Environmental Air Pollution

Prof. Mukesh Sharma

Department of Civil Engineering

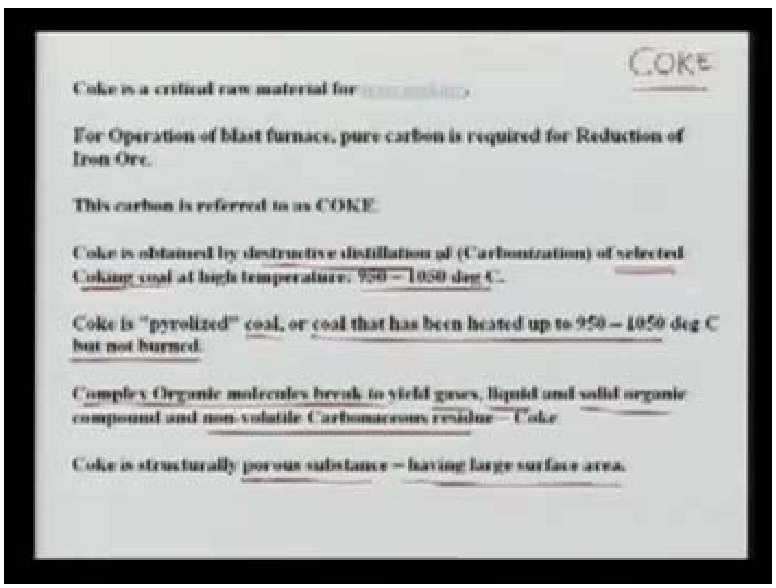
Indian Institute of Technology, Kanpur

Lecture No. 20

Coke Production and Air Pollution

In today's lecture, we will talk about the manufacturing of coke and the related air pollution issues and also the control of air pollution emissions from coke manufacturing. So the focus is today is on coke.

(Refer Slide Time: 01:27)



Let us see what is the importance of coke. As you can see, coke is a very critical, very crucial raw material for iron making and steel making. Not only all large steel plants, as you probably know, would require coke but small plants like foundries using Cupola furnaces would also require coke. Let us see what the coke really is and how it is manufactured. In fact, in all blast furnaces – if you recall from your high school metallurgical processes that you have studied, for the operation of the blast furnace, a pure form of carbon is required for the reduction of iron ore and we also need to supply some kind of energy. This reduction that is undertaken in the blast furnace is essentially because of the coke. Coke is very essential in manufacturing of steel and iron – maybe in large plants or in small plants.

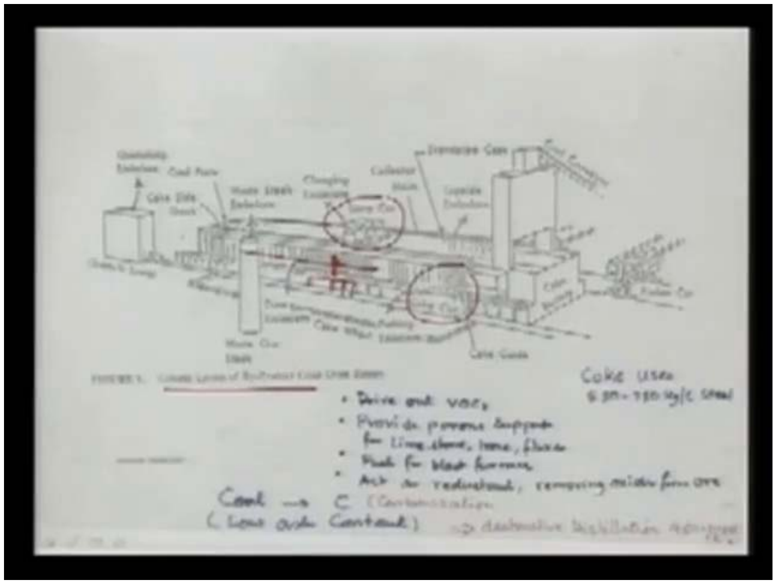
This carbon, the pure carbon is called as coke. We will go very briefly into the process of how it is manufactured. Coke is obtained by destructive distillation, as you can see here, and that process of destructive distillation is also called carbonization. In fact, what you see here, please delete this 'of'. The coke is obtained by destructive distillation and that process of destructive distillation is called carbonization; 'of selected coking coal' is very important, the component here 'selecting coking coal at high temperatures' – that is about 950 to about 1050 degrees Celsius.

Why I am underlining 'selected coking coal' is that not all kinds of coal can be used for the manufacturing of coke, because we need very high quality of coal with very low ash content because we do not want ash to be present in the coke – if we have ash, that will interfere with steel making, we will not be able to make good quality of steel and so it is very important that a good quality of coking coal is only used for manufacturing of coke. Then, coke is basically pyrolized – pyrolized means we are heating something in the absence of oxygen or almost near-absence of oxygen. The coke is pyrolized coal or coal that has been heated up to 950 to 1050 degree Celsius but not burnt.

We do not want to burn the coal because out of the coal, we want to produce coke and we only want to heat it externally. In the process, when we are heating it, what happens to the coal? We will see in a moment. When you are heating the coal, complex organic molecules are formed. As you can see, I am trying to underline it for you. The molecules break to yield gases – we will see what kind of gases, some kind of liquid also comes out and solid organic matter also comes in the process of carbonization.

But what is left is non-volatile carbonaceous residue – that is of importance to us is and that is what we call as coke. We will see the process of coke manufacturing a little bit in more detail so that we can identify what are the sources and what is such an important issue associated with coke manufacturing that we need to discuss in this course. Structurally if we look at coke, it is a very porous substance and the idea of having it in a porous form is to have large surface area, so that the reaction – especially the reduction process that is going on – effectively takes place in the blast furnace or wherever you are making steel.

(Refer Slide Time: 05:05)



Let us see a picture that is more of a schematic picture that gives you an idea. I will give you the idea of the dimensions a little later but just see what it takes to make coke. Here, you are looking at the schematic picture. This figure is the general layout, as you can see here, of the by–product coke oven battery; I will explain to you what is the meaning of by–product. What you see here is a long housing kind of thing and there are lots of slits as you can see here, for example. I will just [05:36] small slit here.

