Power Plant Engineering
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Lecture - 09
Coal Handling

Hello, I welcome you all in this course on Power Plant Engineering. Last lecture, we discussed about the Properties of the Coal and in this lecture, we will discuss about the Coal Handling.

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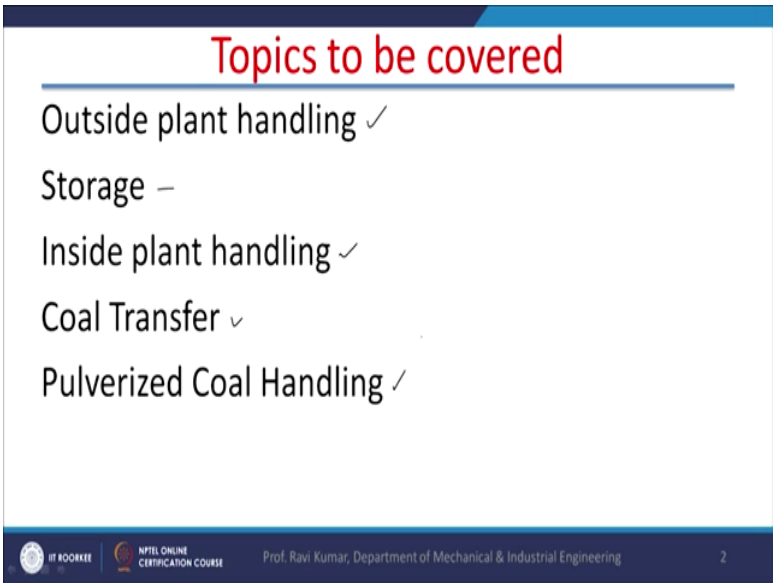

Now, topics to be covered in today's lecture are Outside plant handling of the coal, storage of coal inside the plant, inside plant handling of the coal, coal transfer from one place to other from the coal mines to the power plant side and Pulverized coal handling. So, these topics we will be covering in today's lecture.

In a thermal power plant, bulk of the coal has to be used. I will give you an idea.

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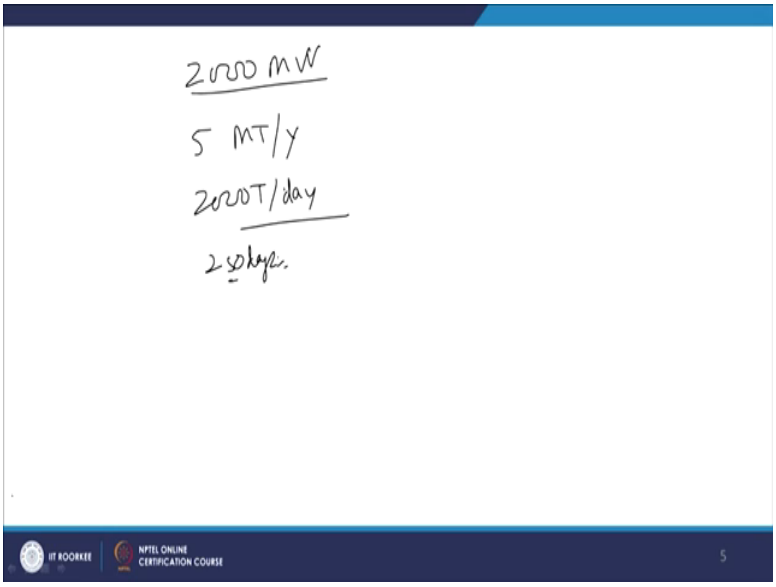

For example 2000 megawatt plant, it is a I mean quite large size of the plant approximately 5 million ton coal has to be consumed per year. 5 million tons means approximately 2000 tons per day on the basis of 250 days, right. So, quite large amount of coal has to be handled. So, this coal has to be brought from coal mines to the plant site, right and from plant site and it has to be stored because we cannot work in a thermal power plant with zero inventory. Some inventory has to be maintained, right and normally this inventory is recommended to be the 10 percent of the coal consumption. So, we should always have 10 percent of the coal reserve 10 percent of the yearly coal reserve.

And then coal handling inside the plant well I mean from coal yard to the furnace right that is another type of coal handling. So, first of all we will start with outside plant coal handling; outside plant coal handling.

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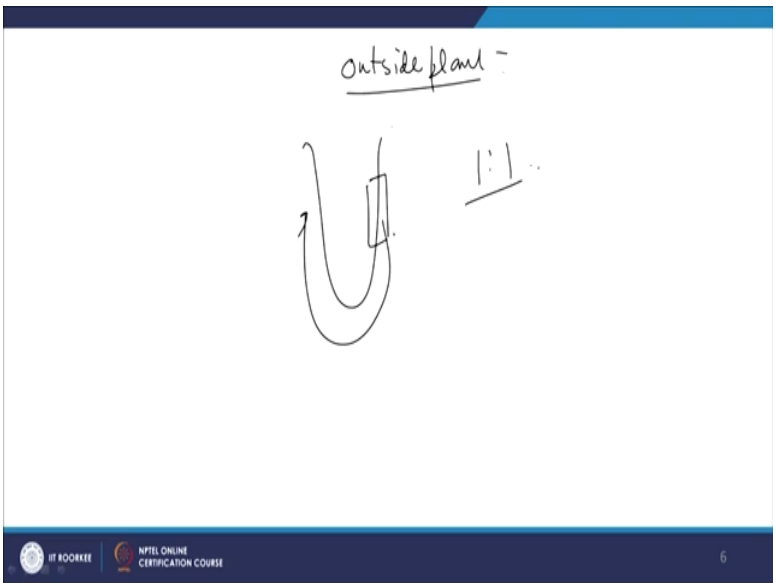

Now, in Outside plant coal handling coal has to be transported in India. You must have seen the coal is being transported by the rail road by railways and wagons of the coals are being transported from one place to another place, right and coal is a high bulk low cost material. If you commercial value if you look at the coals commercial value, it is the high bulk low cost material. So, road transportation is not viable.

