Introduction to Mineral Processing
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Lecture – 02
Importance of Mineral Processing (Contd.)

Hello, welcome everybody to this which is second lecture of this course to Introduction to Mineral Processing. So, in the first lecture we have discussed that what are the definition, what are the definitions of minerals and ores, but our theme of this lectures these two lectures that title if you look at it is the importance of mineral processing.

So, this lecture I have tried to highlight some of the points of importance of this subject.

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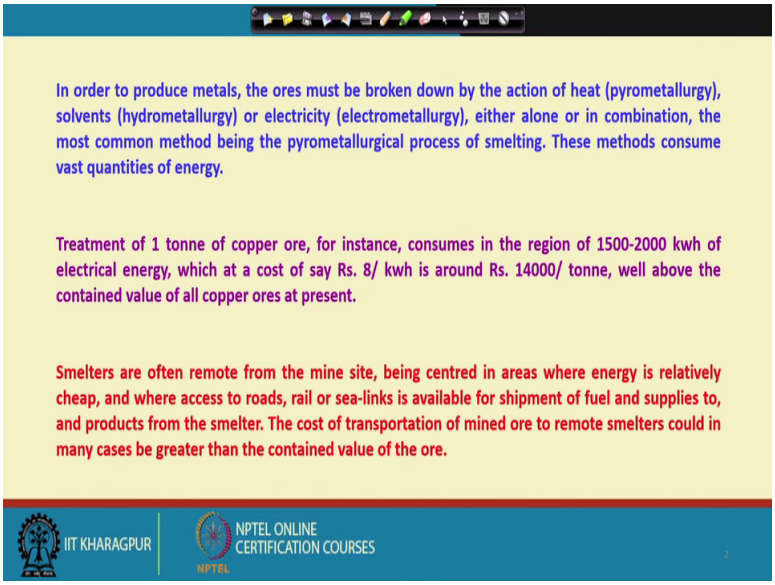

If you look at that is when you have mined an ore now how do you produce metals. So, the ores must be broken down by the action of heat that is you have to bring the contain metal into a molten stage and then even the gangue materials they have to be in the molten stage and then we have to have a separation and we can extract the metals out of that, but that is the subject of we call it pyrometallurgy. Similarly many times we use some solvents to extract my metals there is a subject of hydrometallurgy sometimes we use electricity that is or the electrical properties and that subject is called electrometallurgy. They may be use either alone or in combination, but the most common method being the pyrometallurgical process we call its smelting.

Now, as it is aparent or as it is easily understandable that these methods that is pyrometallurgy, hydrometallurgy and electrometallurgy they all consume vast quantities of energy. So, when the energy consumption is very high; that means, the process is very expensive. Now, imagine if I input cost that is in the form of energy to extract the metal is more than the metal cost itself then what will happen, I am at loss, so the business not going to become sustainable. For instance let us discuss this a rough idea about the energy consumptions I am trying to give it treatment of 1 ton of copper ore it consumes in the region of 1500 to 2000 kilowatt hour of electrical energy 1 ton of copper ore. If we assume that per unit cost of electricity is rupees 8 per kilowatt hour. So, this will be around rupees 14,000 per ton in terms of money will be spending.

Now, normally in any copper ore we get around 1 to 1.2 percent of copper. So, what will happen in that case that how much of copper I will be able to sell after extraction and what is the money I will be getting paid out of that that would be to less than 14,000 rupees. So, how to make this business profitable? That is what we can do we can concentrate this 1 percent of cooper and we can increase the relative percentage of this copper contained of that ore by selectively separating the gangue materials then my energy contained in an energy cost may be reduced.

I will discuss this at a later stage. And you also find that the smelters are very often they are basically located at a place where energy is cheap where you have got access to roads rail or ceilings for shipment of your material because the metallurgy is also they have been converted into a product and there has to be consumer. So, you have to transport those finished products.

And basically because of that what happens that is the cost of transportation from the remotely located mine sites to that extraction plant becomes very high and why do I transporting, you are not transporting only they all wanted material, but you are also transporting a huge quantity of unwanted material. And what happens?

