before it is rejecting. So, all this cost can be saved if you know beforehand that if such rejectable material can be used, we have got some good quality ore to blend with it. Now it is exactly our main objective is to get an ideal product. So, that should be in a uniform and homogeneity will have to be maintained.

So, when you do the over blending, they may affect that is in a beneficiation plant to liberate the material the from the gangue material you do crushing and screening. That crushing that process is called your communication process. Now, when different ore qualities are mixed together then how the combination will take place. And particularly when there will be a grinding if you are having a different density material.

And then they are put together their auto grinding will be having some different effect. So, by properly grinding then properly blending you can reduce if in the grinding energy. So, then sometimes their performance also in the magnetic separation at that time also the performance may be different. So, that means your how you are blending depending on that your exactly the processes which are going on in the beneficiation plan may give different reason.

So, that means the overall performance improvement that can be done by proper planning. So, that is why blending is a very important activity.

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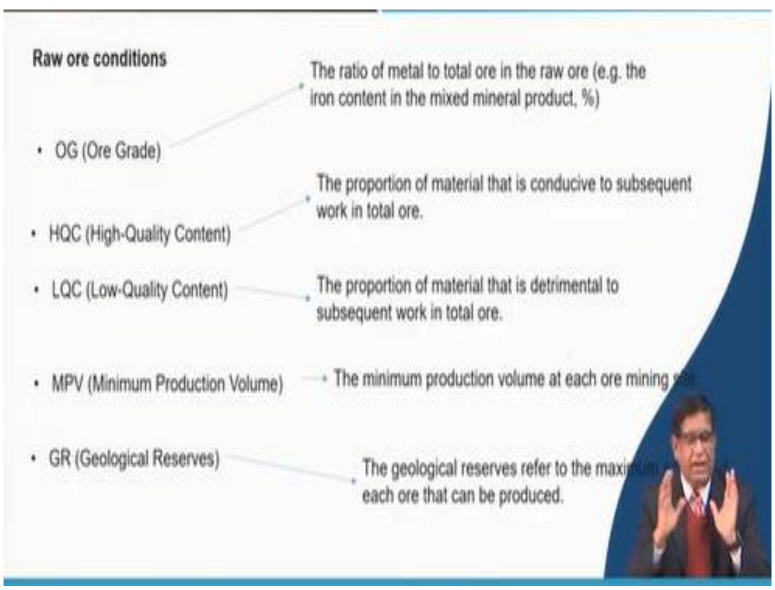

But this blending will have to know that the blending takes place that depending on the material. How the material quality will be coming? That needs to be known. Regarding this in the mining industry when we are taking with ore, we always talk of what is the grade of the ore. That is from that particular ore how much concentration or how much quantity of your valuable minerals can be obtained that will be giving your grade.

Similarly, there are in any mineral there will be certain which are the very quality material that is the main component from where you will be extracting the metal and there are some associated mineral and then some of the binding advantage and all which are in a low quality content will be there. But they need to be eliminated. So, their proportion if it increases there will be a problem.

So, you need to know beforehand that how that exactly the composition of the material is in the high quality content and the low quality contents. And also, what is the production volume that is your how much that mine is giving in a volume how much it is coming. And also, that is total reserve that is whether it is a homogeneous what type of reserve it is that is also very important.

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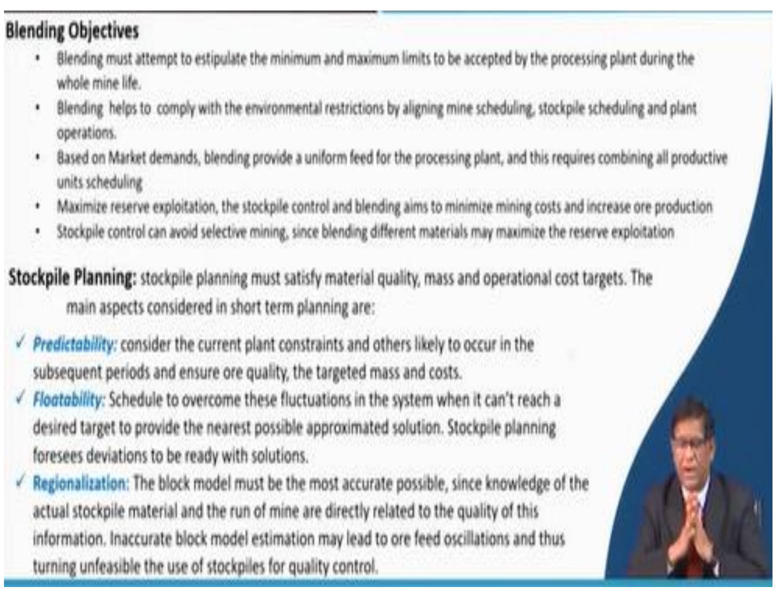

Now once we find that one that is exactly sometimes it is a volume is important and then when you are taking account in the beneficiation plan you may be counting only that how many number of trucks of material has come. Because, though it will be in the mine will be talking about their things in terms of tone. But the toners for your blending purposes may not be very meaningful exactly how the material is received that may be very meaningful.