You must have rarely seen transportation of coal for especially long distance transportation by trucks. It is normally by trains or rails or sea transportation is also been explored because India is it is surrounded by the sea. So, one side if the coal is west is normally available on the

eastern side of the India. So, from where from eastern side to western side transportation by sea is also, so sea transportation is also possible for the coal.

And coal transportation by pipeline, this is a new technique; the coal transportation from one point to another point by through pipeline. Now for pipeline transportation a slurry has to be prepared. So, before transportation through a pipeline, slurry coal water slurry is prepared and in that slurry the ratio of coal and water is 1 is to 1. So, 1 is to 1 ratio slurry is prepared and this slurry is pumped from one place to another place.

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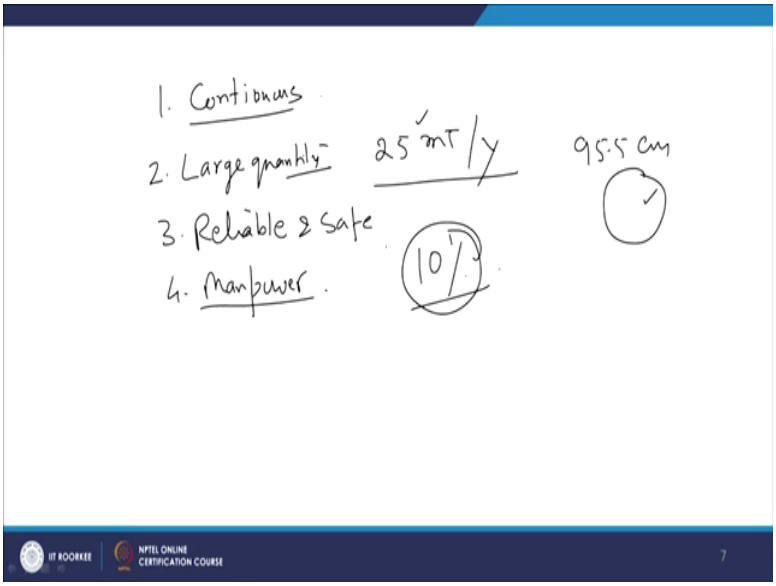

Now the advantage of this type of system is first of all, the transportation is continuous. There is a continuous supply of the coal right and the supply is unaffected by the weather or the climate because if pipeline is closed, so the coal is unaffected by weathering or any change in the climate.

Large quantity of the coal can be transported approximately two 25 million tons per year. This has been achieved by a pi meter 5 diameter of 95.5 centimeter let us say 1 meter diameter pipe, right. If we are using 1 meter diameter pipe, this much quantity can be transported from one place to another place. This transportation by pipeline is reliable and safe because theft is not possible; I mean theft is not possible.

So, it is reliable and safe. Moving parts are not there only, there is a pumping house. In pumping house you need a pumping station and the booster station that is it, right. If the terrain is difficult, in that terrain also you can adjust the pipeline. The terrain we are you can transport coal by train or coal by sea or coal by road; even there through pipelining the coal can be supplied ok. So, that is the benefit. Low manpower, not much manpower is required and maintenance charges are also lower. So, there are many benefits of transportation of coal by the pipeline, but there are certain disadvantages also.

For example, you need a lot of water. If 1000 kg of coal has to be transported, 1000 kg of water will also be required to prepared, the slurry and slurry has to be prepared. So, first the coal has to be crushed right, slurry has to be prepared. So, this preprocessing is required for the transportation by a pipeline and second thing is cost is high I mean you if you want to transport coal through pipeline from one place to another place, a pipeline has to be laid right. So, initial cost is high and then pumping station and then booster station are required, but once this infrastructure is in place, then running cost is not very high, running cost is minimal.

And the and another disadvantage of this transportation of pipeline is because the coal is transported in form of slurry, so consumer should be so because after reaching at the destination the water will be removed, but 100 percent removal is not possible or it is not done, it is not cost effective. So, it is recommended that 10 percent of the moisture will also remain in the coal. So, consumer should be able to accept I mean those whom you are supplying the coal or the slurry, it should be it should be ready to accept coal by 10 percent moisture, maximum 10 percent moisture. It may be less than that also. So, these are certain disadvantages also, but this pipeline type of system is quite cost effective.

Now, this system is divided in three sub systems.