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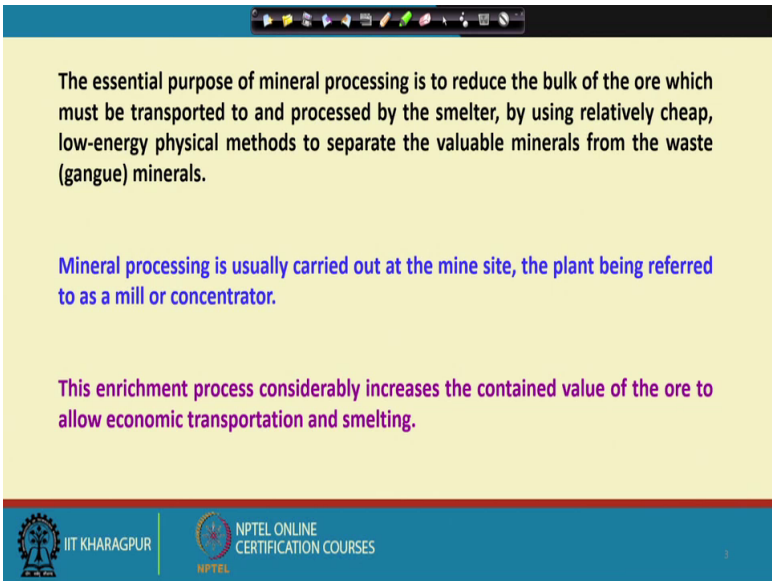

So, unnecessarily you are transporting the garbage from a remote place to a far distance where the smelting plant is located and as I said that where you have got good infrastructure; that means, you have got close to your urban areas. So, you are dumping that garbage from the remotely located mine site to the locality where it is thickly populated and that will create an ultimately you have to throw it out and it will also create the in environmental hazards and unnecessary spending that money. So, why to unnecessary spend so much money on transporting garbage.

So, the essential purpose of mineral processing is one of the purposes is to reduce the bulk of the ore which must be transported to and processed by the smelter. What does it mean? That means, if my copper ore whatever mind if it has got 1 percent copper; that means, you have got 99 percent of unwanted materials. Now if I convert it into 20 percent copper content, it becomes only eighty percent unwanted material. So, you are not only concentrating that copper ore the copper contained in the ore you are also reducing the bulk commodity which will save the transportation cost.

And what are the other implications or other relevance of mineral processing though when these processes are being carried out that is your separation process is being carried out at the mine site we say the plant is as a mile or concentrator and this engagement process considerably increases the contain value of the ore to allow economic transportation and

smelting. Just imagine you have got 1 percent copper only and you are putting it into a furnace for melting.

So, what will happen? Can really extract cooper having 1 percent copper contained in that ore into a smelter answer is possibly no, because everything has to be in molten stage how do you take out separately the your molten copper from the 99 percent of your gangue material. So, the metallurgist they have done all this research and they have come out with some specified limit that we cannot pour a copper ore having a minimum copper content into the furnace and it is solely because of the economics and also because of your the existing technologies.

So, it is the role of the mineral processing paternity to employ a cheap a relatively cheap low energy process, low energy consumption to consuming processes to separate the valuable minerals from the west otherwise what will happen we are adapting this mineral processing technique to reduce the cost of transportation of unwanted materials, but if my mineral processing cost itself is very energy intensive how does it help. So, it is a responsibility of the mineral processing engineers to perform this task in an economically viable manner.