So, that is why depending on the situations you will have to take your input material how you are counting it. Now why you do? What type of blending you will be going for? That blending is to estimate the minimum and maximum limits to be accepted by the processing plant. That means whether after blending that is your how much what type of sizes will be there. So, that means if you need to know that after blending all that thing in your first cleaning itself, you can get a lot of wheel that you are from the processing you are putting it over there.

You are exactly controlling that how much quantity will be going to your plaster. Then blending helps to comply with the environmental restrictions aligned with that means in your mine scheduling, stockpile scheduling and plant operation. In during this time there will be different type of environmental restrictions will be there dust, noise even that if some cases that really sheds whatever will be coming.

So, if you properly blend it that pollutant release can also be kept controlled and also there is a most important thing is to fulfil the market demand. So, that means what your metallurgical plant is demanding for what concentration level. So, your blending will have to be done in such a way that that yield that amount of percentage supplied to the metallurgical plant. And then another thing is there you want to exploit that whatever the resources available in the deposit.

If you can properly blend and properly plan the things that you can get maximum out of it. Otherwise, that even if the deposit is there some of the thing as a Lenore or some as a poor quality ore will be rejecting but we did not if we do not properly look into where the good quality minerals are there which can be blended to make this low quality usable. So, this is where exactly the blending importance are remaining there.

You may be hearing nowadays that there from coal to gasification process is there in Unisia there is also a plant coming that to where your that some very low grade coal is being used for getting producing gas from there. For that what they are doing they will be blending with petroleum coke that from the refinery what is the petroleum coke is coming this pet coke when it is blended with that.

There is the yield of the gasification process and then also that the other utilization is coming. So, that means the pet coke which may be having high sulphur content even with that with our low sulphur content, low grade coal when they will be mixing, they can be made and usable product for those plants. So, that is how exactly the blending objective is to make use of the poor quality material also and so that you can optimize the resource utilizations whatever is natural resources available.

And then what is happening? Sometimes you if your deposit is having a different type of different parts or different quality then early you will have to do a selective mining to separate it out if you cannot do it at all. But thing is that sometimes if you do a proper blending, you can avoid the selective mining. To do a selective mining what happens the mining production rate good goes low. So, there is that this advantage can also be done.

So, the by doing a proper blending operation overall your this raw material management can be improved. But thing is that, for that what will have to be done is a stockpile planning that means in your beneficiation plan before you are feeding the material to your plant how you are making the stock piles. That your stock here how will be managing regarding that your how much material from where from it will be coming, at what interval it will be coming, how it will be mixed together.

And then that is a important job in the stock yield management. Now for that whenever you talk of the planning, we normally need to see the predictability, that is how much exactly will be giving we need to have give a good prediction. So, there will have to be some prediction equations based on the different factors influencing that side. Then there is a one floatability which is exactly to overcome the fluctuations in the system.

That can be exactly if there is a very good quality things coming at sometimes and sometimes very good bad quality coming and there is a fluctuations in the system. So, we will have to get a what is the possible approximated solution. So, that deviations of a different type that will be exactly removed by maintaining a good floatability. And then regionalization is that is your when you are putting the things over there a block model is made in which when you get that quality from that.

That means a sufficient amount of homogenization they get there. So, the stockpile material they will have to be managed in such a way that our main objective of the plant is fulfilled.

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So, for that this stockpile planning will have to be done. Now for that exactly we will have to find out certain indicator and certain measurement by which we can do these planning operations. Now for that your you will have to know about what is the total amount of ore then you will have to know what is the maximum and minimum values of the mixed ore grades. When you are mixing it what will be the minimum grade and what is the maximum grade within which will have to play with.

That need to be as an indicator we will have to fix it. Then what is the high quality material content go how much exactly in a hematite say. For example, in deposits of iron ore there could be a 56 or 46 or 70, 65 different percentages may be there but the high quality content that your iron oxide that should be there up to how much maximum. And then similarly the inferior material like that whether there is a phosphorous coming, sulphur coming those material content how much that is also to be defined.

Now once; these values are determined that the quality of the blended product need to be defined properly that this will be coming over there. And then we will have to make a ore blending product index that which will ensure that the to certain extent that quality of the grinding products or the beneficial products meet the production standards. So, this indicator which will be there specific to that your processing and the metallurgical requirement.

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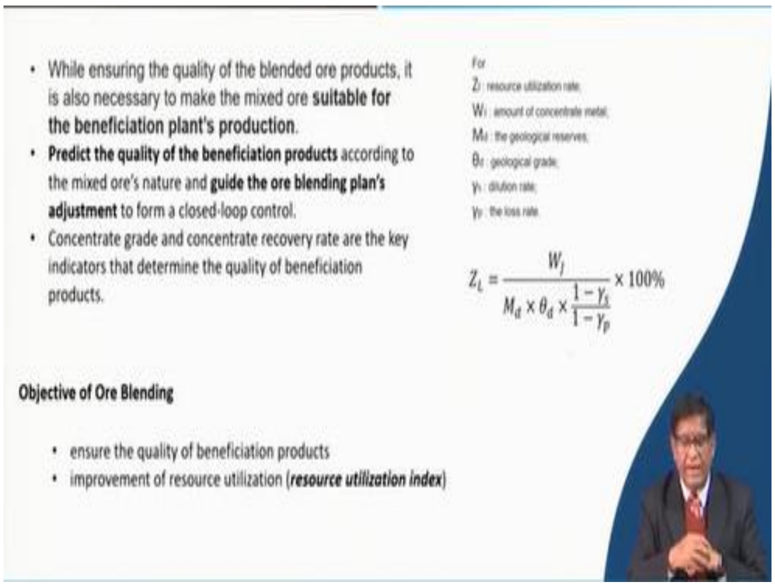

