Bulk Material Transport and Handling Systems
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Lecture - 36
Coal Washery Equipment and Practices

Welcome back to our discussion. We have been discussing about this mineral processing plant equipment and there we have talked about different in the mineral handling operations. But I felt that this is also necessary to know coal washery and the coal washing equipment a bit some important point you should know. Because these many of the concentrating and your screening equipments which we have discussed they are also used in coal washing and coal handling plant. But still, this I am going to tell today about the coal washery equipment and their practices.

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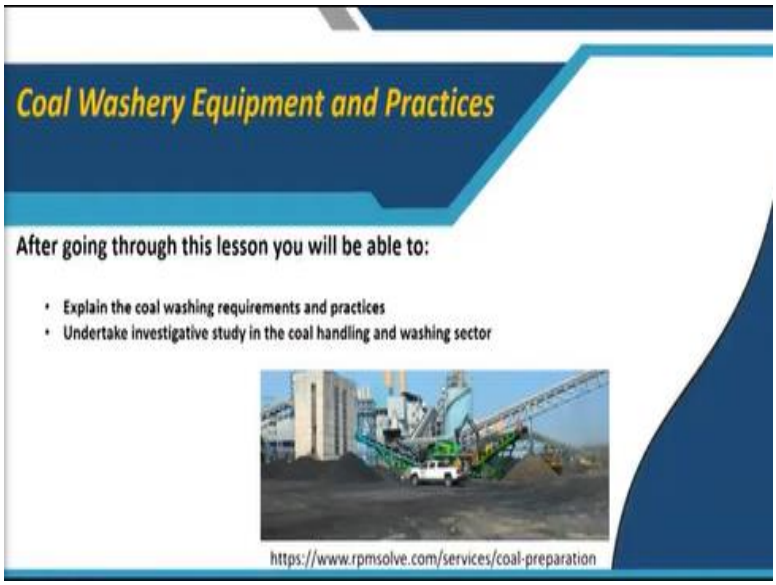

Because this is going to be a very important business in the coming years. You know that our all thermal power stations at present 64% of them are using coal. Now though there is an increasing interest and also the innovative technologies are coming up for alternative your renewable energy sector. But still the non-renewable energy, sources like coal is not going to be exhausted soon in India.

And for our economic power generation and economic power provision to the common people will have this coal as a cheaper source and for this reason, you cannot ignore coal at this stage.

At present we are producing more than 600 million ton of coal out of which a major quantity almost all more than 90% are going to the power sector. So, we need to improve this coal sector by cleaner technology. So, that the coal remain clean.

In the sense while burning in the boiler it should not produce large quantity of ash for re-handling which could be an environmental problem. At the same time in the boiler when it will be burnt not much greenhouse gases will have to be released to the atmosphere. So, in the coal utilization sector lot of handling operations will be there in near future. But still at present also the technology has quite a good amount of developments are seen in this sector.

So, I felt that you should be able to understand that what is happening in coal washing. How it is done? And then what type of investigative study you should take up? So, that in near future; you can play an important role in the country.

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So, here what are the problems associated with Indian run-off-mine coal. You know that in India though coal is available up to 1200 meter depth we are producing most of the coal less than 300 meter depth and more than 90% of this coal is coming from surface mine. Now we have the two problems here. One is the coal seam itself is having a poor quality of coal. That means because this coal is produced by the drift theory.

That what is called that as all the organic material brought and then deposited and under the pressures and temperature it got the qualification. So, in that process lot of inorganic substances are also impregnated with those coal seams. And that is why there is a high ash content of our coal. And also, when we are doing the surface mining, we do not do a very good amount of selective mining.

And at the coal floor or at the coal roof that is where in between these two layers of your sandstone or shelly sandstones where the coal is there when you are extracting by blasting. There is a lot of non-coal material get mixed up with coal and we say it is a dilution. When this takes place and then they are handled by our conventional equipment. Then coal which is stocked and then send it to the users have got lot of non-coal material which when burnt with coal come out as ash.

So, the coal ash distribution in the coal matrix in Indian coal is so interwoven that coal is essentially required to be crushed to small sizes for affecting liberation of coal and ash particles. So, before sending it to the boiler if you wish to clean the coal you will have to liberate the non-coal parts from the coal matrices in the coal block the piece of coal what you get. And for that when you remove that non-coal part it is called beneficiation which is a coal beneficiation.

Which is exactly it will be depending on what are those properties of that coal and then property of that ash material. Now in many places it becomes a big problem when near gravity material at the specific gravity of the cut is very high which means that at any specific gravity of cut there is quite good amount of misplacement of coal towards the sink. That when you separate it by say in a density separation (()) (06:44) method then in the reject part also coal will come.

And then in the coal part also some other particles will come. So, that is why there is a certain scientific investigation necessary for the specific coal seam and then how it is to be cleaned.

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Now that cleaning part of it is. Why that coal preparation is so important? That because if we do this liberate or separate this ash part that non-coal part then it will be doing this ash reduction which is a requirement from the environmental part of things. Because disposal of this ash is a problem and there lot of very fines get generated and it will create air pollution. So, that the particulate matter which will be going to the atmosphere is reduced.

And also, the ash handling in the power plant that is after burning from the cleaning your boiler and taking it out and separately dispose it in a place that problem gets solved. And moreover, sometimes in this beneficiating or washing process if inherently that coal is having sulphur. That sulphur also can be reduced. But it is a problem when sulphur is there in coal then it has got lot of other problem.