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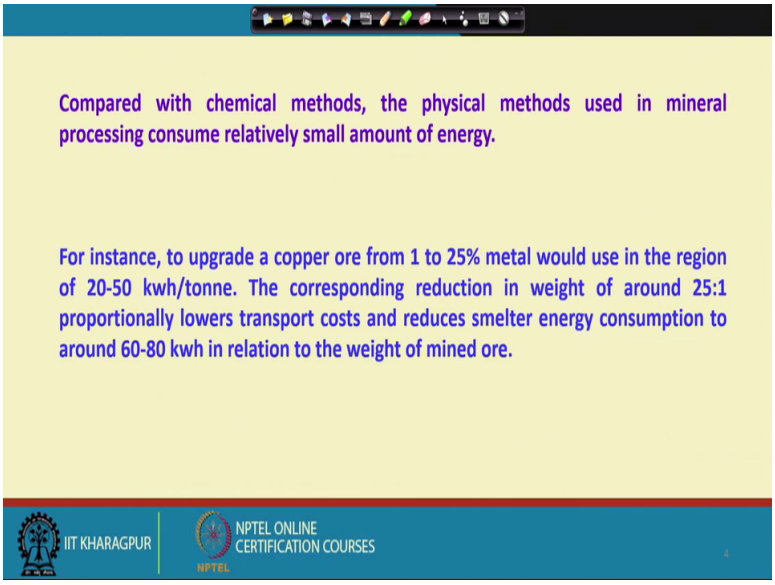

Now, why what sort of methods we use when I take an ore you have the property differences it may be physical it may be chemical property differences between your gangue materials that is the unwanted material minerals and your wanted mineral that is the ore which property should we exploit. If it is chemical property differences then we have to apply some chemical methods, and chemical methods means we have to use some chemicals to promote this

separation. So, the problem will come about recycling of these additional chemicals in harmal related issues and more of a cost that is economics.

So, what is the simplest mode of separation? They imagine if I have two particles that is your copper containing materials and you have got your gangue materials, if they have is density difference can we not exploit that to have a separation there could be differences in their hardness. So, when we break it the relatively softer material will be much more finer sizes and you are relatively harder material relatively coarse sizes then we can have a separation. If they have the differences in that color maybe the optical property based same said with some techniques we can think of, so these are all essentially dealing with the differences in the physical properties. So, essentially this minerals processing deals with mostly the separation based on these physical methods.

Now, what I was trying to talk about this reducing the bar in what you are transporting I will put some numbers like to upgrade a copper role from 1 to 25 percent metal would be use in the region of 20 to 50 kilowatt per ton of energy with the existing technologies focusing more on physical property differences. So, how much of material will be reducing for transportation purposes? The corresponding reduction in weight of around could be around 25 is to 1. So, that will reduce the transportation cost as well as it will reduce the smelter energy consumption to around 60 to 80 kilowatt hour in relation to the weight of mined ore.

So, you look at that I have to look at that and what is the input energy for this separation processes that is separation from gangue and the wanted materials, and how much of cost saving you will be having because of certain advantages like your reduction in the bulk commodity of your or transportation purposes your reduction in the energy consumption in the smelting processes. So, this is another importance of mineral processing.

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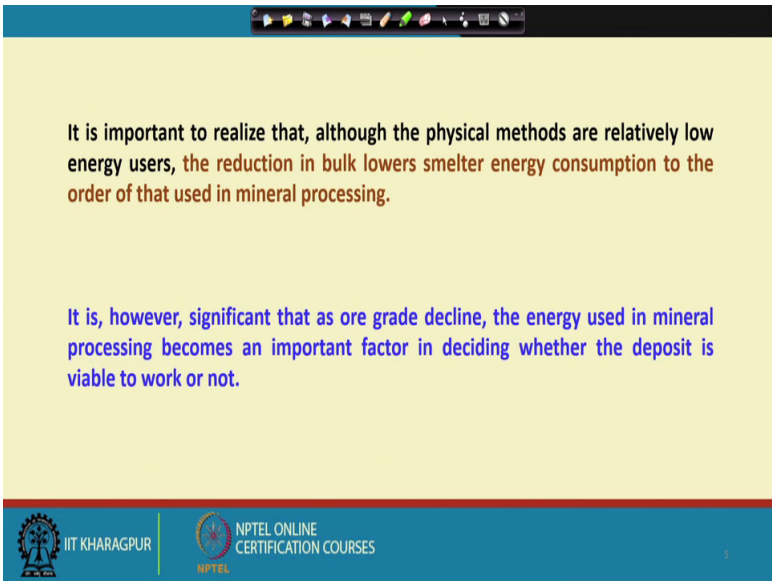