Now while you are going for ensuring this quality of the blended ore products so it is necessary to make a mixed ore suitable for the beneficiation plants production. As we so what is the suitability there that is whether for our crushing plants, whether in our screening part, during our transportation part and during the processing the floor floatation’s or whatever the method you are using. In that process whether it is becoming more compatible or not.

Then predict the quality of the beneficial products according to the mixed ore mixtures and guide the ore blending plants adjustment to form a closed loop control. So, once you know this one then whatever the output or the performance you are getting from another process from there the feedback will be going and then in the stockyard in the blending year that your this blending is necessary.

So, that exactly a linking will have to be done data management will have to be done over there. And this concentrate grade and the concentrate recovery rate they are the key indicators. So, ultimately you will have to maintain your blending operations or the way you are receiving the ore with these two quantities. That is your what is the concentrate grid and then how much concentrate you are recovering.

So, once you can do it then you can do the (()) (18:49). So, ultimately what is that ore blending objective is to ensure quality of the beneficiation product and then improvement of the resource utilization. Sometimes a resource utilization index can be obtained for a particular thing. Now this resource utilization rate it can be measured by different way. So, if you know the amount of the concentrate material which is coming and then you know the geological reserve of that area.

And the geological grids as these values are showing over here. Then the dilution rate and this your mining loss rate these few definitions you need to know for calculating out this your resource utilization rate. Now what is this?

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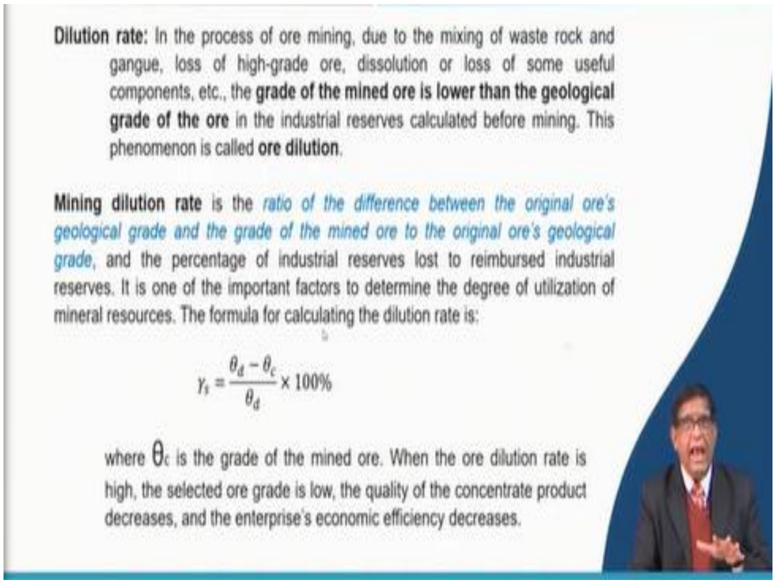

To calculate these ones as you will know that. What is the dilution rate? It is the process in ore mining due to the mixing of waste rock and the gangue, loss of high grade ore and dissolution of loss of some useful components. So, that the grade of the mined ore is lower than the geological grade of the ore. This is happens in what is there? When you do the before starting the mining when you have done the exploration you have done from the borehole.

You have collected the samples and then tested and then you have done it to some number of boreholes and from there you have found out and you have said that this will be the grid. But when you do the mining, those things are getting over there and they lose that whole material which is coming. If you take a sample from there, there is the same grid is not available because wherever that your ore is there then you are mixing with some of the non-ore material then your grade is falling down.

Same thing happens in your coal mining also. You are doing the coal at the same time just above the cold seam there is a your overburden strata or that your whatever the bedrock strata while you are excavating some of that portion also get mixed into it. So, then whenever you are bringing the coal that the ash content of that coal whatever was predicted in the seam is less is much more than whatever exactly you are getting over there. So, you will get less calorific value.

So, that is why this dilution rate is a very important things for the utilization purposes. Then mining dilution rate is the ratio of the difference between the original ones geological grade and the grade of the mined ore. So, if you are having this theta c as the grade of the mined ore and then you can find out by using this formula that is that ratio of the difference between the original geological grade and the grade of the mined ore.

You are having this grade and this gives your dilution rate which you are using in the calculation of the resource utilization rate.