The small thing that you see is a coke oven. There are a series of ovens as you can see – there could be hundreds of them as you can see in this direction, hundreds of ovens are there. Then on the top is what we call as the larry car and this larry car will have the coal. This larry car fills the ovens from the top into the ovens. Down here, you see the little rectangles I am drawing for you – that is where the heating is done. The gas is burnt through this area and then this heated air or the heated gases go up, it cooks the coal, the coal gets heated up in the process and the emissions of the gases or the complex molecules get emitted.

Once the cooking operation is complete, the coke is ready and as you can see here, coke is being pushed out and it is put into the coal car. Again, I will repeat: the idea here is to drive out the VOCs – VOCs stands for volatile organic compounds. We do not want volatile organic compounds because we want pure carbon. So we heat up the things and the volatile matter will go away. Then, provide the porous support for limestone and the other fluxes in the blast furnace. It is also a fuel for the blast furnace – it acts as a reductant removing oxidants from the ore. We are transferring coal into the carbon and using destructive distillation. What I would do is show you the bigger picture so that things become clearer to you – that picture follows.

(Refer Slide Time: 07:47)

This is a real coke oven that I am showing you, just for you to get a feel of how it looks before going to the sources. You can see here this person with the mask on his face, standing on the top of the coke ovens – on the top surface of the coke oven. Somewhere here – you cannot see – is the larry car I mentioned. The coal is filled on top of this larry car – there is coal in the larry car and these are the holes. Then you see here the track, the railway track – the larry car moves on this track. These are the different ovens, these holes are opened, the larry car sits right on top of this, coal is put into the oven and then the heating process goes on.

You can also see that as the coal is being charged into the oven, there is a lot of dust emissions as you can see in this area on your screen. This emission is a serious problem and we will learn why it is serious. You can see the person is standing. Of course, there is a lot of heat – the temperature is very high. Also, the emissions are so toxic in nature that the person has to wear the mask. We will discuss these emissions and what the emissions are in terms of toxicity and in terms of the problems they can cause to human bodies, just to give you a little feel. This picture is only at the top of the battery, top of the oven and I must specify that groups of ovens are called batteries – this is one single battery.

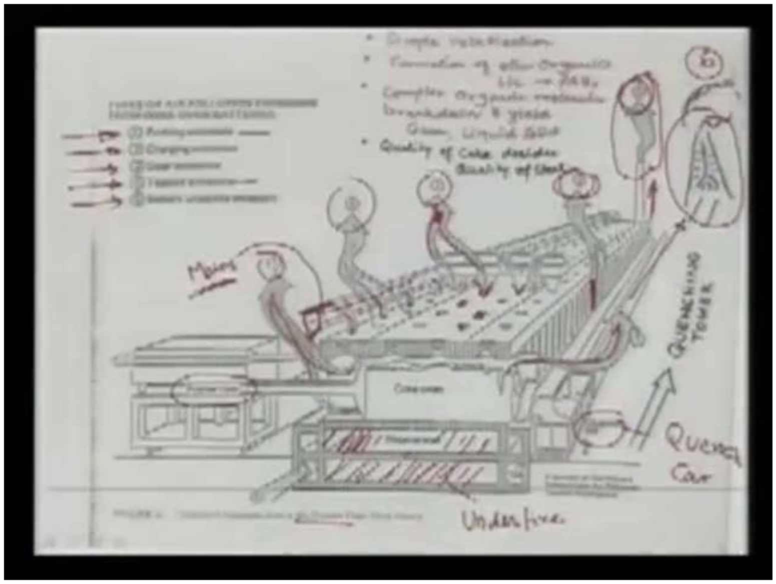
(Refer Slide Time: 09:28)

This is a picture taken from the site or from the ground. You see here the larry car was somewhere here at the top, the person was standing somewhere here, but now we have the picture that is taken from the ground – this is our ground. These are the ovens and you can see here the slits – it is an oven. Here at the bottom is the underfire and right now, just understand that some heating is done. This heat flows, the hot air flows around the oven but does not come into contact with the oven, because we do not want to burn the coal – we just want to heat it; something like cooking in the kitchen – we do not want to burn our food but we just want to heat our food. The coal is being heated externally and this underfire heats everything and goes out from this chimney as you can see – on this chimney. After some time, what would happen is that the coke is ready; once the coke is done, we have to have the coking of the coal at a temperature of about 950 to 1050 degree Celsius. Coking takes normally between 20 and 30 hours. When the coke is ready, we need to push it out.

(Refer Slide Time: 11:13)

Maybe I will show you this picture before the [11:12] we will show the next picture. Now, what is happening is that coke is ready and it must be driven out. You see here that the coke is being – I will draw a picture – pushed from the ovens. See here the red, it is not burning but it is very thing. Then, what you see here is another car or cart, if you like, and quickly it is transferred here. This must be immediately cooled and we will see how this is cooled in a moment. So this is the real picture, just so that you get an idea as to what is happening and what are the size of the machines that we are talking about – they are huge and it also means high pollution. I will show you the earlier slide. Now, we will talk specifically about the sources of air pollution.

(Refer Slide Time: 12:07)



Now you have clarity – we are seeing the picture from the top as well as from the side and also from the bottom portion. The bottom portion as you can see here is a kind of regenerator but we mostly call it underfire – underfire means we are firing some gases to give us heat and that heat should be used by the ovens. Inside this picture, this is your coke that is being readied. As you can see here, as coke gets ready, it is being pushed. You see here: this is called the pushing arm (Refer Slide Time: 13:01) and it is ready, the whole thing is being pushed and takes up a lot of energy – huge machinery requirement. You can see this whole thing is falling down on the quench car. Can you see here? Quench car. Why quench car? It is because we must quickly cool off the hot coke. If you do not cool off, what will happen is that it is hot, it is open in the air, oxygen is available and when oxygen is available, things start burning.