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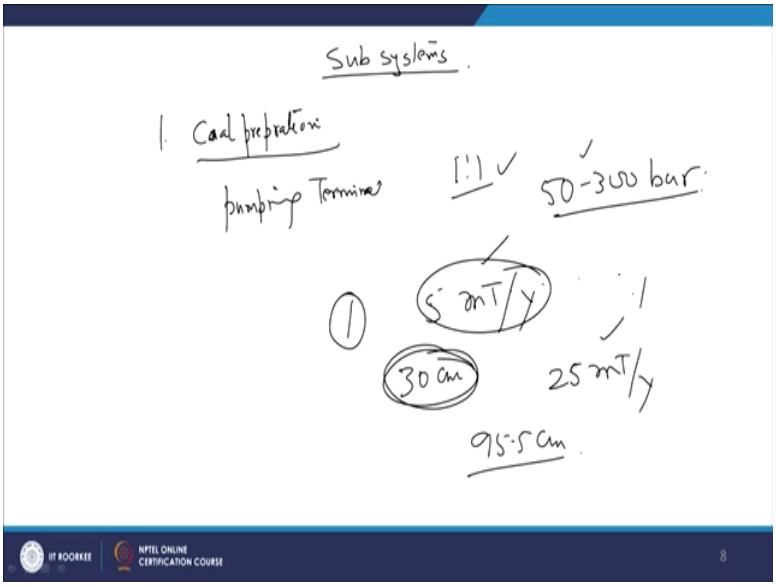

Now, first of all Coal preparation because you cannot just simply dump the coal in the pipeline, it will move. So, first of all coal preparation is required. Now coal preparation is required, it is required at the pumping terminal right. So, in preparation coal has to be crushed as a as I said earlier, it has to be crushed, mixed with water and the slurry has to be prepared and coal water ratio is 1 is to 1 and very high pressure is generated pressure of the order in a range of I will I will give you physical idea. 50 to 300 bar pressure is generated by the pump. It depends upon the distance of boost station because in one go it cannot go in between I mean there is two points. So, here the pressure is generated, then there are number of booster station to compensate the pressure laws in course of travel through the pipe right so, but initially the pop pressure has to be generated of the order of 50 to 30 bar.

Pipeline has to be made with a very high quality steel. I mean the pipeline which is being used should have high quality steel, it should have a corrosion paint, the corrosion resistance painting because pipeline is exposed to atmosphere and sometimes it may be buried in the ground also, right. So, corrosion resistance paint is put on the pipeline surface and that it is covered with the tape, right.

Now, inside corrosion is also an issue, outside we have taken care of. For to in order to provide inside corrosion, some chemicals are mixed in the slurry, so that the corrosion of the pipe inside the pipe is prevented. So, there is a anti-corrosive paint which is put on the outside, some chemical is mixed in the slurry mix slurry, so that corrosion of the pipe is prevented.

Ah regarding the sizing of the pipe I mean I will not discuss designing of the pipe in details, but I will give you some idea. For example, you want to transport 5 million tons of coal per year. For that case a 10 inch diameter pipe will be required I mean 10 inch diameter, it means around 30 centimeter diameter pipe will be required right and suppose if you want to transport as I said earlier 25 million tons per year approximately 95.5 centimeter diameter or 1 meter diameter pipe is required for the transportation. S

o, this is the physical size. So, if 5 million tons per year, a 10 inch diameter pipe is required so, this is the I mean size of the pipe these are the size of the pipe for relative quantity of transportation of the coal, right. So, for the longer pipeline there are booster stations as I said earlier. So, the cost of the booster station is also included in the total cost of transportation of coal.

Now, after reaching at the destination after reaching at the destination, there is a recovery terminal.

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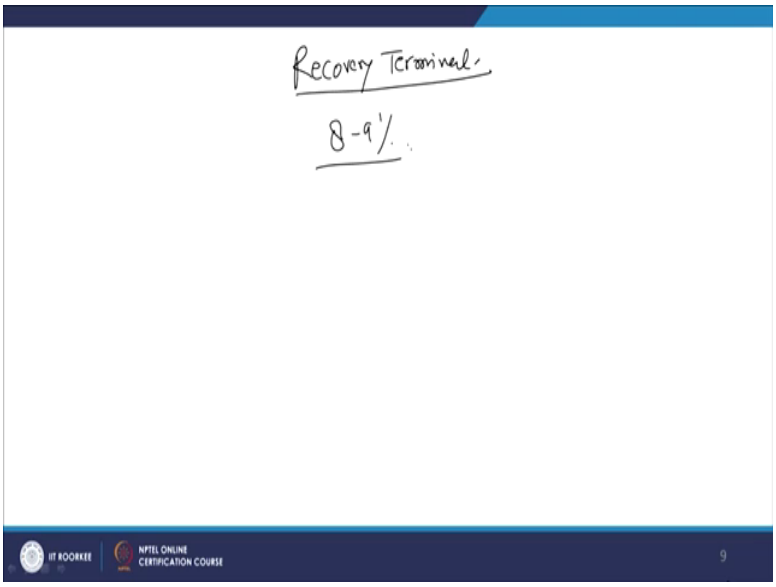

Because once coal has reached the destination, now recovery has to be done because slurry form coal cannot be used, right. So, dewaterization has been done. Dewaterization of the coal has is done and coal is dried, so that moisture content is limited to 10 percent. It is targeted 8 to 9 percent, moisture remains inside the coal, then coal is ready to use, not ready to use then from the from the recovery terminal.

It will go to the storage area say immediately it cannot be used say the moment the coal reaches the recovery terminal at the site, it cannot be used, it is not used. First recovery is done, coal is recovered. Now at the recovery terminal the coal dewaterization of the coal is done, water is removed. Now coal is remaining with moisture less than 10 percent.