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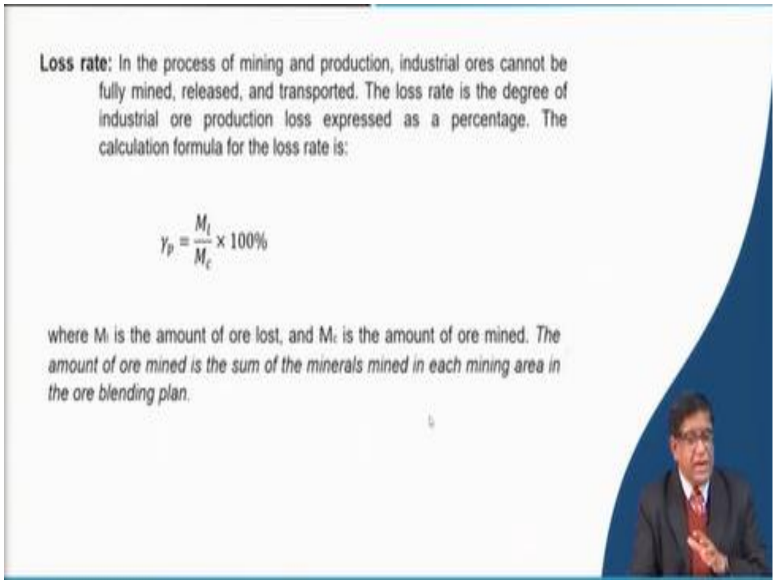

Now next thing is the loss rate which is used in that your research utilization index. It is that your industrial ores cannot be fully mined released or transported. The loss rate is the degree of industrial or production loss expressed as a percentage. Because the amount of ore lost which is coming over here and the amount of ore mine exactly when you are mining say 3 million ton in a year there may be you have you could not mined say 20% of the whole deposit whatever is there.

So, that gives as a loss. And in some of the thing in underground coal mining we are most of the old underground coal mining we are giving only 25 to 26% were collected, restored remaining as a loss. So, that resource utilization factor that is why we will be going down with this things.

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So, that is why our whole observation is there, there is a need to study the quality of the beneficiated ore in our iron ore beneficiation plants. Exactly as a material handling person in developing this expertise, you can see that most of our Indian beneficiation plants were designed and operated say 30 years 40 years old now. So, at that time when it was designed with the type of ore, type of situations in the mine and today it is different.

So, now the processing plants and all which were there if there functionality need to be improved. There is one possibility is there if you can make it proper blending of it with the existing machinery, we can get a better rail. So, for that of course a systematic study will be necessary and the new algorithm will have to be developed. So, that our how to the receiving pit will have to be changed, how our the mining blocks will be defined that need a periodic overview is necessary.

Many a times adding the quality control department of the mines and the plants they do it. But there is a scope of doing research in this and then there is a scope of getting economic benefit of it.

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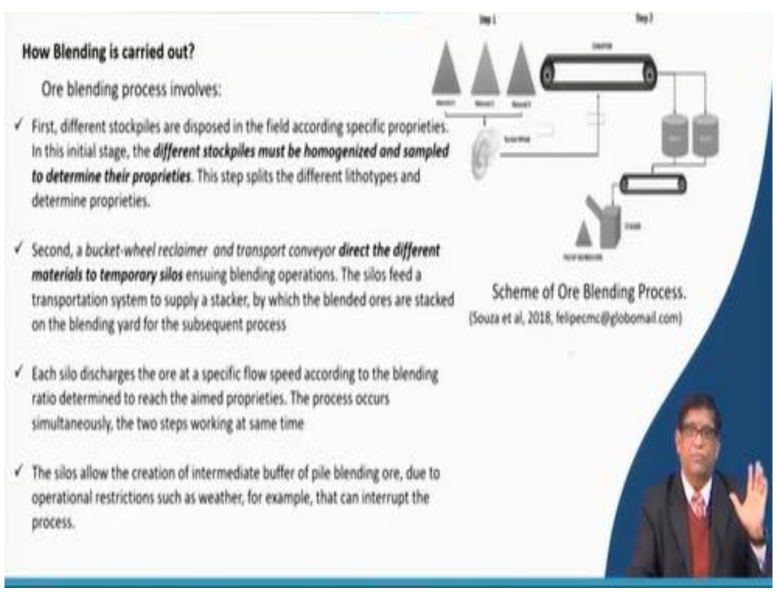

So, for that how that blending is carried out. You can know that in different stockpiles are disposed in the fields according to their specific properties. So, different stock piles these are the homogenized stock pile their samples are taken and they placed it over there. And from there you will be doing by a reclaimer will be reclaiming it. Whether you are using a bucket filler reclaimer, barrel type reclaimer with a harrow, without a harrow, we have scrap out of those different reclaimers we have seen.

Depending on the quality of the material, depending on the types of the material, depending on the homogenization we get during stacking those reclaimers will be used and they will be giving and feeding it to over there. Now while reclaiming that necessary blending will take place and the conveyor belt will bring them and keep it in some silo. From that silo again depending on that thing you will be making a proportionately you will be loading on to this conveyor.

And then ultimately when it is coming to your main blending site you get the blended material over here. So, this is what exactly in the receiving station of a ore beneficiation plant the operations will have to be done. So, that is what exactly we are doing the stockpiling then we are transporting, making silo and from there it is giving to stockpile. So, these operations how to optimize it, how to get these things the maximum of it.

It will require proper stacking machinery, proper reclaiming machinery, proper transporting machinery, properly getting it into the stocks that is yours that whether it will be silo or bean or bunker. And there when will be keeping it then from there how will be doing the feeding to this conveyor. Each and every operations will be having number of factors they will have to be optimized for getting a optimal blending.