In fact, if you do not take it and quickly quench, it is going to catch fire, you can see the flames coming out and our entire purpose of coke making will be defeated. So as soon as the whole thing is out, we should quickly take it to the quench tower. Here, the whole thing is like on a railway track and then, this is pushed quickly in this direction and taken to the quenching tower. I have drawn this picture of the quenching tower and we will see a little bit later as to what a quenching tower is and what it does, but the idea of the quenching tower is to put lots of water, tons of water, which is stored on top, on this coke. This is because we need to cool down that coke and we do not want it to be exposed to the atmosphere so that it starts burning –we are then in trouble both from the pollution point of view as well as from the production point of view. So this is one part.

Let us go back to the top of the coke ovens and see what is happening. You see here the coke oven top, this is the larry car I showed you and these are what we call as the charging holes. For example, this is a charging hole, this is a charging hole, this is charging hole and this is charging hole. The larry car moves back and forth and it fits exactly on the charging hole. For example, this is the oven that is being charged, here this is the hopper or larry car that has coal and this is another hopper that has coal and it is dumping the coal inside the oven.

What happens when it is dumping the coal? When something is being dumped in a certain room, it should replace the air that is there. Once you are dumping things, the air must come out and where does that air go? What you can see here is that this air that is being replaced by coke is driven out from these pipes (Refer Slide Time: 15:45). These are the pipes that are active right now; all the air has got replaced and all the emissions that take place are passed through this duct – this is the duct and this is called mains.

All the air got replaced and in the process, the emissions that are taking place must go to this duct. Then, all the dirty air is sucked through this duct and taken to a process called by–product recovery plant. Right now, we are not showing by–product recovery but you can see in the title that there is by–product recovery. So all the emissions that take place must go to the by–product recovery plant; if we did not have this duct here and we had not done the collection of the emissions that are taking place, they would come out in the air and cause a lot of problems.

You can see that we had this mains, we had the collection system but even then, the person was wearing the mask – there were problems but if we had not had this mains here, the emissions will be even enormous so that they go to the by–product recovery plant. You can also see this chimney number five – the numbers will come slowly. These are the emissions that are taking place from the underfire. The underfire gets heated up and then it is coming out from the chimney – at the end through this chimney and again, emissions takes place.

Now, although we are having the mains – you have to pay a little attention, most of the pollution or most of the emission is being collected and going to a by–product recovery plant where we will control the source. But in spite of having the system here, air pollution still takes place and the major sources as you can see are listed as number 1 (Refer Slide Time: 18:09), number 2, number 3, number 4 and number 5 and I would also say number 6 – we will talk about that in a moment. Number 1 as you can read from here is called pushing emissions – because as you are pushing the things, whatever are the vapor forms or vapor compounds, they are getting emitted from the sides; earlier, everything was closed, now it is open because we are taking the things out, so all this emission takes place.

The second thing what you can see here is charging emissions – the charging emissions is again when you are charging the coal. What is charging the coal? The larry car is charging the coal. When the coal is being charged here and as it replaces the space underneath – the space or air, emissions take place and that is the emission number 2. This emission is a very significant emission. In fact, in the picture I showed you, the person wearing the mask was trying to be far away from the larry car so that he is not exposed to the air pollution problem. Here, the emission takes place as the coal is being fed into the oven.

Let us look at the third thing – the door emissions; here, the third emissions are the door emissions. Here, the ovens have doors because after all, we have to push coal out or the coke out and so we have to have doors. No matter how tight we try to make the doors, there will always be some leakages. Why will there be leakages? It is because all our ovens are under positive pressure. If something is under pressure, some room is under pressure, air will tend to come out from this – wherever it finds a leakage. The entire oven or all the ovens in fact will be under positive pressure and when things have positive pressure, they tend to come out and there will be leakages.

For example, in this oven (Refer Slide Time: 20:25), these are the doors and there will be some leakages constantly. There can be some door that is not very tight – there will be more emission, some doors are very tight – there will be less emission, but there will always be some emissions. Also, do not forget that all the time we are sucking out the emissions that are taking place. How are we sucking them out? We are sucking out from this duct or from this main – it is happening all the time. Then it is going to, do not forget, the by–product recovery plant where we will recover certain things.

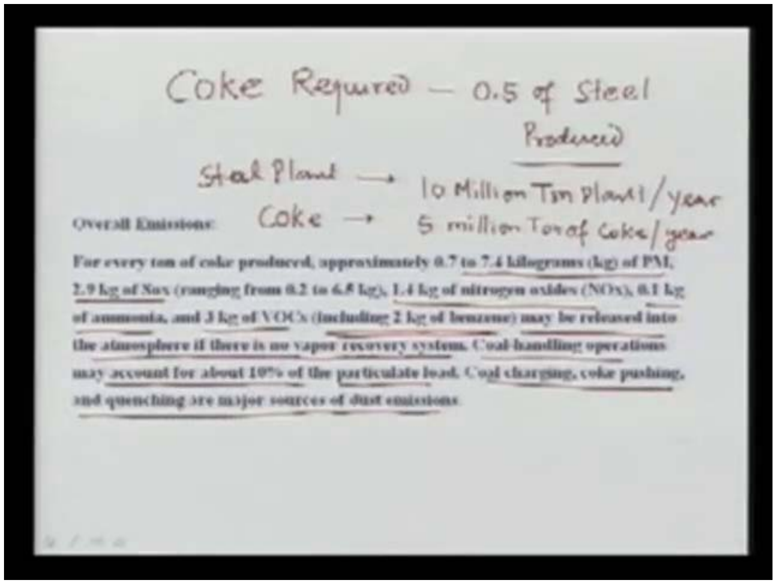
There are other emissions, number 4 as you see in the picture – top emissions. Again, these holes, which are the charging holes, need to be open – as the larry car comes here, we will open these and the larry car will charge the coal into them. No matter how much we try to make them tight, you will still see emissions continuously taking place – that is called top emissions or battery top emissions. Battery underfire emissions: as I showed you with this [21:40], as you can see here, the underfire is the heat that we are producing to heat the coal. Finally, after heating is done, the entire emission from the heating process goes out from this chimney – that is my number 5.

You can see the sources of emission but emission number 6, which is very important, is when the quenching car takes the coke out and goes all the way in the quenching towers, huge amount of water is put on the coke and we suddenly have a large amount of burning coke – you put lot of water and so there will be lot of emissions and evaporations that you can see almost in the form of vapor clouds and this will also cause serious air pollution.