If further we you want to dry the coal, then hot air has to be passed. So, the moisture content will be reduced otherwise the coal is stored in the coal yard. So, it is now the next is activity is Storage of coal.

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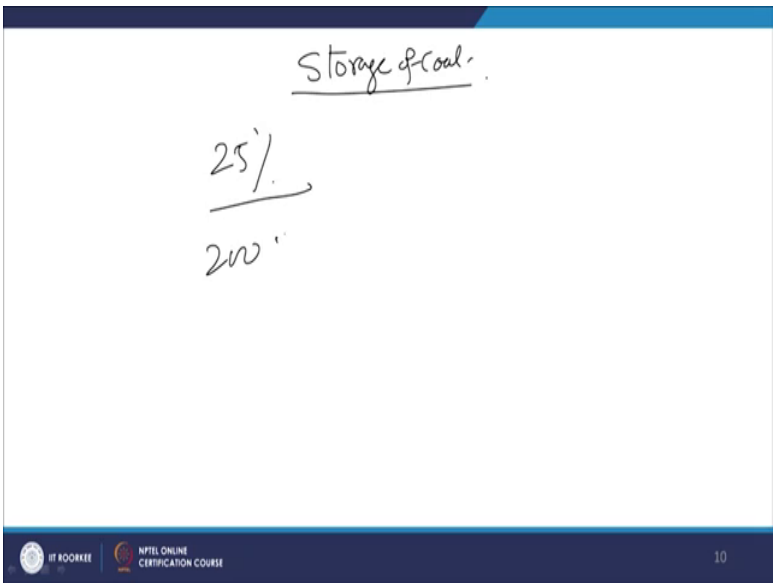

Now, the issue is how much coal has to be stored because the storage is a sort of insurance against the shut down. Suppose there is a strike of the railways, suppose there is a problem in the coal mine, so some stock has to be stored at the site ok.

Now if you are storing the coal, then we can take advantage of the seasonal market also because the coal prices are they also fluctuate in the market. So, when at when the prices are the low when the prices are low at that time the coal can be purchased and stored in the store

yard. So, storage quantity is if you take conservative estimate, it has to be 25 percent of the yearly consumption.

So, if early consumption is let us say 20 million tonn, so 5 million tonn storage capacity has to be there that is conservative side, but minimum 10 percent has to be there. So, so that has to be chosen by the management how much coal has to be stored in the court, but it should not be less than in and 10 percent under any case. For example, for a 200 megawatt plant 200, so for example there is 200 megawatt plant, right.

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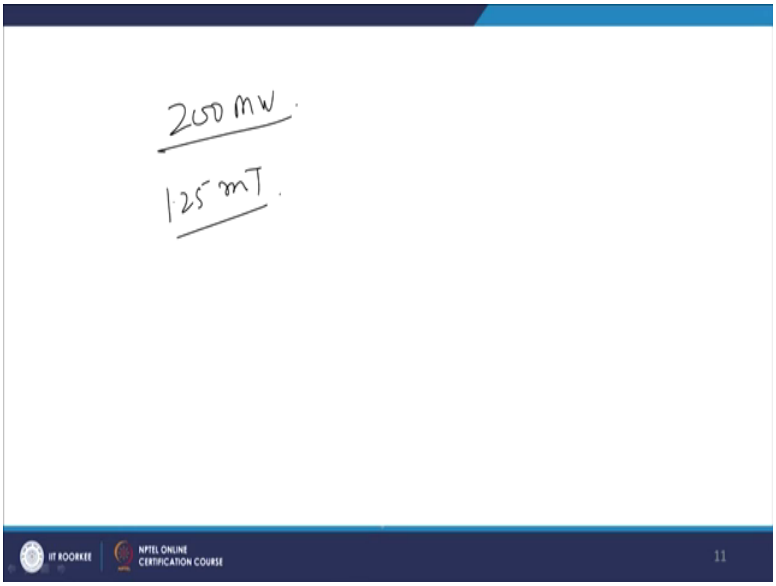

For 200 megawatt plant the storage is and the annual burnt is approximately 1.25 million ton right and 25 percent of that has to be stored.

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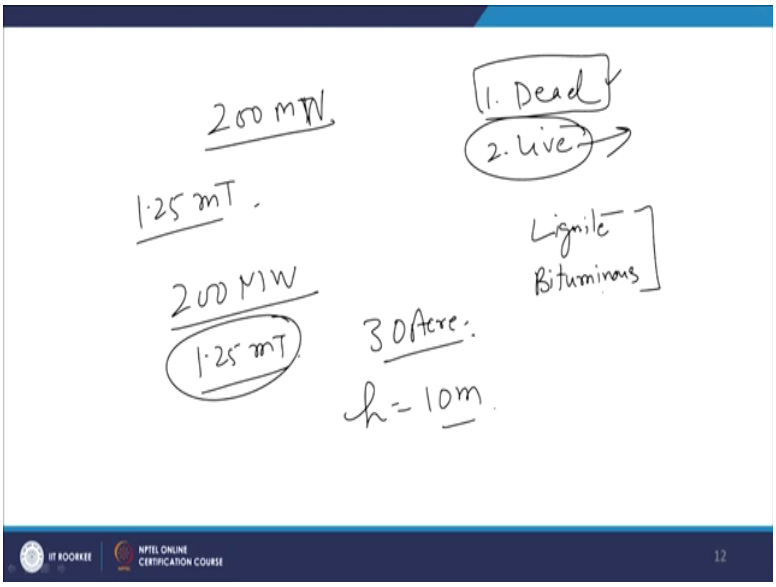

For example for a plant of 200 million ton capacity, the coal storage requirement is 1.25 million ton million kilowatt megawatt, sorry not this is million ton this is. So, 200 megawatt capacity plant the coal storage requirement is 1.25 million tons, right.