Because that the boiler life as well as this is in the washing and then it may if you are putting it in your metallurgical coal, it may totally affect the quality of your end product. So, and carbon emission reductions is also another issue by which when you are getting a high calorific value you get it properly burned and then the carbon dioxide productions can be controlled. There are other issues related to your greenhouse emission also can be reduced over here.

There are even the different gases which can be coming out of that stake can be also caught. Now, reduced transportation cost per unit of heat or per unit weight of coal. From the mines

when you are taking out this coal if you are taking say 100 ton of coal having 40% of ash then exactly your 40 kilos of coal for this turn off for that quantity transported much is if you can remove it those ash at your mine pit itself.

Then this transportation cost per unit amount of coal will be reduced or that is per unit cost you will be getting now more calorific value. That is the way you should think of. And to increase the heating value of the coal as you will be increasing the carbon percentage in the coal that calorific value will be more or you are going to upgrade the coal you can sell it at higher price. So, that is the heat value which is asked by when you are selling the power producer.

That how much exactly kilowatt they will be producing by burning? How much amount of coal? These specifications you can maintain. Because in the natural coal seam there will be variations of your constituents that is your carbon content or ash content. But when you are washing you are more or less getting a uniform quantity of that carbon or ash you guarantee it. And then you can claim the price for it.

So, that the; situation that you are not supplying the committed one and getting subjected to penalty will not be coming in. So, that is why this coal preparation is necessary. Now the efficiency of coal preparation plant has a major impact on the profitability of the mining operations. That is why all coal mining people they do think that how the best quality can be given to the thermal power stations for this.

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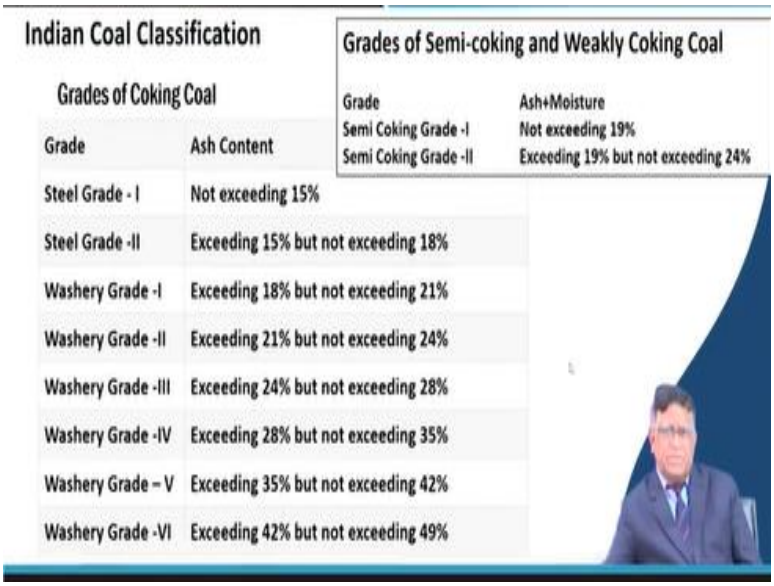

Now coming to this you must know about that what is the scenario of our Indian coal? How they are classified? You know that we have got a metallurgical coal that is called your coking coal and another is your non-coking or thermal coal. Now this coking coal they are depending on the percent of ash we are telling that steel grade 1 not exceeding 15% of your ash content. Similarly, that grade 1 to 6 grades are there where that is more than 42%.

That is 42 to 49% that is a very poor quality of grade steel. In your steel grade you have got these two and then in the washery grade that is you can wash it over there. This is the grading system of coal up to the different percentage it was done. But recently there have been certain changes also in this. So, you can see that the semi-coking grade has also come that is both ash and moisture together. If they are not exceeding 19% then it is called your semi-coking grade.

And if the ash and moisture together their percentage is between 19% and not exceeding 24%, they are called semi-coking grade. Now why this grading is done? Because on the basis that in our Indian coal pricing were done. But in this lot of thoughts are also now going on that exactly how coal should be priced and then how the grade should be determined. A national level standard that the; basis on which these grades were determined.

That standardization is still people are doing research on these things. But this is an accepted norm at present.

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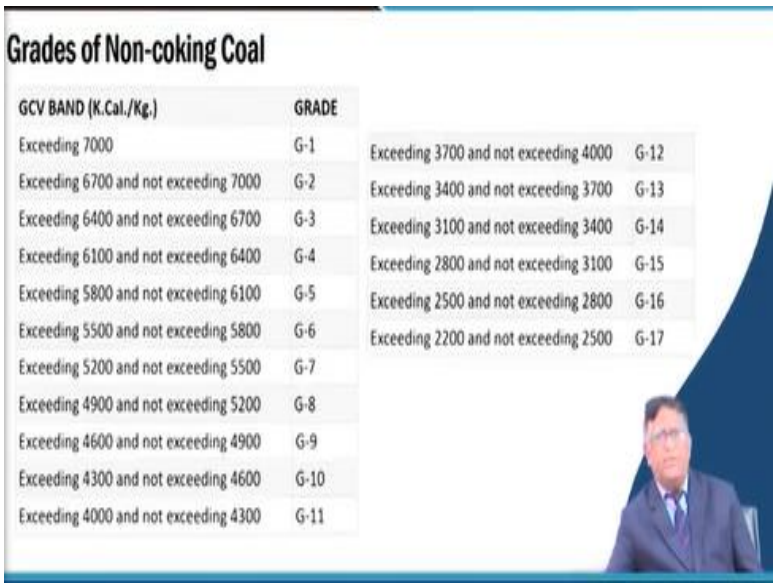

And then now for all this thermal grade or this non-coking coal their grading is given up to 17 grades. And this grade is given on the basis of the calorific value that is how much kilo calorie per kg is there. Now if you are getting more than about 7000 kilo calorie per kg then it is a grade 1. In India there are very few mines where this grade 1 coal is available. Somewhere there in the northeast coal field some places it was there up to 7500.