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So, that is why that what you will have to develop your expertise in stockpile scheduling and blending operation. And in that whatever you have learned in operation research need to be applied over here and there you might have many things in the past it was done by linear programming. Nowadays they do by this goal programming many of you may be knowing now this is exactly and that is your and colony modelling.

I think they say that the new advanced techniques of then using neural network lot of optimization systems are being used in this field, where you can take up your project work in any of that our beneficial plant and you can do it. Now what is there? How you will be planning it?

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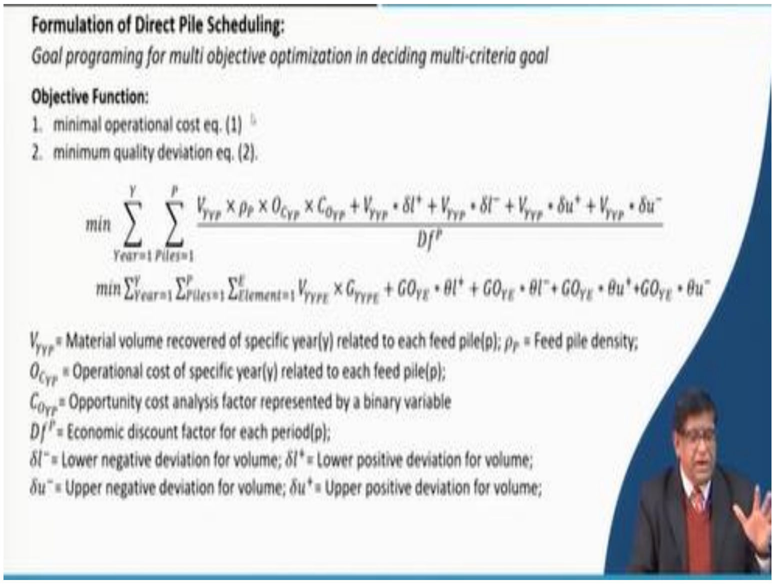

So, this can be given as an example I will just give you a brief idea of it on which you can take up your own projects works. In a goal programming what is normally done? You define an objective functions and you define the constraints. In a beneficial for the blending purposes our minimum the operational cost that is, operational cost should be minimized and the our quality deviation should be minimum. These two are you can give by equations.

So, for example there is a cost part that could be depending on the material volume recovered specific year related to each pile. If there are number of pile from each pile how much volume is coming and that will be that because for knowing the tonnage that what is the pile density of the material also need to be done and they will be giving the effect. It will be having then the operational cost of specific year that cost can be derived by various ways.

In the field when you will go directly for a data collecting you can find out or you will have to read little bit. Then opportunity cost is another thing that if you cannot do suppose because of your blending not coming properly you could not supply the material at the right time and when it was demanded that means you have lost a opportunity, there is a cost involved in that. If your plant is not operating because of improper blending then also you are incurring and you are losing your incurring and opportunity cost.

So, that is another thing then economic discount factor for each period that for what time year you are using it that is taken into and that your deviation volumes are taken by considering these things they form a this. This is an example just in a reality when you will be going to a particular plan this objective function formulation is very important.

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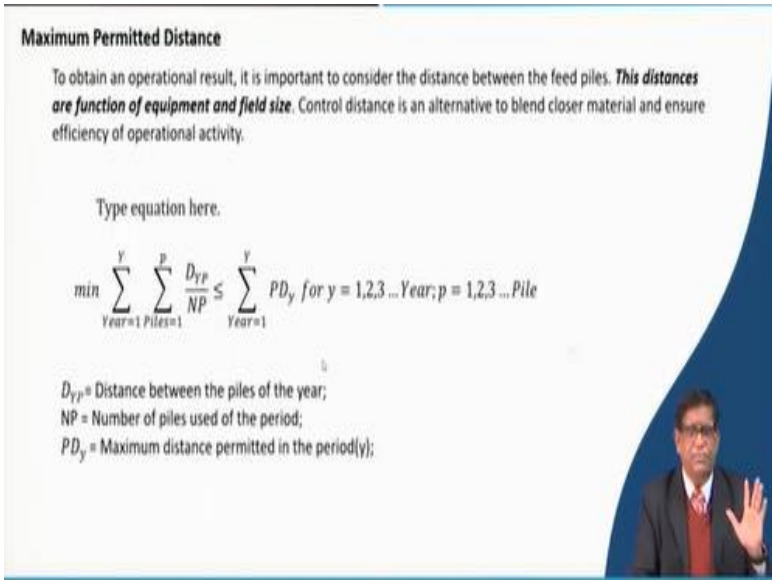

Similarly, your maximum permitted distance. Because where exactly you are putting the stock piles then from their stock piles the material will have to be brought over there that your distance and quantity movement that is also one constraint may be there that is one objective may be there. So, that you will be having that permitted distance you will not go beyond that. So, that means distance will have to be restricted to this.