Now, for so now we should have physical idea how much area is required. So for the storage of 1.25 million tons, we need 30 acres of land right. 30 acres of land will be required and the coal will be stacked up to the height of 10 meter. Now this much quantity of coal is there I mean I am talking about the 1.5 25 million ton. If it is spreading, the coal yard is spreading in 30 acres; height is stacked up to the 10 meter height.

The problem of any accidental fire is there because it has volatile material, the coal has a volatile material. So, accidental so fire safety has to be ensured at the coal yard and production

from the weather deterioration due to weathering that has that that has I mean that has to be prevented, deterioration of the coal during weathering has to be prevented in the coal yard.

Now, there are two types of storage. One is dead storage, another is live storage. Live storage means part of the coal we are consuming every day, but the dead storage is it is dead storage is not touched. Dead storage is touched when there is a crisis. Suppose there is a shortage of supply of the coal or there is strike in the mine or there is a railway strike, in that case this dead storage is used otherwise most of the time the live storage is being used for power generation.

Now, high sulphur content the coal has certain I mean sulphur content also. So, if the sulphur content is very high in the coal that may also cost fire and other hazards, right. So, the sulphur content of the coal has to be contained very low. It is not desirable and it is to be noted that the lignite and bituminous coal lignite and bituminous, these two coals have high sulphur content if you compare with the anthracites, right. So, a care has to be taken regarding the sulphur also that may also cost a hazard

Now, to how to store the coal storage of storage method?

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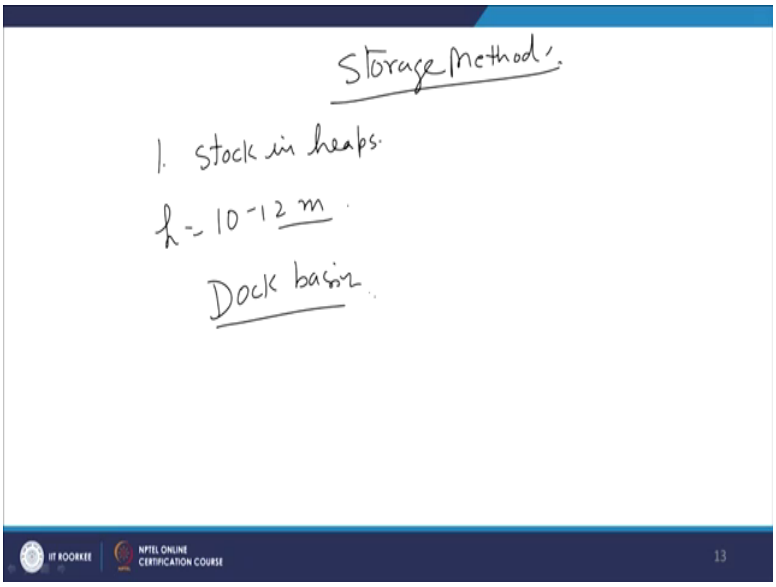

It is it should be stocked in heap, but the heap should not be conical. I mean it is to be prevented that the heaps are not conical, it should be compact. Air circulation should not be there because air contains oxygen. So, compacting is done with the help of a bulldozer where the in the yard also the compacting of the coal is done with the help of bulldozers because if compacting is not done, the air will be there and that may call the fire hazard.

The height of the heaps is approximately 10 to 12 meters and they have compacted layers I mean 15 to 30 centimeter. Different compacted layers of 15 to 30 centimeter thickness, some slope has to be given it not it should not be conical, but slope has to be given at the top to drain off the rain water in the in the coal yard and sealing can also be done with the asphalt. The sealing of the heap can also be done with the help of asphalt.

Underwater storage is another type of a storage of the coal. Coal can be stored underwater, but that should not be the still water. Proper drainage facility has to be provided for storage of the coal. So, dock basin is the right place, dock basin is the right place for the storage of coal right, but proper drainage has to be ensured. There should not be any still water, it should be clean from the foreign matter, no paper or any other combustible material should be there and piles should be built in like a success as I explained earlier in successive layers, the coal piles should be built.

And dressing has to be done and fire fighting arrangement has to be made at the site because the coal there chances are high if the air circulation is there compacting, proper compacting is not done because coal already contains combustible material. So, any an any spark or any anything can trigger the fire in the coal. Once the fire, it catches fire, it will become very difficult to control because quantity of the coal is quite large.

