**Environmental Air Pollution**

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**Lecture No. 16**

**Sources of Air Pollution**

Today, we will begin with sources of air pollution.

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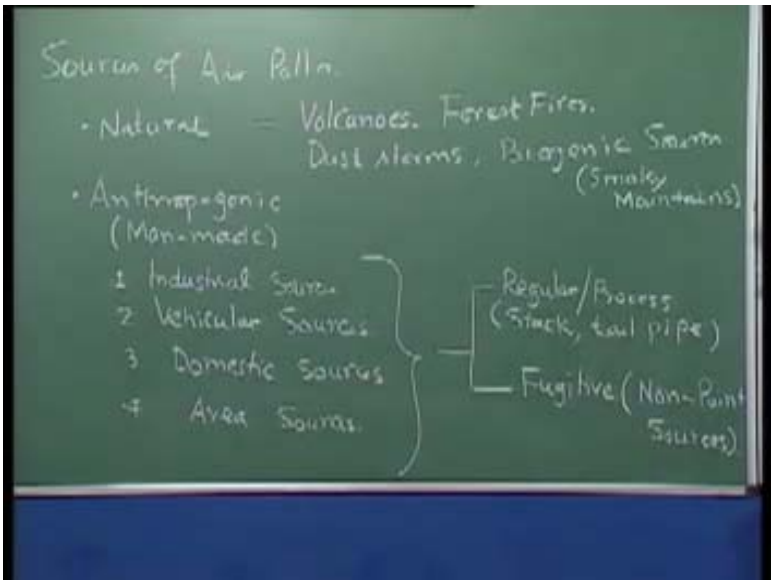


When I say sources, these can be broadly classified into two groups. One is natural and the other is anthropogenic. Anthropogenic sources of air pollution are more manmade. When we talk about natural sources, let us take some examples. Emissions from volcanoes cause lot of emissions and so do forest fires. There could also be other sources like dust storms and there could be biogenic sources like plants. The plants sometimes emit hydrocarbons. You might have heard about Smoky Mountains. These are some examples of natural sources.

If one quantifies natural sources, sometimes they can be quite large and the amount can be very very significant but when it comes to anthropogenic or manmade sources, we can further classify them into four categories. You all know that industries cause serious problems, so there can be

industrial sources. Then we have vehicular or automobile sources, there can be domestic sources and lastly, cooking in our homes. Whatever fuel we may use, even if we use a very clean fuel like LPG, it still causes some amount of emissions. That amount can vary depending on the fuel that you are using, but this can also cause problems associated with domestic emissions. So let us talk about domestic sources.

There are other sources that we sometimes refer to as area sources. We can club the sources and put them together in an area. They may sometimes be a mixture of many sources. We will talk about these sources in this lecture and coming lectures. But whatever you might think these sources are really, each one of them can further be divided into two components. A very interesting category for these two is…. We will see in a moment why it is interesting. One is the regular or process-related emissions and the other category is what we call as fugitive sources or we sometimes also refer to them as non-point sources.

We will go into the specific details of this but the regular sources are more through chimneys or a defined duct or a vent through which the actual emissions are taking place. The regular sources are through stack (if I can use the word) or you can also think of tail pipe emissions. What it really means is that the sources are generalized and emitted like regular sources. Fugitive sources or non-point sources are those sources that do not necessarily go through or which do not in fact go through chimneys or through regular means.

One simple example that I am teaching you is…. I will give you the example straightaway of the fugitive source. As I am writing here, a little bit of dust from this chalk is generated and no matter how small the emission, this chalk can also be referred to as a fugitive source. We will get into these specifics as you go by in this lecture. Let us talk a little bit about fugitive sources or non-point sources, because sometimes they are of great significance. Not only can they be of great significance but they can also be a major contributor.

Sometimes, we do not even know that problems exist – we keep on looking at tall chimneys and say that there is pollution. But sometimes these little tiny sources can be a major contributor. In fact, they are the ones that may sometimes largely decide air pollution or the air quality that we are breathing in. We need to understand these very well apart from the sources that we see in the regular pattern. Before we move to the fugitive sources, let us also talk about why we are not

placing so much of stress on natural sources. Natural sources can sometimes be in quantity be very high. Why is that? Normally, these emissions may be large but in the sense of the local air quality that people breathe, these sources do not contribute so much at the local level. What I mean to say is that suppose there is a volcano that is likely to erupt or is very active… there will not be many people living in that area. So is the case in the forest – many people will not be there. But these sources that are more manmade occur in the vicinity where we live.

We can see industries, vehicles go all around us, we cook (we cannot live without food and so that would be there) and there will be the other small tiny little sources (these would continue to be there). So we tend to place more emphasis on these sources rather than placing emphasis on natural sources. Of course, they do have significance in the global sense, but when we talk about local air quality, these sources are far more important than the sources that we see in the natural category.