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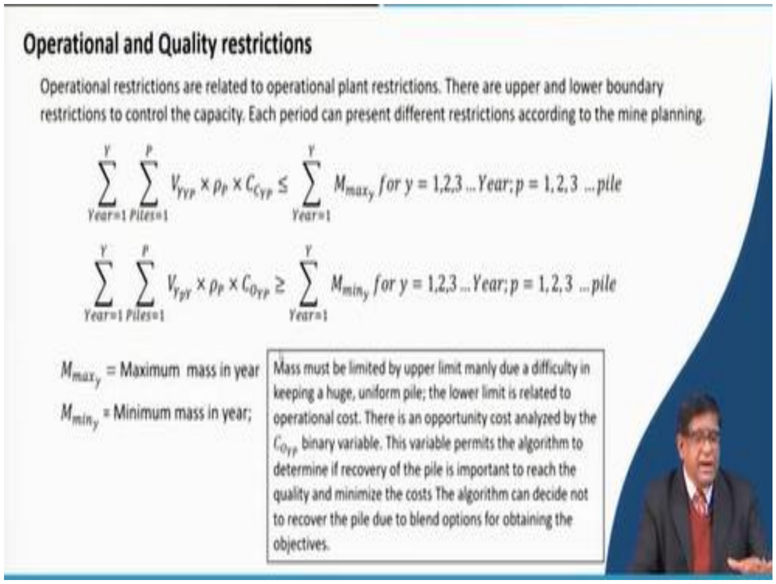

So, that is an objective and this can be yourself some of the restrictions that is related to the plan. That are upper and lower boundary of the restrictions control on the capacity it should be less than certain maximum value of the year it can be given. So, like that when you will be putting the constraints into then this is subjected to the goal programming.

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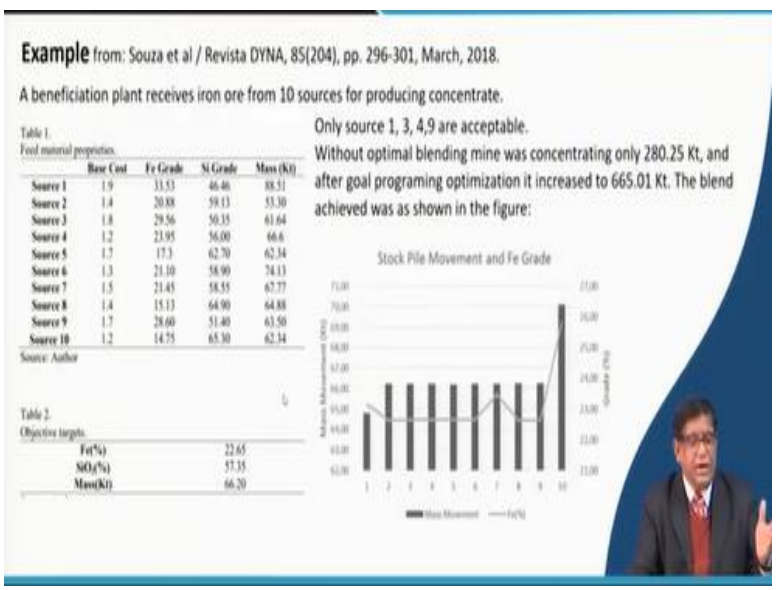

And if you carry it out then you can find. Say one example from Brazil you can read on this on the reference I have given in the lecture at the end of this presentation you see there in that mine they were having the iron ore coming from 10 different locations. And there base cost indicator was there and the iron ore grid it is varying widely that location 10 has got a very poor quality of ore and then there is the silica content also is a different here, very high silica content.

So, this should be minimum and this should be maximum there allowable things are given. So, if iron ore that is on up to 22.65 that our the metallurgical plant can take. So, in that case what we will find? Number of them they are exactly cannot feed their material for your steel plant. Similarly, because of the high silica grate some of the things are not allowed that is that will not be allowed.

So, that again these sources they have got a different quantity of material are coming from there. So, while they are there by using this goal programming, they were finding out some mix that every year from how much they will be giving from which sources and then they find out a mix and that blended material they could give it. And then this resulted in earlier they were utilizing only 280.25 kilo ton from the mines different places.

But now because of the blending they are able to use 665.01 ton, that means this difference which were otherwise reject and would have gone for the over then that is your waste dumps now they are being utilized. So, this is how exactly blending serves.

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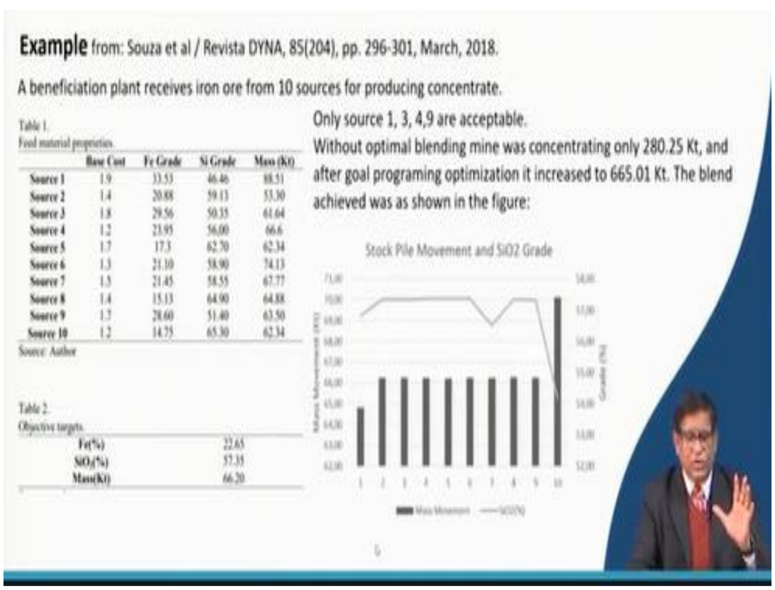

So, similarly you can see that this the silica contents that also could be optimized by this method.