However, they had the problem of ash content. But this G 4, G 5 are to certain extents they are available in (()) (14:21) coal field. In Bharat coking coal field also it was there. But most of the coal in our country they are going to be in the G 11, G 12 and mostly big companies producing a lot of coal say for example Mahanadi coal field they are having more mines with G 9 to G 13. That means that if you are getting a 3500 kilo calorie per kg is a very good expectation.

So, there are many places in India where you are burning a coal you get only just somehow near to the 2500 kilo calorie per kg. So, those are G 17 type of coal. And then accordingly the prices are fixed for this coal. So, this you should have a knowledge of it.

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But the impact of what could be there? When your pricing will be on the basis of this grade their impact is the mine can think of how they can optimize their mining operations. That how they will be handling the coal produced. So, if they are seam, they have got a different quality, different calorific. And if they can improve that a certain amount from if they have got say about G 5 quality if by cleaning it if they can bring it to G 2 then if they are having some as a G 10 or G 12.

Combining that together if they can make it as a G 5 then their economics will be there. So, a case-to-case basis an economic study is carried out. That means if they want to invest in terms of a washery and by that exactly how much return they may get because how much blending will be possible. So, there are lot of decision-making problem can be there. So, that side whether you will be investing your money in washery or not can be decided on the basis of lot of this.

Your mathematical model can be created on the economics of the coal washing. So, the government of India has taken number of initiatives exactly the need came from the impositions given from the environment sector. That means if you are selling coal with a very high ash content then it should not be carried to a longer distance. That is why if you are making power plants which are located more than 1000 kilometre.

Then there were a restriction that you should not have at least more than 35% of ash. Because then you are exactly wasting per ton of coal transportation you will be spending more fare. And moreover, that you are carrying out the pollutant from one place to another place. So, that is also certain restriction share there. Now power plants located critically polluted areas, urban areas and ecologically sensitive areas there also there are restrictions.

That your thermal power stations if they are going in such an area, they must use a beneficiated coal. So, that they produce very less amount of ash to be disposed of. Now if there are also in the burning technology there has been a lot of development that is your fluidized based combustion, your air dense fluidized based combustion different type of combustion systems by which that exactly you can get better calorific value of the coal. So, those considering that washing demand that is created.

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So, now how exactly this washing is done? This washing is done by two methods. One is called your dry deshaling or by wet process. Now in dry deshaling that is exactly other than water you can use by air and with that you will be able to separate it. That is a dry washing system. And in the wet process as already we have discussed in our mineral beneficiation here instead of the mineral the coal is also crushed into smaller size.

And put in a liquid media of adjustable specific gravity to separate the lighter coal. That media which when you will be increasing the gravity by adding certain particles that media will become heavier so, that the coal can float. And the rejects from this process that is they will be having lot of carbonaceous matter. So, in a wet process when you are producing this coal that washed coal that the reject which takes the tailings we say.

It will be going through the tailing, tailing 1 there lot of this carbonaceous particle will be there. And we discussed earlier also how very fine particles of coal which is lying over there how to recover it? How to use that the calorific value in that? That is also an area where future research and technology need to be developed.

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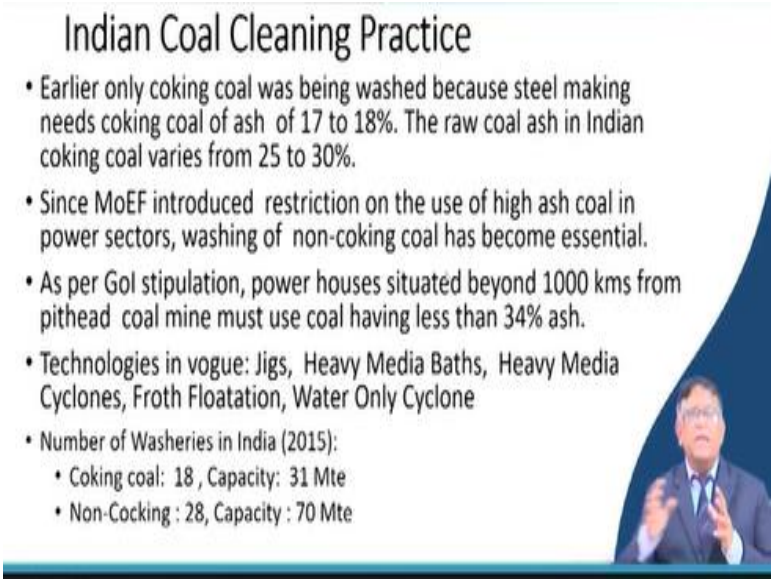

So, in our Indian coal cleaning practice earlier only coking coal was being washed because steel making needs coking coal of ash up to 17 to 18% in India. Now the raw coal that is whenever the coal is coming from the mines they are washed. And then the ash content in most of this our coking coal coming from BCCL there are 25 to 30% ash. So, they have to be washed. And that is why the coal washery was established in India after the coal mine nationalization.