Now, above also look at when we adapt these mineral processing techniques that although the physical methods are relatively low energy uses the reduction in bulk lowers melted energy consumption to the order of that used in mineral processing. So, we have to do an energy balance. But what happens when the ore grade is declining and, so I say that what is the contain value of that and how much it depends on how much quantity of that metal or to the metal bearing minerals is there into that particular ore that will dictate the entire economics.

Now, if the ores are very low grade, low grade means metal contained is less, but I have got huge amount of unwanted materials. So, these energy used in mineral processing then becomes an important factor and that is why the many people are in research in the mineral processing area that is to innovate some low cost techniques for separating the wanted and unwanted materials for quality upgradation of the ore.

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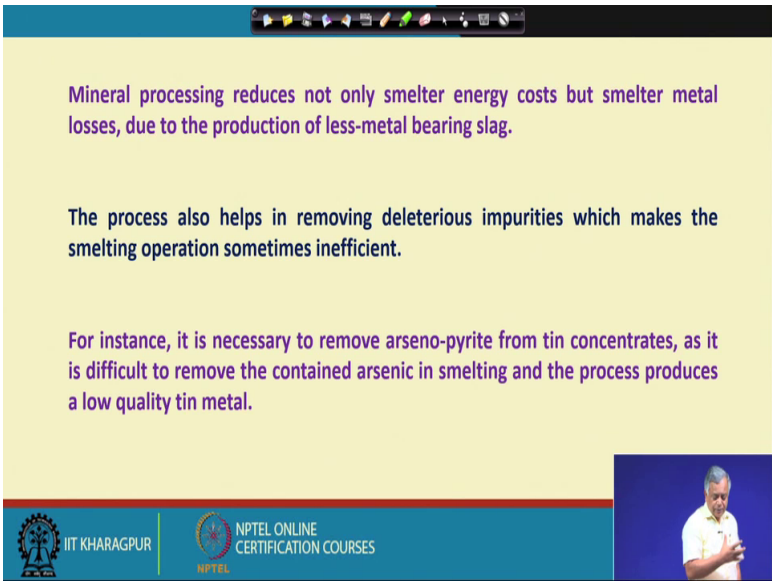

Mineral processing reduces not only smelter energy cost why I said that if I have only one percent copper bearing ore and if I am putting it into a furnace it is impossible to extract that copper from that because my gangue materials when they are in molten stage they will also carry certain amount of copper. So, I will be losing certain amount of copper, so what I am being left to it that will be even very less than what I had initially that it could be much much lesser than 1 percent.

So, there will be huge losses of my wanted material when the relative percentage of that metal into that ore is less during the smelter process, smelting operations also. So, when I am concentrating by the mineral processing operation he got basically reducing the losses of this valuable mineral in the smelting process itself there is also another benefit of having mineral processing operations.

Now, many times he may have good quality ore, sufficient quantities, but you may have some deleterious impurities which makes the entire smelting operation sometimes inefficient. Like the example that if you have arseno-pyrite in a tin concentrate that is your try to extract tin as said. Then what will happen. Now, it is very difficult to remove this arsenic in smelting process even if we have very less amount of arseno-pyrite and the entire process produces very low quality tin metal. So, ultimately what is happening? That although your tin ore qualifies to be a very good great, but because of some unnecessary deleterious material called arseno-pyrite the entire process becomes economically not viable.

Similarly, if you have alumina contained in your iron ore which is commonly the problem or with the Indian iron ores we will discuss more detail when we talk about I do not know beneficiation, but just for the your basic knowledge; now I am telling you that because of the if you have 4-5 percent alumina in your iron ore the entire process of converting this iron ore to molten metal because very difficult because the energy input energy cost suits up like anything. And metallurgist that is why they have put a restriction that we should not have alumina content more than this in my iron ore. So, who will remove that alumina, who will remove the arseno-pyrite we try through some physical property differences that is the mineral processing it is the responsibility of the mineral processes.