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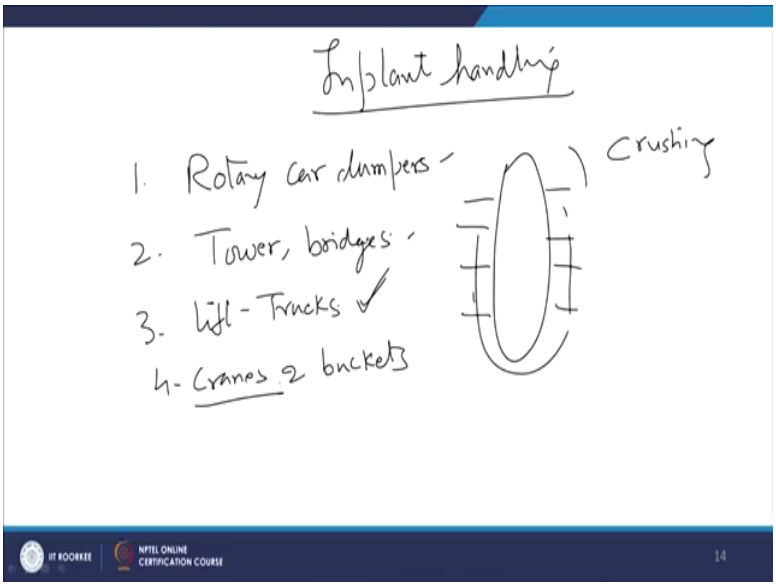

Now, Inplant handling: now, coal has been transported from the mines to the site and the site to the coal yard. Now coal has to go to the plant for final dispatch into the furnace of the boiler, right.

So for core unloading, there are different methods of core unloading and loading the most popular is rotary car dumpers. Rotary car dumpers are very large in size and they accommodate full wagon, full wagon full of coal is accommodated and that wagon is tilted and emptied. So, that is why they are called rotary car dumpers. They are very popular and they are very efficient also.

And the second is Unloading towers and bridges also. Unloading towers and bridges also used for unloading the coal lift trucks, cranes and buckets. Now lift the towers and bridges are also used for unloading lift trucks. You must have seen the back side of the trucks, it gets lifted

hydraulically. It is filtered and the material which is filled in the truck gets removed from the truck, right.

So, they are known as lift trucks, they are also used for handling the coal. Cranes are also used for handling the coals, cranes and buckets and the bucket and chain type of arrangement right and these are the buckets. So, they will take the coal empty here and the empty bucket again will pick the coal, right. So, this type of arrangement is also there several methods of handling the coal inside the plant.

And in the plant again the coal has to be crushed again crushed. So, crushing has to be done and then their sizes it has to be crushed to a different size, then drying of the coal has to be done and magnetics if there are any iron particle, it has to be removed from the coal. So, some magnetic separation has to be done. That is how the coal is prepared for use in the furnace. Now coal is prepared for the use in the furnace.

Now, after preparation the coal has to be transferred to the furnace. Now implant handling we have used these devices these dumpers and bridges and cranes coal is it is this these brings coal for the coal yard to the site, at the site coal is prepared again and then it is conveyed to the furnace.

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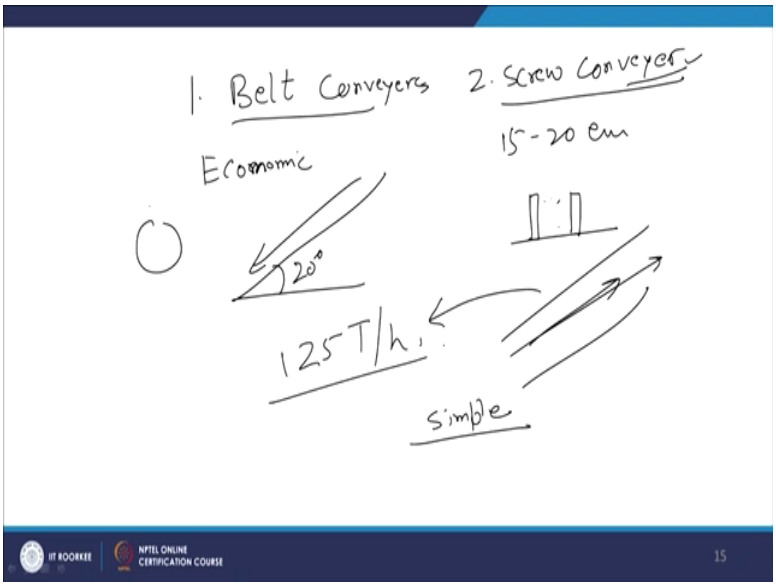

Now, transportation to the furnace: the popular method is Belt Conveneyer. Belt conveyer belt conveyer though the coal is put on the belt and it is emptied at near the furnace because belt conveyor is because it is used because it is economical. It is economic and rate of the coal supplied can be varied. Just you control the rpm of the wheel, you can supply control the supply of the coal to the furnace and coal when it is moving over the belt, it can be also protected against the rains because if there is a rain, then the water will be mixed to the coal.

So, the covered conveyer belt in the covered conveyer belt the coal will be protected from the rains, but the problem is the belt if you are using belt, the angle cannot be more than 20 degree centigrade. Sorry 20 degree, not degree centigrade. 20 degree if the slope is more than 20 degree, then it is not recommended tool to convey coal with the belt because reverse flow of the coal will start, right.

And there is another method which is known as Screw conveyer. So, a screw conveyer the diameter of screw conveyer is approximately 15 to 50 centimeter. It works like a screw compressor. There is a screw and inter I mean interspace between two it or there is a groove, there is a groove in the screw, the coal is filled in the screw and when the screw moves, the transportation of the coal takes place along the axis of the screw.

So, there is screw type of conveyers, but they have limitation of the maximum capacity. They cannot handle 125 tons per hour more than one 125 tons per hour. So, screw conveyers they have certain handling cap issues. So, if small amount of coal they can be handled, but if you go want to go for the large amount you will have to go for the belt type of conveyer, but screw conveyers are cheap. They occupy less space, simple compact dust tight.