What we have done with this is that we told you something briefly so far about what is coke, why we need it, what is its purpose and how it is manufactured – the main principle is destructive distillation of coal and we call as carbonization. We also tried to show you certain pictures to get a feel of how big are the units that we are talking about and also what are the possible sources of emissions even from a plant that has a by–product recovery system and why these emissions occur – mostly, they are the door leakages, top emissions, underfire emissions, pushing emissions, quenching tower emissions and battery underfire.

You can see that these emissions will still take place in spite of the fact that we have a collection system. If we had not had the collection system, things can look very very bad – it will be very difficult for anyone to even stand close to the plant. These are the issues. We will go to the next slide, try to show that pollution is there and see what is so important that we need to study it in a separate lecture and not just do it combined with some other lecture. This picture I have already shown you (Refer Slide Time: 24:07). Now, let us go to this one.

(Refer Slide Time: 24:09)

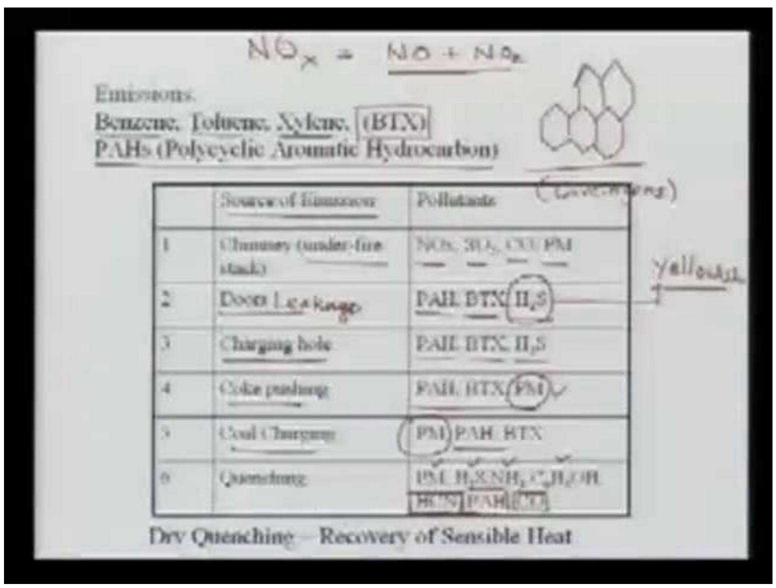


Let us look at the emission. I am giving you the general emissions and we will then go to a little bit of specific emissions. I will read the sentence here: for every ton of coke produced, approximately 0.7 to 7.4 kilogram of particulate matter (PM stands for particulate matter, which is largely dust), 2.9 kg of SO_x. What is SOx? Oxides of sulfur – huge amount; I will give you a little feel but maybe we can give it right now to give you a little feel about the coke requirement so that you know the quantity of the coke required. It is almost 50 percent of steel produced.

You know that steel plants are very huge – very big plants. Steel plant sizes vary actually but a typical plant that is a little bit on the larger side can be a 10 million ton plant – this is a large plant, very large plant – per year or annual capacity of 10 million ton. This plant will give a little feel… this plant will almost require coke of about approximately 5 million ton of coke per year. These are not small quantities we are talking about. Once we are making coke, what are the emissions that are taking place? 0.7 to 7.4 kilograms of particulate matter, 2.9 kg of oxides of sulfur, 1.4 kg of nitrogen oxides, 0.1 kg of ammonia – you would not expect ammonia but ammonia is also emitted, 3 kg of VOCs including 2 kg of benzene (you remember VOCs stands for volatile organic compound) – most of the volatile organic compounds are cancer causing, can very adversely affect human health and so this becomes very very important and we all know that benzene is a carcinogenic compound and is also emitted from automobiles. We all talk about benzene control but in no way is this a small amount – this is a huge amount and may be released into the atmosphere if there is no vapor recovery system.

A vapor recovery system is the same as the by–product recovery plant I was talking about. If there is no by–product recovery plant, the emissions could be of this order as specified in this slide. Apart from this, coal-handling operations may account for about 10 percent of particulate load, coal charging, coke pushing and quenching are the major sources of dust emissions always. So you can see that the emissions are large both in terms of quantity and also in terms of their toxicity, because some of the compounds that are emitted are very serious cancer-causing compounds and we need to control them.

(Refer Slide Time: 29:55)



Let us go to the next slide. The emissions are not only the particulate matter, SO_x, ammonia but there are more things. Now we are trying to get a little bit more specific on the kind of pollution that is taking place. I said benzene earlier but in other quantities, toluene is also emitted from coke making and so is xylene. The common name given to these three compounds is BTX and in the rest of our discussions, we will be referring to this emission as BTX rather than simply calling it just benzene or calling it benzene, toluene, xylene – we will simply call this as BTX. Apart from these, the emissions are also the PAHs, which are nothing but polycyclic aromatic hydrocarbons. These are again a group of compounds that are very toxic and are proven carcinogenic – they can cause cancer in the human body and so, this becomes an important issue.

If you do not remember what aromatic hydrocarbons are… when you have more than two benzene rings diffused with each other, that becomes a PAH. There can be many benzene rings as I am drawing – they can be also combined like this and can also become combined like this. This is a typical structure – the chemical structure of PAHs. This is just one compound and you can see that you can almost produce or in fact, hundreds of PAHs are formed and most of these PAHs are carcinogenic and can cause cancer – therefore we need to control them.

This is the table (Refer Slide Time: 30:04). What we have discussed were the sources of the emission but we did not discuss what kind of emission is coming out for a particular source. I made this table so that you can see the different sources (you remember we talked about 1, 2, 3, 4, 5, 6) and what would come out from those. The first source was a chimney or underfire – it will have combustion-related emissions because here we are burning things. NO_x. Do you remember what was NO_x? NO_x is the summation of NO plus NO_2 – that is what we call as NO_x. You have NO_x, sulfur dioxide, some amount of carbon monoxide and PM here (particulate matter), which is dust.