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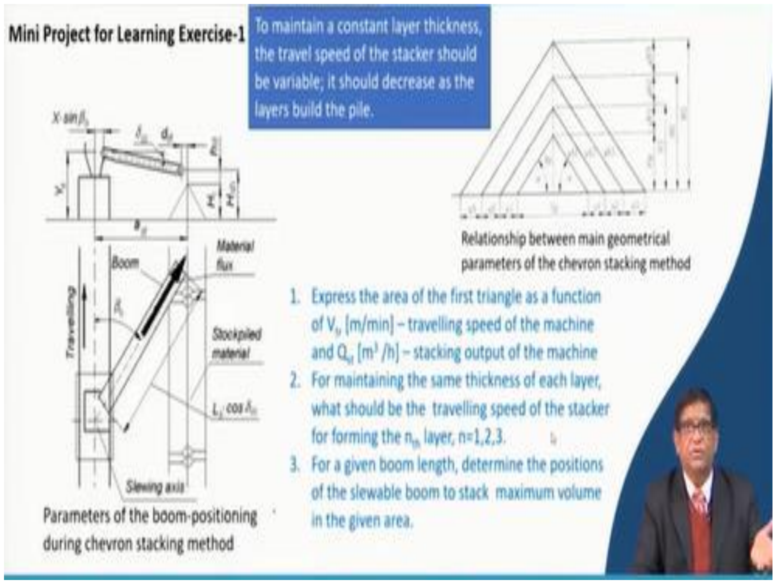

So, that is why you will have to do the blending in a proper way. But you have seen that these stackers different type of stackers form the stock piles differently. So, the blending will be achieved by how you have stopped. So, for example if you have got a slewable type a boom over this, this is here you can see that this is the conveyor belt by which the material is coming and it is staking over here, this in the side view and this is the top view.

Now you can see that a triangular form is forming. Now this particular stacker has got a speed by which it will be moving over here. Now when it will be done that initially it will be giving a first one pile will be formed then this your boom will be raised, another layer will be form, another layer, another layer. Now what is necessary? That means for proper blending you will have to know what should be the thickness of each layer.

And then when you are reclaiming as we have seen in the reclaimer can go on reclaiming like this one by one layer by layer or it can do by like this. So, that means there if you know this quality of each layer then the what will be the combined layer quality can be known and that will be achieving a particular blending ability. So, what is important here? How will you exactly do some calculations on such type of things.

Now they say how will you maintain a constant layer thickness. Now the layer thickness will be on the basis of how this stack stockpile at what rate the material is coming and then at what rate it is moving. Because that conveyor belt will be discharging onto the stacker and the stacker is taking at a particular meter cube per hour and at the same time it is moving at a particular linear velocity. So, that material which is there will be that is it is going on pouring like that.

So, what will be that layer by controlling the speed that layer thickness may be more. If it is moving at a very high speed the layer thickness will be less. And at the same time when it was only this base was formed and then what will be the volume of this extra layer? What will be the volume of the next layer? Now this length initially it will be determined by the angle of ripples of the material. So, this is where exactly you need to exercise.

One simple exercise here is express the area of the first triangle as a function of this velocity and the flow rate of the stacker. You try to do it. Then for maintaining the same thickness of layer what should be the traveling speed of the stacker for that area that is here for layer one, layer two, layer three you calculate it out. For a given boom length and determine the position of this slewable boom to stack maximum volume. So, this is an exercise you can do.

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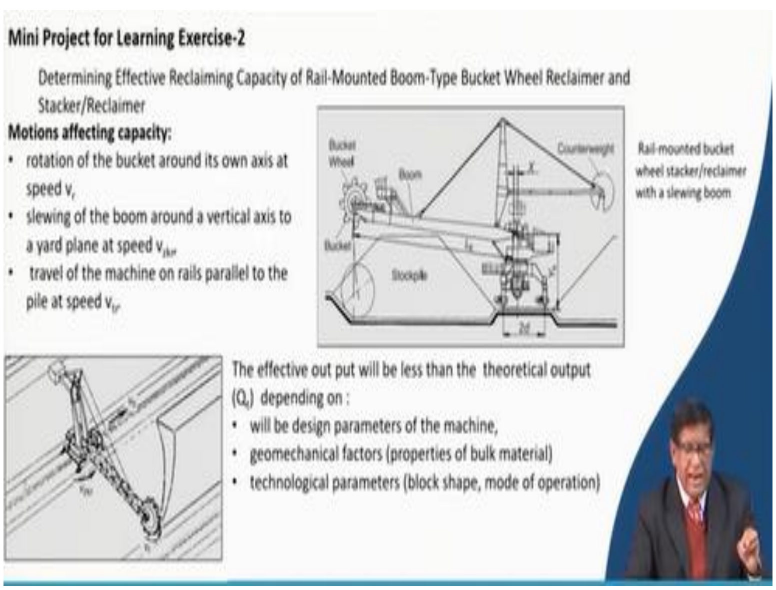

Also, you can think of if you are having a bucket wheel reclaimer that was a stacker. If you are doing a reclaiming at that time what is happening? Exactly from the stock pile when this bucket will be reclaiming it will be cutting. Now this is what depth it is cutting and how it will be exactly it is the wheel is rotating and at the same time it is slewing. Now this under the slewing and rotating positions how exactly the cutting is taking place.