And some of the very old coal washing plants like that in Sudamdih (()) (21:18) and all these mines it was running. Now since this ministry of environment and forest introduced restriction on the use of high ash coal in power sectors. Washing of non-coking coal has also become

essential. It is a comparatively recent phenomenon. And according to this government rules that is any powerhouse any thermal power station situated beyond 1000 kilometre from the pithead coal mine must use coal having less than 34% of ash.

So, that created a new business. That means the mines will have to build up their washer. Now there are many technologies are there like your jigs, heavy media baths, heavy media cyclones, froth floatation, water only cyclone. These are the equipment which we have discussed earlier. These can be used also for our coal washing and the number of coal washeries are there in India. In coking coal sector there are 18 washeries which can do, up to 731 million ton of coal can be washed over there.

In the non-coking coal sector, there are about 28 washeries totalling about 70 million ton they wash per year. So, this is an interesting and this gave a lot of industrial activities and that construction of washery. And because of this that some of the mines they did not have the properly planned washery at the beginning. When a new washery came the transportation route from the mines to the washery had to be changed.

And because of that some places like Dipka and all they got the washery after that the coal transportation route got changed. And they get the different type of environmental problem in their townships and colony. So, this is another aspect of this business.

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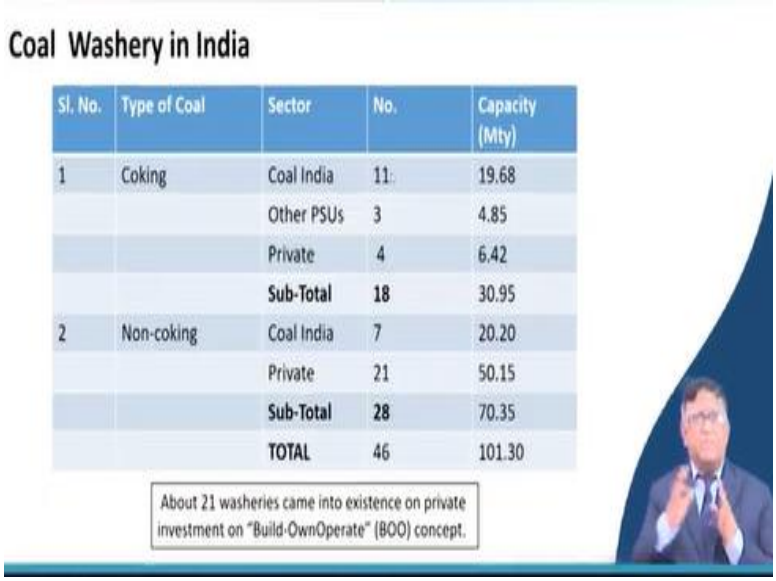

But you can see here that in coking coal sector coal India alone has got 11 number of this washery. And other public sector units they have got also three washeries. And in private they also because some of the coal which are the private companies, they import from outside but as per the requirement of the steel plant they need to wash them. That is why they also built washeries like that in the coking coal sector these 18 washeries came up.

And then in the non-coking coal sector coal India had 7 and the private sector they have come up. There are 21 washeries were created in number of mines distributed different subsidiary. And like that in total our Indian coal washing capability about 101.30 million ton right now. As I said that that means our coal consumptions in the country is more than 750 million ton by now. And in another 3, 4 years we are thinking of 1 billion ton of coal will be exactly consumed in India.

In these coal if a certain amount is to be washed that means there is a big business line. So, our public and private investment that is which came up and under that number of Indian firm they started constructing this washeries.

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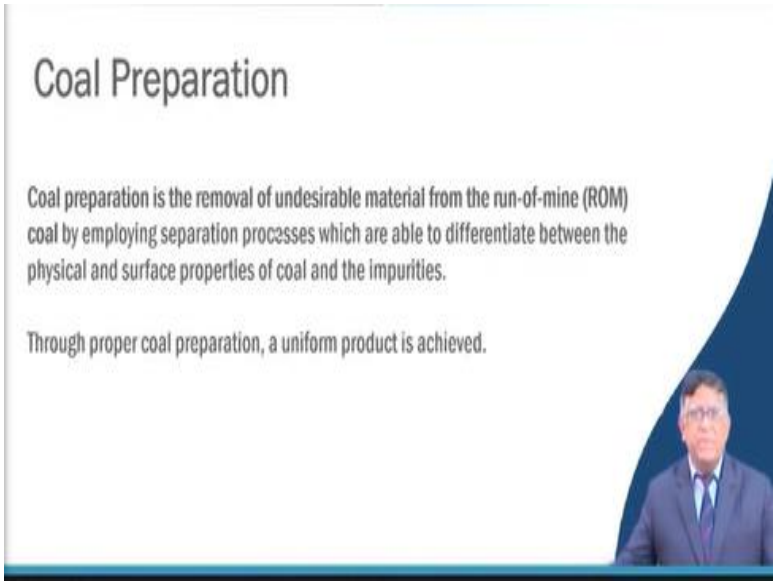

Now in a coal preparation is the removal of undesirable material that is whichever, is not wanted means non-coal part in the coal they will have to be separated from the ROM run-of-mine. Then coal what will you do the separation processes which you have already studied. Those processes will have to do it and then as I said to give the uniform product.