You also remember door leakages – we can even write here leakage. What emissions will come out? PAHs, BTX and H_2S. Dust is not likely to come out but carcinogenic compounds are a serious problem. We also have benzene, toluene, xylene and H_2S. Why H_2S? It is because the coal may contain some sulfur. We are not burning sulfur, the conditions are reduced condition, so this sulfur will come out as H_2S – hydrogen sulfide gas. Then as a result, maybe it is worthwhile to indicate that in the doors that are leaking more, more H_2S comes out and the emissions are little yellowish – you all know that H_2S gas has a little bit yellowish color.

In fact, sometimes you do not even have to go and see – you can see something yellowish coming out from the coke oven doors and you can say that this is the oven that is leaking. Once it is leaking, we need to do something about it. If it was colorless, you will not be able to see anything and you will not know about what kind of emissions are taking place, but the moment you see a yellowish thing coming out, then you are sure that that particular oven is leaking and the door is leaking – it means the door is leaking and it means the door is not tightly placed.

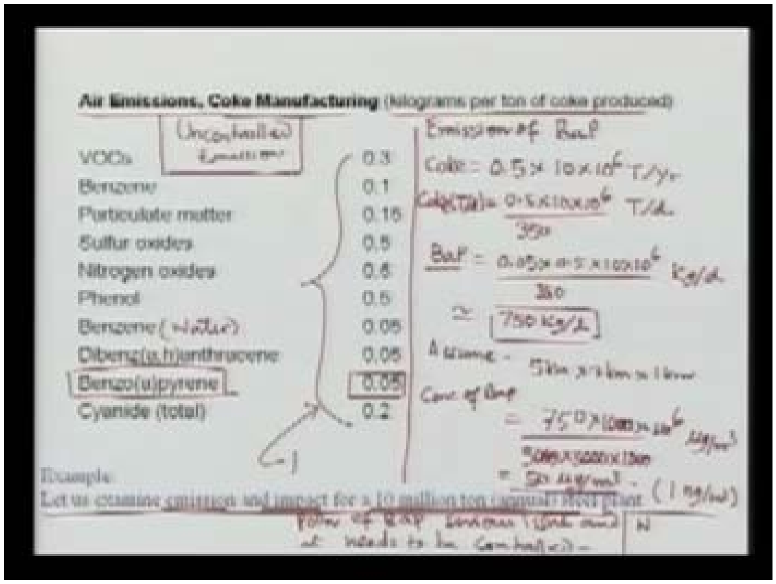
The charging hole that we discussed will have the same emission: PAHs, BTX, H_2S – that is the type of leakages that are taking place from the charging hole. We have seen coke pushing – again, PAH, BTX, particulate matter; the new thing coming out here is the particulate matter because when something is being dropped from a height, there will be dust emission that will come out and automatically, particulate matter emissions will be there.

In coal charging, as you recall, when the larry car is moving back and forth and is going on top of the coke ovens and charging the coal into them, that again causes PAHs emission because it is replacing the air that is inside and also if something is falling down, it means there will be dust emission – if you drop anything from some height, there will be emissions. What happened in coke charging? We are really charging or dropping the coal into the coke ovens, so there will be dust emissions. Again, you can see here that particulate matter has shown up in the coal charging area.

When the coke is ready, we are taking it for the quenching operation and we put tons of water on it. Let us say that very high temperature thing is cooled off. There will be particulate matter, H_2S comes out, a little bit of ammonia, some of the alcohols and it has also been reported that some amount of cyanide in the form of HCN is also likely to be either emitted in the air or will become the part of the water – this is because we are quenching the coke with water and so some of the cyanide has also have reported, some of the PHS and some carbon monoxide.

What we have learnt here is that in spite of the good recovery system – through the mains, through the duct in which we are sucking the gases or the volatiles that were being formed, there could still be emissions and the emissions quantity can be large; not only large, they can be very serious in terms of their toxic nature. So this issue of coke ovens has become very significant because it has a direct impact and a very significant impact on public health, especially for the people who are operating coke ovens (remember the person standing with the mask on his face).

(Refer Slide Time: 35:16)



Let us take our discussion further and let us talk about some of the controls. This is a little table here and this table shows the total air emissions that can take place from coke manufacturing. Do not forget that the units here are kilogram per ton of coke produced – the units are also mentioned here (Refer Slide Time: 35:37). What are the units? Kg per ton of coke produced. I must also mention here that these emissions are uncontrolled emissions – these quantities are not small in any sense, they are really large quantities and they can influence the air environment

This benzene is probably in the water. I should have given the source actually but the source where I got this information is from a World Bank document. This gives a fairly good idea of what is being emitted, in what quantities they are likely to be emitted and why they are important because of the associated toxicity. I want to do an example for you just to give you a feel that these emissions are not small – they are very serious emissions. The example is the following. Let us examine both the emission and impact for a 10 million ton steel plant that is producing annually 10 million tons of steel. Let us make a little space here. We will see the emission of, let us say, a compound – we will just take one example; let us take the example of this one because it is the most dangerous compound in the category of PAHs. Benzo(a)pyrene is the PAH having five benzene rings and in short, we call it BaP. Let us see the uncontrolled emissions. For a 10 million ton plant, how much is the coke that it needs to produce? 50 percent of the steel that it is making. The goal you need is that it should produce 50 percent of the steel that you are making.

How much steel are you are making? 0.5 into 10 to the power of 6 tons per year – this is my coke requirement, simple thing. Now I want to know the coke in terms of tons per day because I also want to see the impact.

I have 0.5 into 10 to the power of 6 and suppose I am taking, let us say, about 350 days of the working of the plant, so if I take this as 350.… Do not forget that these are the… am I doing it right or am I doing wrong? I am doing right. Let us write it properly. Now, this is the coke I need in terms of tons per day – not per year, so tons per day. Let us write this spelling correctly. Now, you can also tell me how much the BaP emissions will be. Let us go to the factor here – 0.05 kg per ton of coke produced. I can say the BaP will be 0.05 times 0.5 times 10 million divided by 350 – that is what is my BaP.