This is another very interesting problem you can start investigating it that this because the effective output will be depending on those parameters. Normally a theoretically output of a bucket will reclaimer will be if you are having n number of buckets and if it is on a say particular diameter of the bucket is a 10 meter and then if there are eight or ten buckets are there then when it will be rotating set 30 rpm or 40 rpm at that time how many number of buckets will be exactly discharging per minute.

If you know the number of bucket the charging per minute and if you know the bucket size then you can find out what is that tons per hour will be coming by making the that is your multiply the density. You can find out on this or it will be giving you the meter cube per hour. So, but thing is that this theoretical capacity will not be achieved. Why? Because that bucket may not get properly filled in it. Why?

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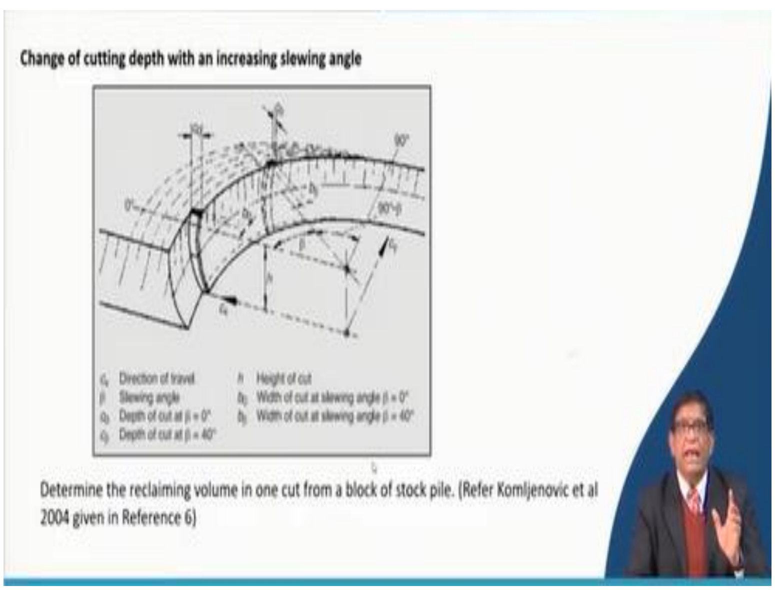

Because when it is rotating suppose this is your block which you are reclaiming with a bucket you can see here there is a thinning over there. The thickness of each layer will be going down that means when the bucket is filling over here more material is going into the bucket. When it is going over here less material will be going in the bucket. So, there is again a lot of geometry and mathematical formulations can be done over here.

So, I have just told you to develop your interest in this particular analysis so that you can take up a problem and you can define and you can do it over here.

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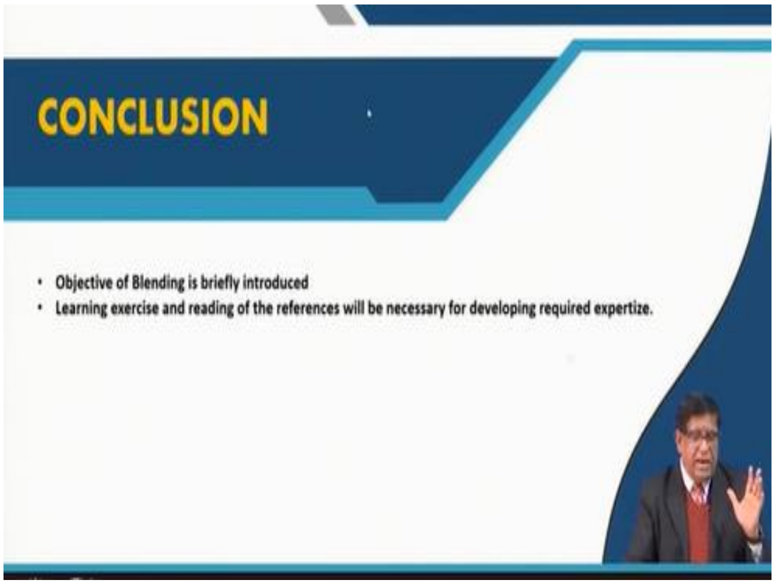

So, basically your objective of blending is briefly introduced to you and learning exercise and reading of the references will be necessary for developing the required exercise.

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So, you please see these references with these references and that the concepts which you have now got. It will help you to take this mini project or the learning exercise tool exercise I have given over here. Please go through this and try to work then only you will be developing an expertise on this field. Thank you.