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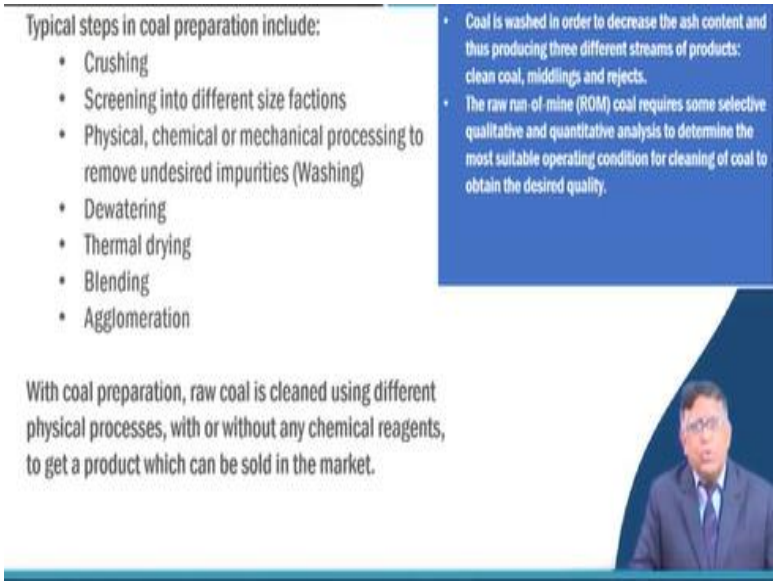

Now what are the steps? You can note it down that our steps in coal preparation include your crushing. That crushing is the first job you will have to do it. And then there is a coal preparation if this process starts with this crushing or combination job that is your freshly mined coal will be crushed into pieces by different type of crushers. They will no need of having a big jaw crusher or gyratory crusher. Coal of softer one may be crushed by rotary coal breaker.

And there are different type of coal breakers are available. Now this washing is actually the process of separation of this non-coal material and for cleaning this coal represents the most important step of this coal washing. That washing part is the most that is the core part of it. And for that we will have to decrease it. Then after that that is basically it is a screening. The different size fractions will have to be screened.

And then the physical, chemical and mechanical processings are done. That is here physically that means you by density chemically sometimes because of your content then constituent species and by mechanically you are just by (()) (27:11) stirring, spiralling those operations you will be separating it out. Now once you have done that by wet process then you will have to dewater it. And then after dewatering sometimes you need to dry also it by thermal drying.

And then different grade of quality can be blended also and sometimes they may be agglomerated depending on that from the very finest coal recovered from the tailings if you can agglomerate for purposes to make it a small briquette that is also done in typical coal handling plant. With coal preparation raw coal is cleansed using different physical processes with or without any chemical reagents to get the product which can be sold in the market. So, that is how it is done.

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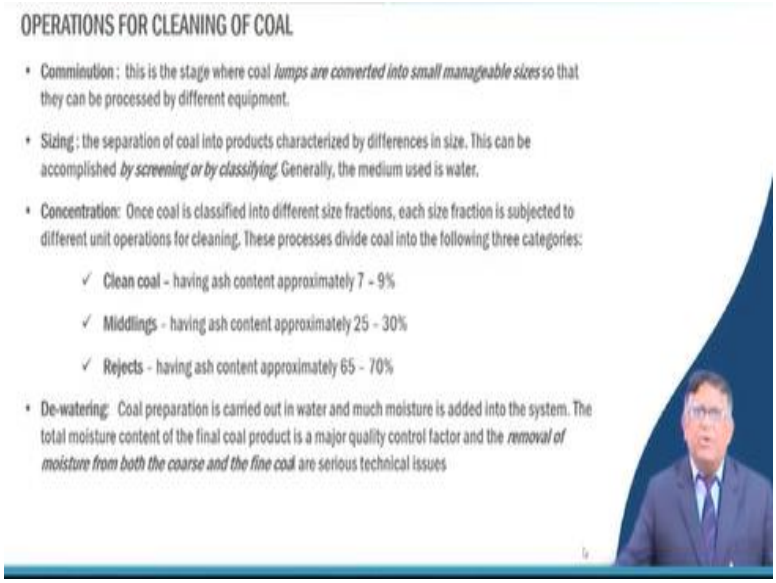

Now the operations for cleaning the coal it requires then summarily we can tell it that comminution then sizing, then concentration then your clean coal means may be having different grade. A clean coal means with a 7 to 9% only ash. Then there could be middling with 25 to 30% of ash. And there will be reject if there is 65 to 70% of ash is there you are rejecting. And then dewatering is another job where coal preparation is carried out in water.

And much moisture is added into the system. So, that is how you will be dewatering and drying. That is also a part of this washing process.

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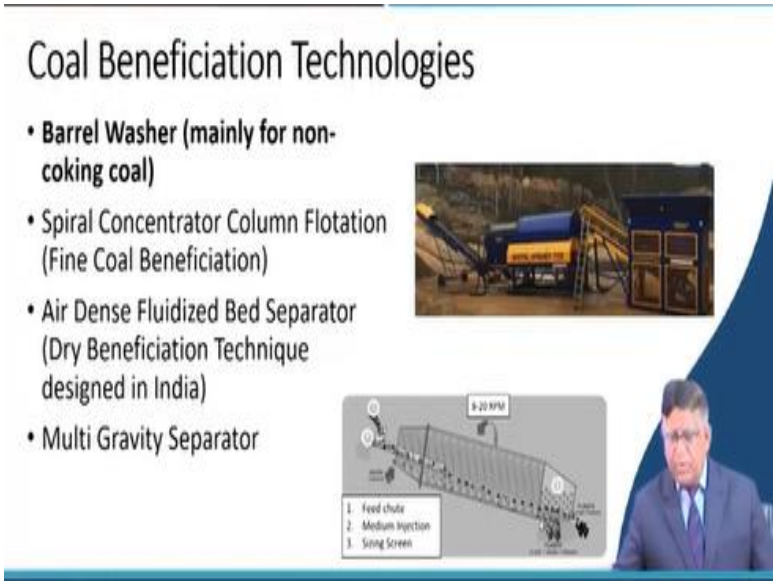