There are there are many advantages of the screw type of conveys, but if these type of conveyer the power consumption is high if you compare with the belt type of conveyers in the screw type of conveyes, the cost of the power is high and the feed cannot be more than 30 metres, the length of the screw cannot be more than because it is a cut out of a cylinder if screw is cut out of the cylinder. So, it cannot be more than 30 meters. Even it is more than 30 meters, then some torsion related issues will come into the picture right. So, it cannot be more than 30 meters and some wear and tear related issues are also there with the screw conveyer.

So, if I mean one has to choose between belt conveyer and a screw conveyer depending upon the requirement at the site, there bucket conveyers also bucket conveyer as I said earlier all the buckets are chained and there are two wheels and the these chain this chain is put on the wheels and these two wheels for example they are to next.

Another method of coal transportation is Bucket elevator.

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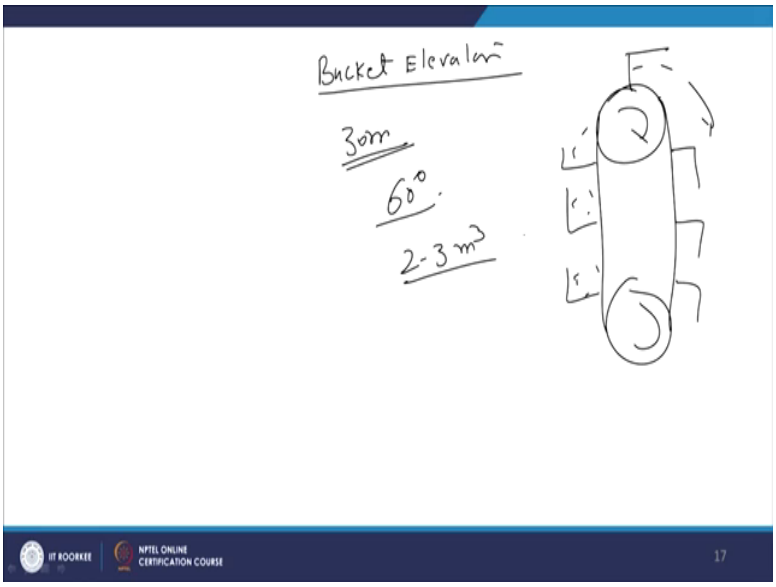

In Bucket elevator there are two wheels and the wheels are connected with the belt and outside the belt, there are buckets and these buckets are filled with the coal. When they reach at the top, the buckets are emptied and they return and again they get filled but here again there is an issue. We cannot go beyond 30 meters of height, 30 meters of height with this type of bucket elevator and inclination it is. I have shown it to be vertical, but it can be inclined also. So, inclination can also be not more than 60 degree.

So, there is a restriction for the vertical and restriction for the inclination also the. The volume of the bucket is approximately 2 to 3 meter cube which is used for the transportation of the coal and it can handle around it can handle around 125 tons per day. This is the quantity of coal; it can handle the bucket conveyor.

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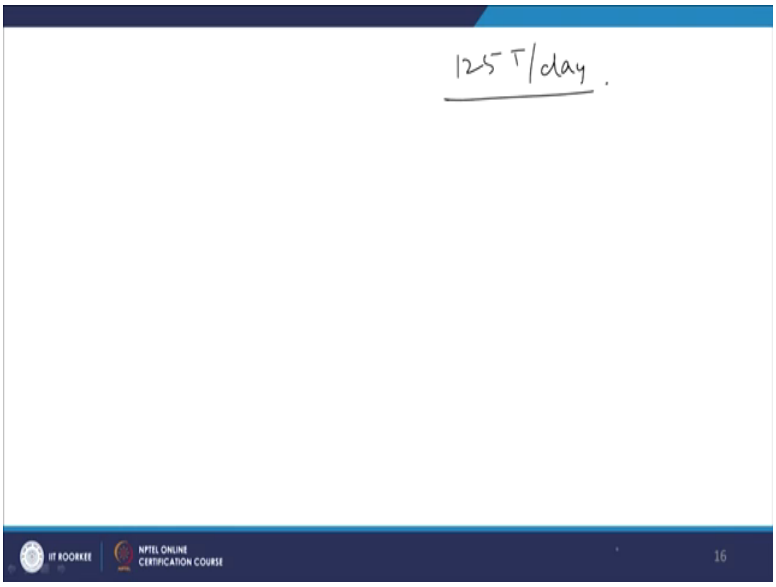

And after that I will switch to Pulverized coal handling. Nowadays pulverized coal is used in many of the power plants. Pulverized is just very fine powder of the coal is made right and this fine powder causes very effective burning or very effective combustion of the coal. So, this pulverized coal has to be handled in the power plant. So, there are two systems for handling the pulverized coal; one is unit system, another is bin system for handling of the pulverized coal.