Now, you have to tell me the units of this. What will be the units? Do not forget that the units are kg, kilogram because this is nothing but kg per ton, so this will be kg per day because my factor has units of kg per ton, so so much ton is producing and for every ton, 0.05 kg is produced, so this becomes the BAP. With a little calculation, you will see that the BaP emission comes out to be approximately 750 kg per day – it will be nearly 750 kg per day. What we are saying is that the emission of BaP is.… This is some approximation that I have done here, so let us write approximately 750 kg per day – this plant is likely to emit 750 kg per day if it is uncontrolled; do not forget what I said here earlier here: this is the uncontrolled emission.

Now let us also see what it really means to the people living in that area, because after all, public health and good health of the people is what environmental engineers always try to do. This is a simple example or calculation that we are doing but there are more complex, difficult ways to do it. Assume that the entire BaP amount is spread into the volume of let us say 5 kilometer by 3 kilometer and height of 1 kilometer – let us say everything disperses into this. What does it really mean in terms of the concentration of BaP that people will be breathing in their lungs? That is what you want to find out.

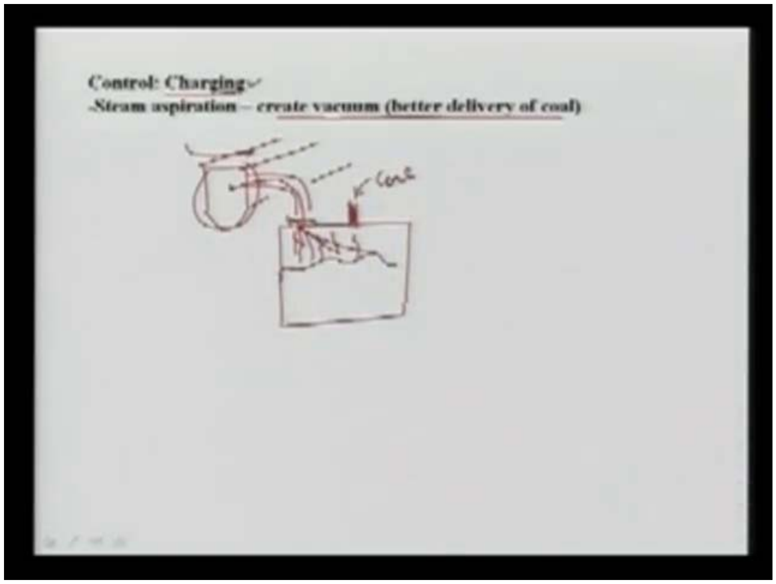
Let us do the concentration part, concentration of BaP. We are talking of every day, so almost 750 kg is emitted, correct? In how much volume? Let us write in meters, 5000 (5 kilometer is equal to 5000) into 3000 into 1000. Then, what I can do is I can convert kg into grams and these grams I can convert into micrograms and so the units that I am having now is microgram per meter cube. So 1000 and 6, so nine 0s I can remove and you are left with 750 divided by 15 and then this comes out to be 50 microgram per meter cube.

This concentration is very very high; people are exposed to this concentration and it is very very high. In fact, the standard can be something like 1 nanogram per meter cube. What is the conclusion that we want to say? Pollution of BaP is a serious issue and it needs to be controlled; to a large extent, it is controlled in the by–product recovery plant, but it is still a serious problem and so efforts have to be made to reduce the emissions, efforts have to made to reduce all the emissions because BaP will be emitted from door leakages, from the charging holes during the charging, during quenching, during pushing – all these will cause serious emissions of BaP and so, we need to control all sources.

Just simply saying that BaP must be controlled is not enough. In order for planning the control, we should know where to control, what are the sources and what are the difficulties. We will talk about some of the control systems that people are using and then one can think of. I think this is a simple calculation. Normally, we should also account for the wind, but we have taken a simple example just to give you a little feel. We will learn the actual modeling part a little later in the course – that will require some more information on meteorology, the wind direction and other things, so we will not discuss that right now.

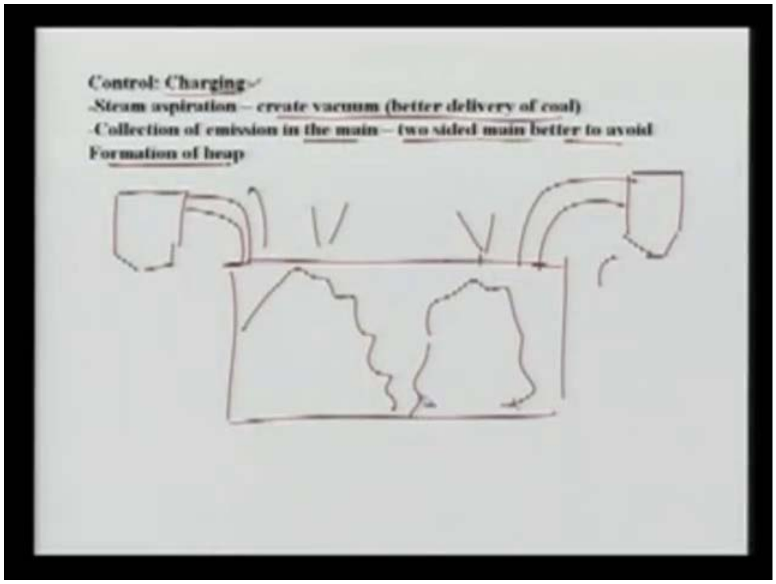
Now, let us talk about the control. Let us recap what we have done so far very quickly in half a minute. We have talked about the process, we have talked about what is coke, why it is required, what is the process, what are the emissions, what are the emission sources, what are the important compounds that we need to know within the emission sources, then we have done a little example to say how much of the quantity could be released and how much could be the impact. So comes the question we have concluded that we need to control.