And for that there are a number of different equipments are available. Already different type of concentrators and all we have discussed. Now that a barrel washer which is a type of washer which is used even, they are used in when you are doing that in the river stones when you collect. That in civil engineering purposes when you are doing the river sand and stone mining then they come with lot of your soil dirt or sanded particles.

Then they are exactly fed into in this type of your barrel washer. Exactly there is a one this side through a hopper it will be fed into it. And then when this feed material is coming through a chute inside this one. And then they will be giving a media which can be your water media is coming. Spiralling things are there and there your screen part is there. You keep on rotating then that lighter particle that will be that your smaller things will get separated out.

Larger washed stones will be collected over here. This is the way how barrel washers they do. And in coal when we do with this your coal and that part can be separated it out.

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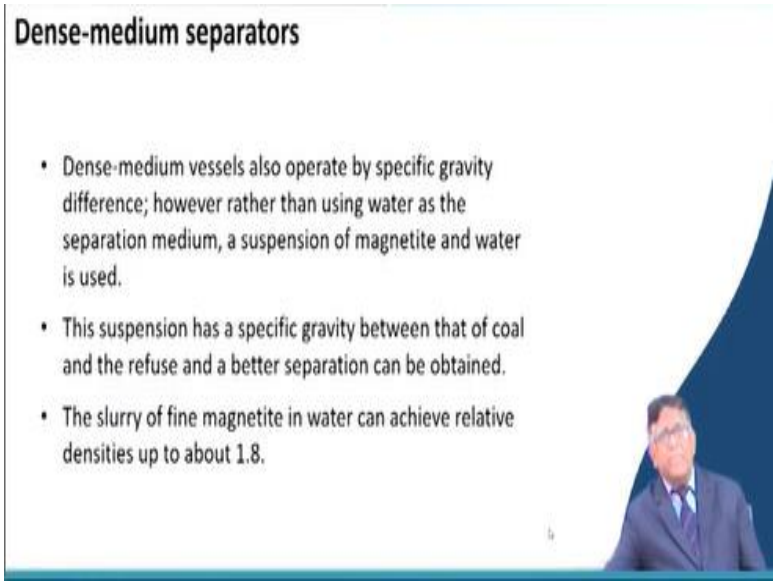

So, there are the dense media separations in which exactly we have discussed it earlier where your high specific gravity material is mixed with it. So, many at times they give magnetite and water and by that when they are moving in that the coal particle it becomes now lighter than the media. And that they come up and from the top it is separated it out. So, that is a dense media separation they use.

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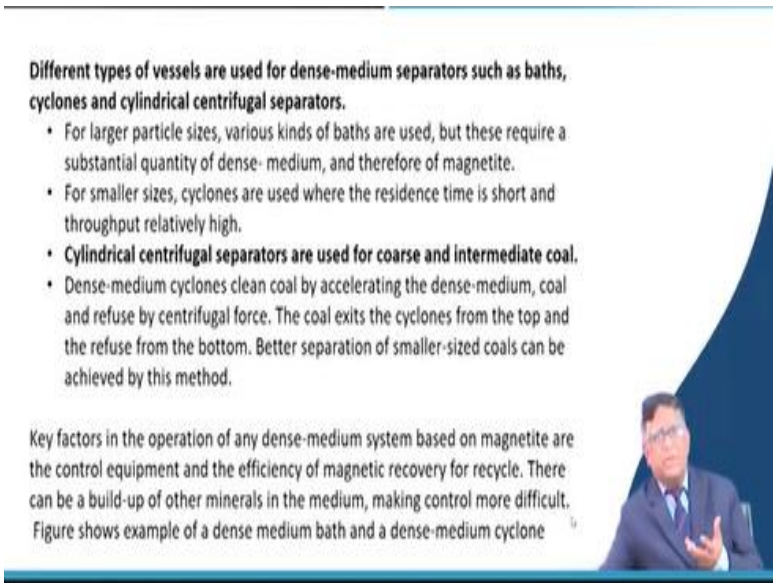

So, for this dense media separation there are different types of baths, cyclones and then centrifugal operations are used. Earlier we have discussed about that how these different cyclones water only cyclones or these medium baths can be used for this.