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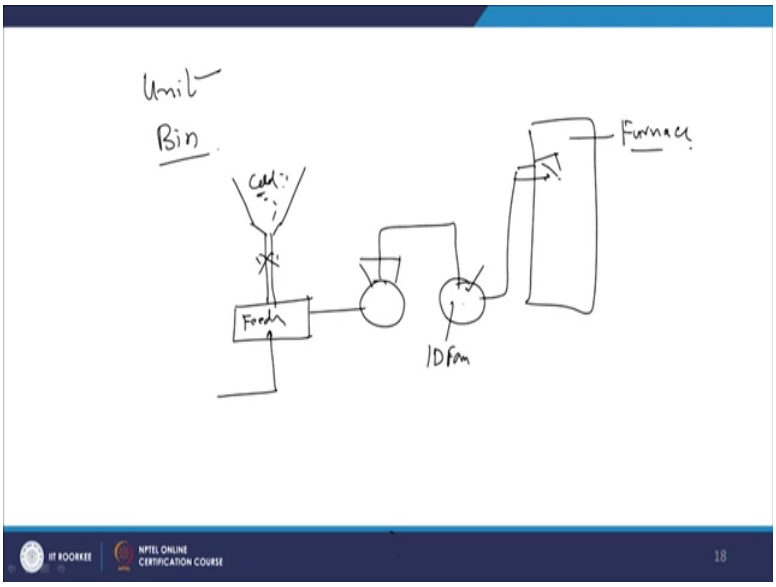

So, in a unit system there is a feeder, there is a feeder and in feeder the coal is this is a raw coal bucket raw coal bucket and raw coal bucket, the coal comes to the feeder, there is a wall, right. This is preheated air which goes to the feeder right and here the mixing of coal and air takes place in feeder and then it goes to a mill, there is a pulverization mill where pulverization of coal takes place in pulverization mill.

The pulverization of the coal takes place and the coal enters the induced draft fan that is ID fan, then the mixture of fine particles of coal and the air they are transported to the burner furnace. This is furnace burner where burning of coal takes place furnace because here the fan is handling the fine particles of coal and the air, the wear and tear of the this fan this equipped this component of the system takes place.

Second thing is, so wear and tear of this part takes place and the second type of arrangement is the bin type of arrangement. In bin type of arrangement there is again a feeder.

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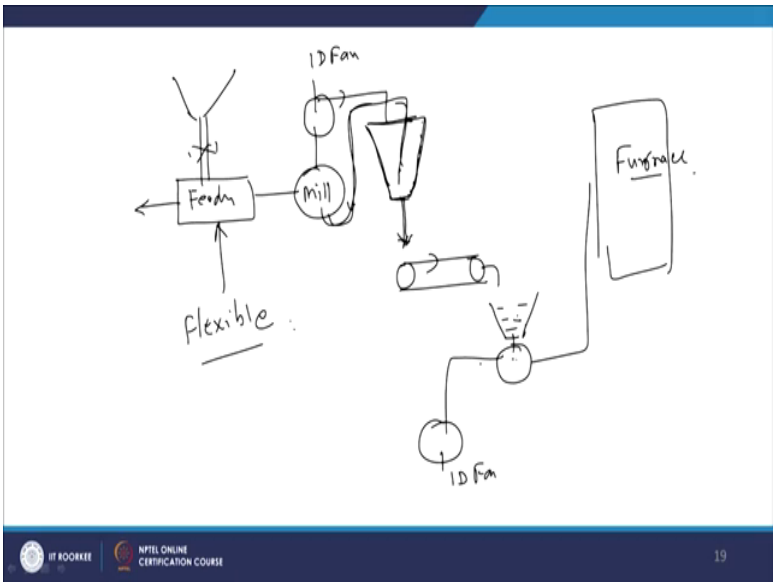

And from here the coal is supplied to the feeder and coal hot air is supplied from this side right and some part of the cold air is, it comes out from this side and from feeder it goes to the this mill where pulverization of the coal takes place, then it goes to the induced draft fan and from induced draft fan it goes to the cyclone separator. There is a cyclone separator. The cyclonic separator because these small particles are high density particles so, high density particles will come down, low density particles to the center, they will go back and they will go back again to the mill.

So, I am repeating from the mill it there is ID fan. From ID fan it the mixture goes to a I mean cyclone separator, in cyclone separator the because the fine particles have high density, they

try to stick to the surface of the cyclone separator. There are subsequently they come out from the bottom, the low density thicker particles I mean which are larger in size. There are low density, they move through the center of the cyclone and they are fed back again to the mill

Now, the fine particles are put on the conveyer belt. They come to the conveyer belt right and then again there is a feeder here the coal is collected here, right and there is another ID fan which supplies air and mixing of mixing of fine particles of coal and the air takes place in this chamber and then, it is supplied to the furnace and we can have n number of furnaces here right, we can have n number of furnaces here. This is known as the Bin type of system for the pulverization of the coal.

So, central bin type of system, this is central bin type of system. First of all its flexible power consumption is less I mean the centralized system if you have suppose there are four furnaces, you have 4 units, right. So, definitely the cost will be high. So, here there is a centralized bin system and it is feeding all the furnaces. So, the cost is high and the system can be shut down.

If you have sufficient stock of the pulverized coal, the system can be shut down and you can simply run the furnace and here you can see the ID fan is dealing with the air only, right. So, the wear and tear is less in ID fan good coal and here control is good I mean there is a good control over the fineness of the particles because we are using the cyclonic separator in this case, right.

But this system occupies more space, space requirement is large in this type of system is comparatively larger system, auxiliary power is also high because we are dealing with high bulk of the coal, possibility of the fire hazard especially for the fine particles of the coal are high. So, fire protection has to be ensured. And dryer is an essential part of this type of system.

So, so there are certain advantages and disadvantages of the Central bin type of system. So, these two types of systems are used for preparation and use of the pulverized coal. That is all for today.

Thank you very much.