Why it is the responsibility of mineral process to separate that? Because it is the most economically viable route you try to find out that whether we can separate arseno-pyrite from my tin ore or whether I can separate alumina bearing material minerals from my iron ore in an economically viable manner.

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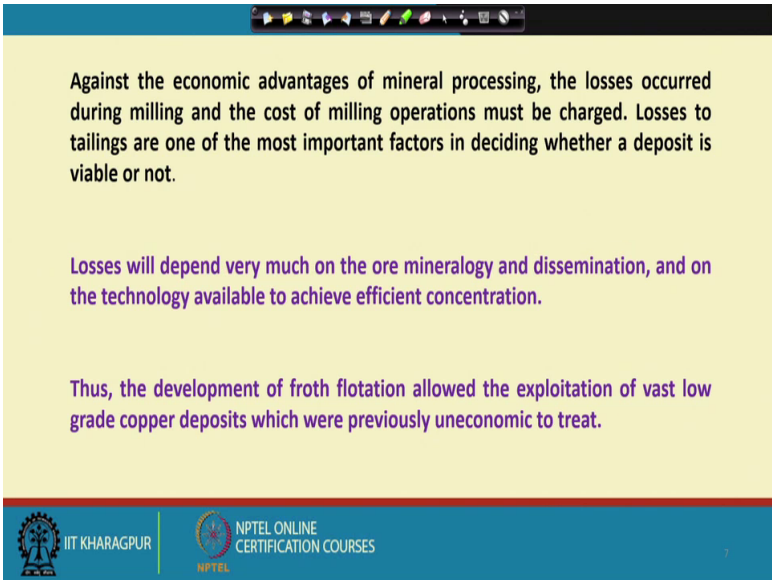

Now, even during the mineral processing operation you must be very careful that during this mineral processing operation when you are breaking them particles because as I said that first is the second step of any mineral processing operation is combination. That is the you have to break the material to free them from one another that is your gangue and your wanted material has to be end up to some extent in a free state to enable separation based on their

physical property differences, but that also consumes energy and there will be losses during this milling operation.

So, the losses to tailings are one of the most important factors in deciding whether a deposit is viable or not. What does it mean the tailing? Tailing means what we are throwing out in a mineral processing plant, we say that as of now this quantity of material does not have adequate amount of valuable minerals to extract the metals. So, we either dump it somewhere or we use it for some other applications.

So, does the tailing is free from your valuable mineral always know you will be losing some wanted material into the tailings also. So, that is also losses. How much you lose? That depend on the geological formation of that particular deposit; that means, what are the mineralogical behavior of that. How my wanted and unwanted materials they are basically oriented into that particular matrix one of the grain sizes individual grain sizes. So, the losses will depend very much on the ore mineralogy and dissemination and on the technology available to achieve efficient concentration. This is a very important point what is the availability of the technology.

We always try to evaluate an ore based on the existing processes; that means, I first try to see that one of the physical property differences and whether my existing processes they can handle it. So, that is the common job of a mineral processor, but many times we say that this ore cannot be upgraded. So, for example, like your chromite processing plants even in the tailing.

So, we are losing around 16 percent of CR 2 o 3 because I had a very fine size ranges because we say that with the existing technologies it is not economically viable to further upgrade it and that is where the research for new technology development is required. And this is a great example that how the innovation can change in the year 1900 a technique or a process called froth flotation technique was developed in Australia and it helped, this process itself helped to upgrade many ores as per the requirement specified by the quality requirement specified by the metallurgist through this process which were earlier used to be discarded because there is no technology available.

And friends, there is a very relatively new subject engineering subject and the importance of mineral processing will be much more held with the new innovations. So, with this basic knowledge during this course I think some of you will be motivated to put your mind in

developing new technologies in making some of our natural resources to be economically viable to qualify as an ore.

Thank you very much.