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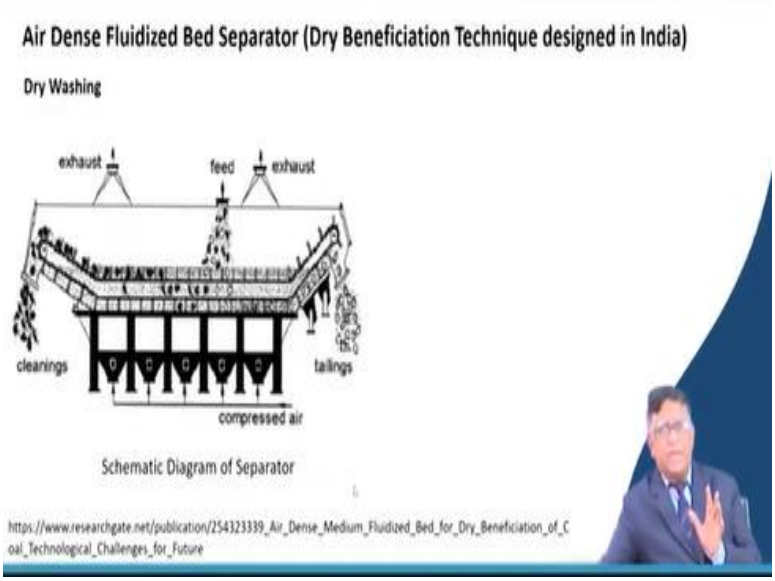

But another thing when we say about the dry washing, dry washing is an air dense fluidized bed separator. Now in this there is no water is used but your air is pumped and your conveyor belt you can see this is a scrapping system a chain conveyor is running over here it is a scraper. And then your holes are here and then when material is fed the mixed material and then there is air compressed air is passed into it. So, it gives a jerking to this material.

And by that smaller particles and that lighter particle they come over here that are heavier particles they come into this which is scrapped by this skipper chain conveyor. And they are rejected to go to the tailings and that the lighter and is your useful part which is floated over this air vents. They will be separating as a clearing. So, this type of heavy that is your air dense fluidized bed or that dry deshaling is also carried out.

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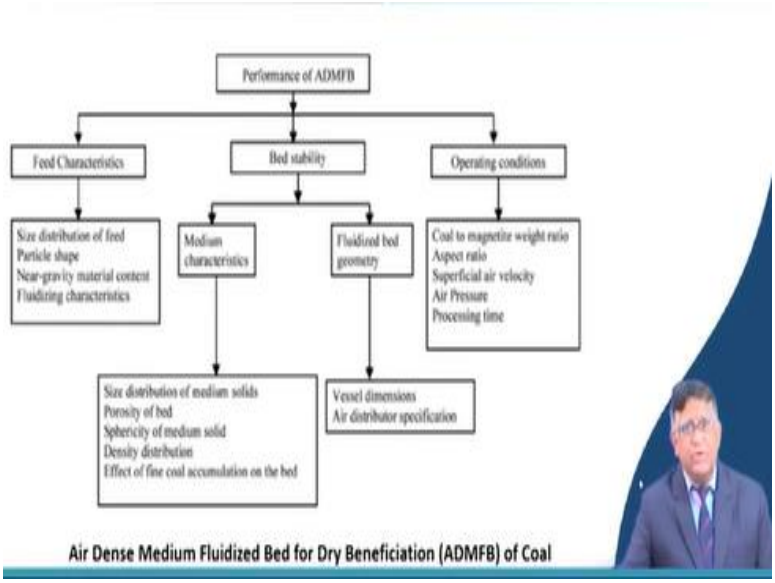

Now when they do this dry beneficiation process there are a number of parameters they exactly affect. So, that the; performance can be based on the feed characteristics. What is the feed quality pool quality? Then the bed stability. How the medium and the characteristics that is with air how they do it? And the fluidized bed geometry in what way they are exactly arranged for floating then operating conditions that whether if you are using coal and magnetite if the ratio.

And then how much is your superficial air velocity? How much is coming? How much air pressure? How much your processing time it require? Those things will be affecting in which way the separation of the non-coal material takes place. So, that vessel on which it is there their geometric dimensions and then geometric dimension will determine how the air will be circulating over there. So, again your size distribution of the particles how you have crushed.

What is the total bed porosity is how much? How compact the material is becoming? All there are different variety of factors affected.

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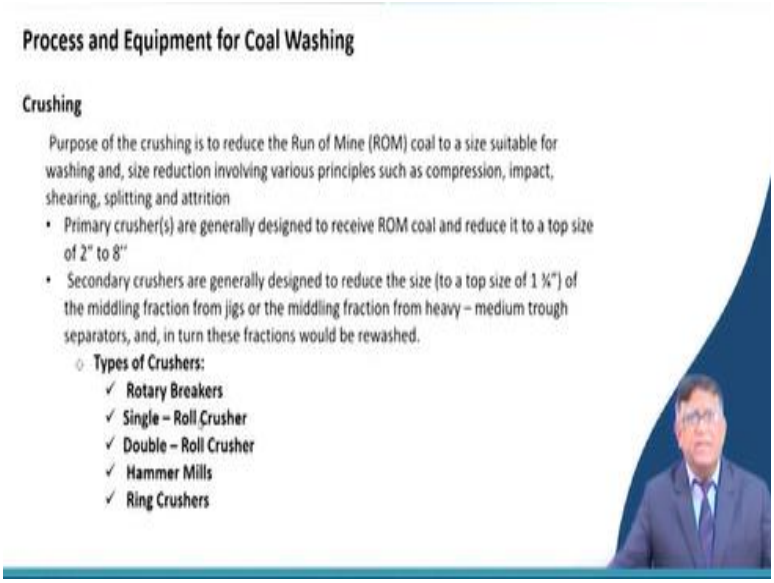

So, when you want to do a study deep study in this you will have to roll into it. And then you may just try to find out that while you are doing this job of crushing other than what is the difference of an iron ore crusher or a rice powder making crusher or a coal crusher, there will be difference. You can make a comparative study. But the types of crushers which are used for coal are rotary breakers.