(Refer Slide Time: 45:49)



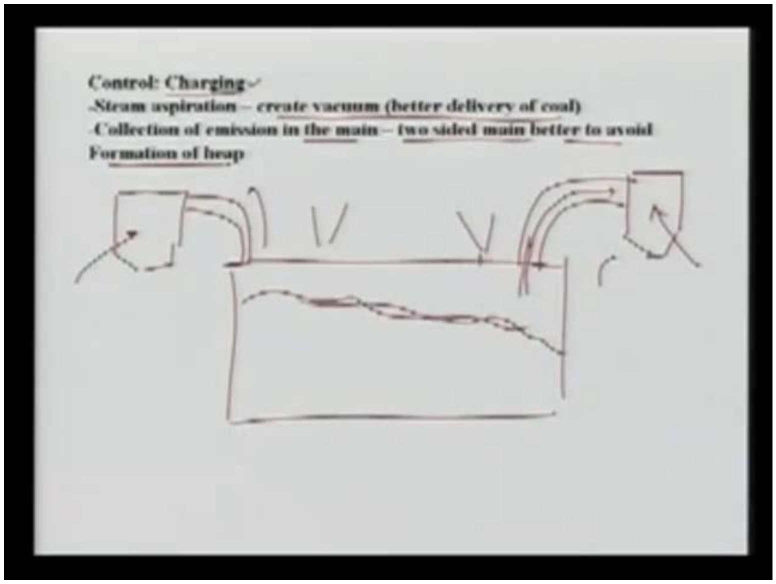
The problem we are talking about right now is what can be done at the time of charging. You remember there was a main duct on the.… This is the cross section of the battery and this is the coke that is being made. What were the emissions that are taking place? This is under positive pressure. They are sucked through this main (Refer Slide Time: 46:48) and then the main passes in three dimensional if I need to make this. What is done is when we are charging something, the larry car is pushing something and that is the time we should increase the vacuum – we should increase the suction rate so that the emissions that are taking place are taken out. How is it done? Suppose at the side of this one, I put some steam in there so that it creates a little vacuum here and quickly, all these emissions will go through this. What we do is create a vacuum and once there is a vacuum, there will be better delivery of the coal. I am sure you understand that by creating more vacuum at the time of charging, we are sucking more.

(Refer Slide Time: 47:35)



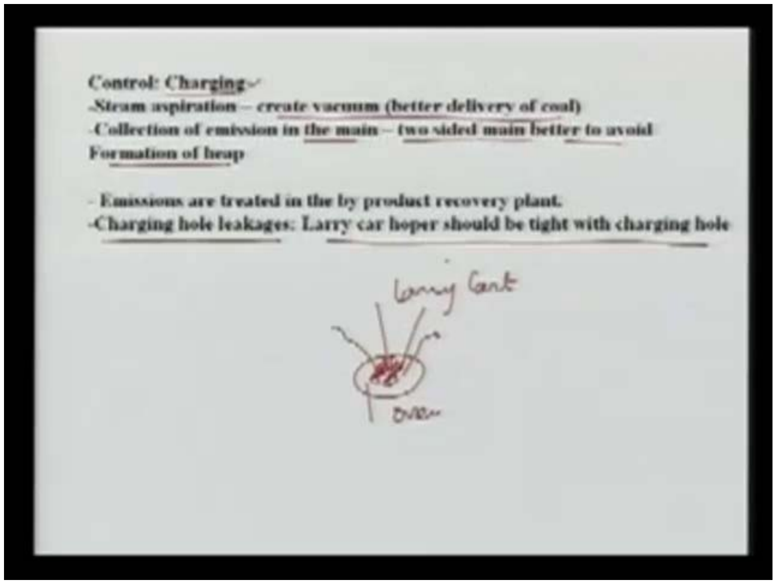
Let me remove this so that you can see it clearly. Collection of emission in the main: two-sided main is better to avoid the formation of heap. What is happening is that suppose you are charging something, this is your oven and then you are charging; as you charge from the larry car, it will form a kind of heap here and then as you are charging this side also, you will create a little heap here. What is the new technology? You are taking this thing to the main pipe or main duct, which looked something like this. You should also do it from the side as well, so that from the two sides you are taking out the dirty air and not just from one side. That is what is written here, collection of emission in the main: two-sided main better to avoid formation of heap. Otherwise, heap will be formed. If you are sucking here, the heap will not be formed.

(Refer Slide Time: 48:35)



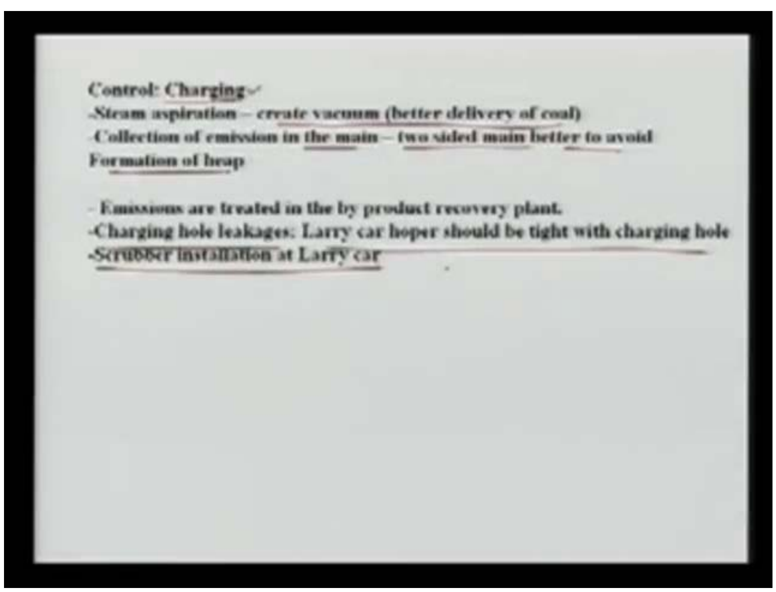
If you are sucking from this side the air and this side the air, the coal will not make a heap but it will tend to spread out like this all over the area, because you are also sucking from this side, so the coal is spread. Then, the emissions that are taking place will go to this main also and to this main also. Remember where the emissions are going – emissions are going to the by–product recovery plant. The major pollution problem is during this charging and we are able to resolve this problem.