There are roll crushers there are double roll crushers, hammer mill and ring crushers. These are the different type of crusher they use.

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And then the screening, as you have seen in other screens here also you have got the scalping screen or you can have different type of the coal screening system depending on what type of size of material exactly is being demanded. But the most thing comes when there is this desliming we have discussed about that the desliming operations. There very fine screenings are necessary.

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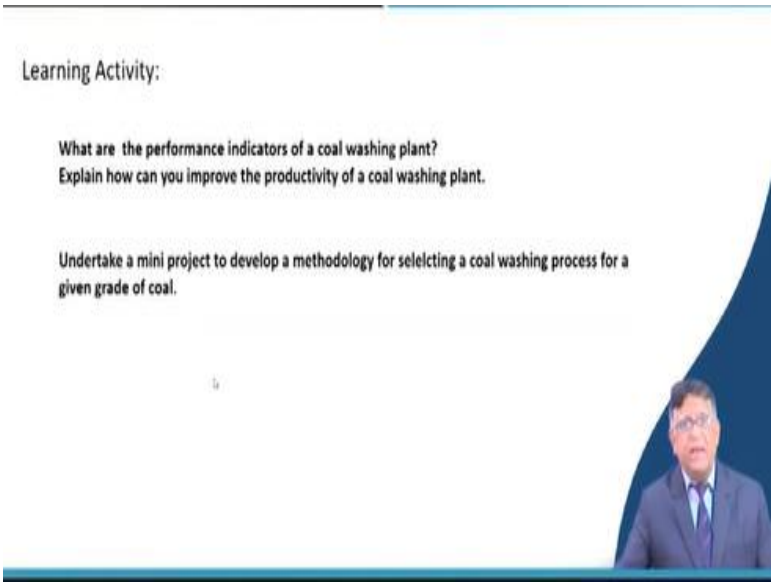

And then once you know about that these are the things in the washery now I hope that you will be able to do some of your study. Particularly what are the performance indicators for a coal washing plant? And then that whether the energy consumption whether the total maintenance are required. How the manpower required? What is the operating cost? What is that exactly the capital cost required over there? What are the recurring cost coming over there?

What type of overheads will have to be keeping? So, that a cost benefit analysis can be made for a performance indicator. So, explain how you can improve the productivity of a coal washing plant. So, that coal washing plant they have got enough objective that what is their productivity? Exactly what amount they want to do of what quality? And without exactly giving any environmental load or their environmental footprint.

So, if you want to explain these things you will have to study the flowchart of a particular coal washeries washing and then each and every item you will have to prepare a questionnaire. Then

you will have to collect the data and then it will give you an idea that how you can improve the productivity of this. Now, again another thing is you can take a mini project that to develop a methodology for selecting a coal washery.

So, now you know there are different types of coal and there is a different purpose for your utilization. For a particular purpose if you are given a particular value of coal then exactly what should be the best washing technology to what you will have to do it? So, that is lot of research and very high studies are carried out in that. But to get a touch of it you can do develop a table for different type of systems and methods, their utilizations. Make an interactive questionnaire.

You can design a simple graphical user interface. So, that the questions will be coming and then you link it with your original information database. And from that you give a decision just like a simple decision to exercise you can do it by yourself for. So, that you can apply whatever the; knowledge you are acquiring for coal washing.

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So, you are advised to study some of the book like this coal handbook. If you are there in your library may have this or that there are a number of mineral processing and coal washing books. And internet you may find number of very good and relevant articles, go to it. And then to start with you can do only a Wikipedia search. From there your basic general knowledge for carrying out serious studies you may find it. Thank you very much.

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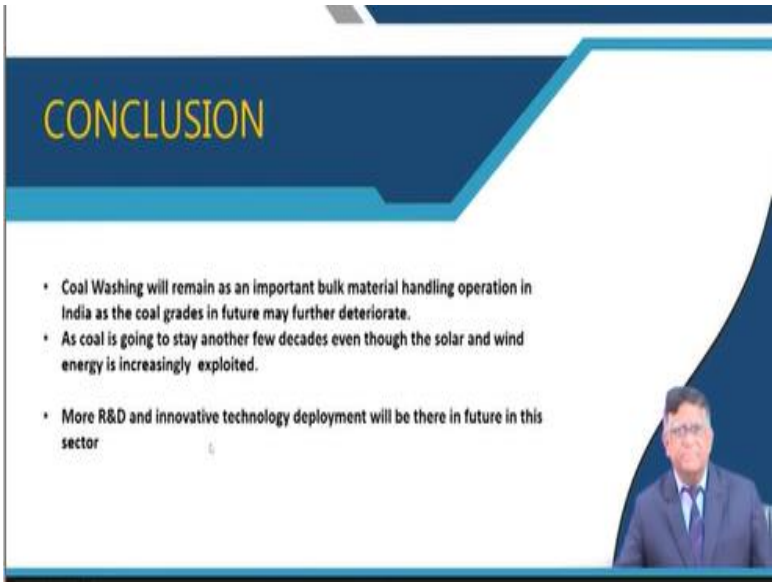

You can do this by coal washing will remain as an important bulk material handling operation in India as coal grades in future may further deteriorate. As coal is going to stay another few decades even though the; solar and wind energy is increasingly exploited. More R and D and innovative technology deployment will be there in future in this sector. So, you should aim at developing your competency to serve this sector. Thank you very much.