(Refer Slide Time: 49:17)



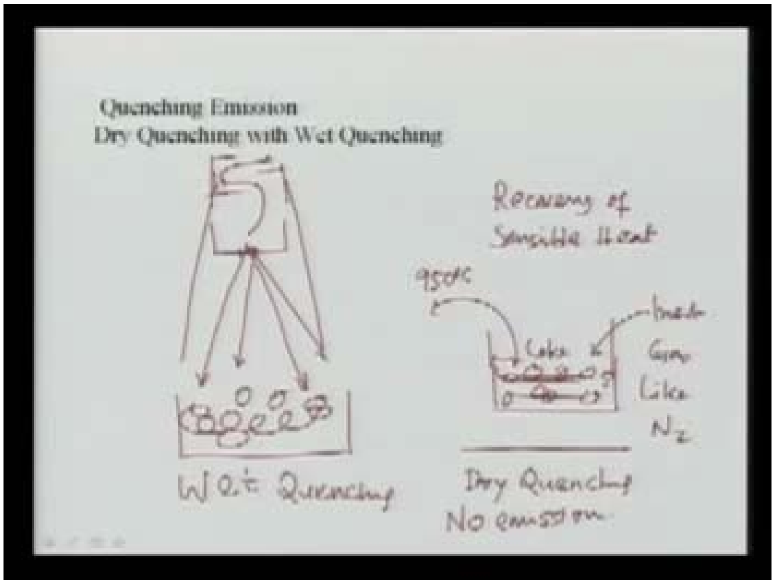
Emission is treated in the by–product recovery plant and once the emissions are collected from the main, they go to the treatment plant. Some people also talk about leakages: the larry car hopper should be tight with charging holes. As the larry car is charging and there is a hole here, this must be made be tight; otherwise, what will happen is that there will be leakages from here. This is the larry cart, for example, and this is the oven. This fitting should be very tight.

(Refer Slide Time: 49:54)



Sometimes on the top of the larry cart, a scrubber is provided. The emissions that are taking place are passed through the scrubber process. After charging, the hole must be luted – luted means closed seal. You all know M seal. This is called luted and luted means you put some chemical around this – mostly, it is clay that is used so that the charging hole become airtight.

(Refer Slide Time: 50:33)

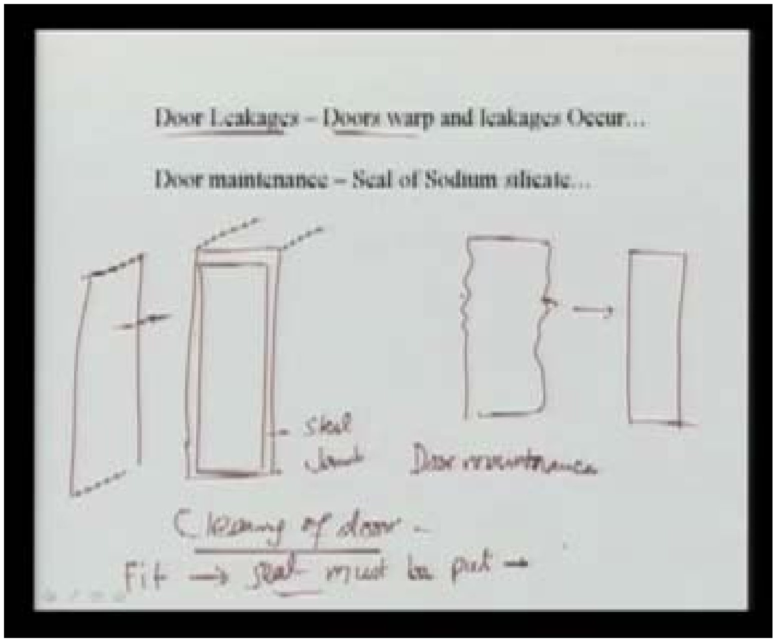


In quenching towers, what we do is.… As I said to you, in the quenching tower, what is happening is.… This is here and the cart with the hot red coke and is brought underneath that thing. There is a water tank on top of this. You open this water tank and the water starts falling down here because we have to cool down things, but there is a lot of emission in this process. What people do is provide some kind of baffle trays. The dirt has to travel this path and because of the inertia, the dirt will fall down. This is the wet quenching.

The latest technology is dry quenching – extraordinary thing. You have the cart and then use an inert gas like nitrogen to cool the things. Again, here, there is hot coke and once I am heating, we are cooling it off with the gas, then no emissions. Emissions are taking place because you are putting lot of water. In this process, there are no emissions. Additionally, the big advantage that the dry system has is the recovery of sensible heat, which is a great advantage in terms of the production economy. The reason is…. Do not forget what the temperature of the coke was – nearly 950 degree Celsius. We have to cool the whole thing off and so lot of heat will be wasted.

Rather that wasting the heat by putting water, we recover the heat by the inert gases – heat transfer can take place and the inert gases can be removed.

(Refer Slide Time: 52:57)



The other problem was door leakages, as you recall. What happens when the doors are that of…? Suppose I show you the section of the coke oven and then there is a door. This is the coke oven that is going like this, there is a door and this is the steel jam – that is what it is called. This door (Refer Slide Time: 53:34) – that is again made of steel – should go and fit exactly onto this one. What is happening because of high temperature, low temperature? If you look at the sides of the door, it is not a simple plane and so when it fits here, there is always a leakage here – there will be a leakage here. What happens? Regular door maintenance is required.

We have to clean the door, straighten it from here and we should make the door straight. Otherwise, if you are putting some seal, there will be some leakages from the side that is not perfect and so we need to stop and do the maintenance. Cleaning of the door is important. What happens is that there will be some particles that get deposited here and as a result, they stop the proper fitting here. Thus, cleaning of the door is required. Finally, once the door is fit, the seal must be put all around. Nowadays, people are using sodium silicate – seal of sodium silicate is put and that almost makes it very good.

People have been able to control these emissions very effectively. Plant managers and plant engineers are able to control them very effectively, but to make sure that they control effectively from the production point of view and from the health point of view, there are also certain laws and regulations from the Government of India. Every plant needs to follow and ensure that those laws are enforced and that proper actions are taken. Otherwise, the industry can be in trouble because the pollution control authorities can close the plant and put fines, etc., because this is a serious emission issue that we are talking about with regard to coke manufacturing. We talked about coke making, the sources, the associated toxicity, we did an example, we finally showed what the possible controls are and there are laws that the industry needs to follow. We will stop it here.