The other issue, which is technology-related or engineering-related problem…. With regard these sources, there is very little we can really do to control them. There is no way that I can control a volcano and its emission. When engineering solutions are not there, then it becomes extremely difficult. So it is in the case of a forest fire. Keeping the focus on manmade sources…. Within manmade, generally people tend to ignore the fugitive sources or non point sources. Let us talk about the fugitive sources, because there is a tendency to ignore – not many textbooks would like to cover this because that is where we see and that is where we tend to recognize these sources. Let us talk about the fugitive sources.

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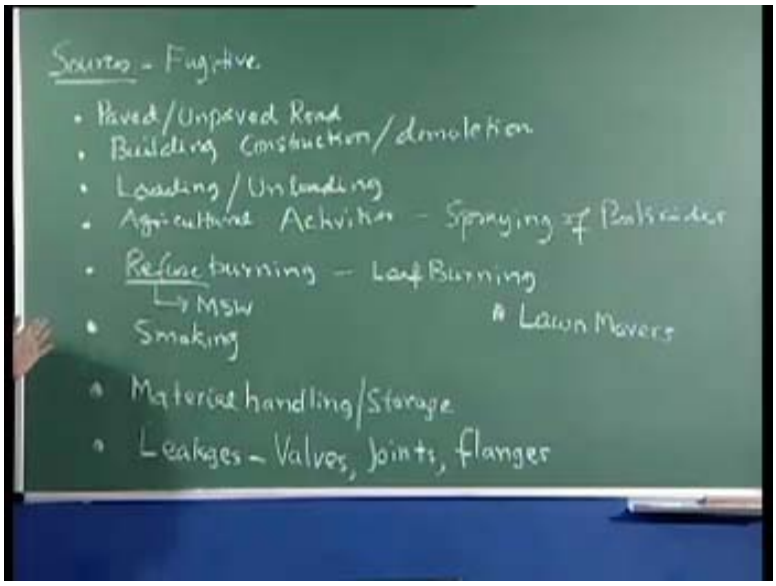


To make a little sense of fugitive sources, what I would do is I will start writing some of the sources of fugitive emissions so that we get a little feeling that these fugitive sources are a lot many. The sources that we are specifically talking about are fugitive sources – fugitive or non-point sources. For example, paved or unpaved roads. We all see vehicles moving on the road and of course, there is emission from the vehicular tail pipe but as they travel on the road, there is dust on the road because the friction between the tire and the road causes a lot of emission. So that could be one example of fugitive sources.

We also see building construction activities. You see the way the contractor and the people spread the building material all over. If a little wind blows, there will be dust emissions. Not only construction activities but also building demolition can cause serious air pollution. Let us also take some more examples. You say the loading and unloading operations. Again, the simple example is construction activity or industrial activities. Suppose somebody is loading cement bags, you see the emissions everywhere.

Loading is just an example but loading and unloading can be related to anything. Unloading can be related to organic solvents. When organic solvents are being transferred from one container to another, there will be emissions [11:44] compounds. Loading and unloading operation can also lead to serious emission problems. We will see a little later how loading and unloading can be a

serious issue. Let us also look at the agriculture activity for example. I am just writing as these come to my mind. In fact, anyone can think, be a little observant, go around and see what are the sources. Of course, there is no way one could completely list down all the fugitive sources. It is just a matter of your own observation – seeing, observing and making sense of what is causing serious air pollution problems.

In agricultural activities, you must have seen farmers spraying urea or plowing the field or they might be in fact spraying pesticides. Some of the pesticides and in fact many of them are volatile. As the farmer is spraying the pesticide, the pesticide becomes volatile and it becomes part of the emission, part of air pollution. I have given some examples. Let us write one at least so that we can remember it – spraying of pesticides. We can take some more examples. Refuse burning is a very common problem in most of our cities. People collect garbage in their houses, some of the industrial units cover some of the garbage and what they would do is put it outside, set it on fire and they think this is the best way of disposal. But it causes serious problem as far as the air pollution is concerned. All these will fall into the category that we are trying to emphasize on – fugitive emissions.

We also collect together the leaves that fall from trees during the fall period or during the Basant period and set them on fire. We can also see leaf burning in many of the cities in our country. There is no proper disposal of [14:32] solid waste. We can also refer to this as… I will write the short form as MSW, which means solid waste. They cannot dispose it off and if they do not dispose it off, it is going to degrade, it is going to cause a lot of emissions and it will emit a bad smell. Sometimes, people find it easy to set leaves on fire without knowing that this also causes serious air pollution. We have also seen people burning tires in the wintertime, for example, to heat themselves up. All these will come under the category of refuse burning.

Let us take some more examples. I would also say that smoking can come into this category of fugitive emissions; cigarette smoking would also come under this category. Let us see if we can remember some more fugitive sources. If you go into industrial plants, material handling… to some extent, we cover that under loading and unloading but material handling can be a serious source of fugitive emissions. Not only material handling but even material storage. What I mean by storage is that suppose you are storing coal dust (the coal that you are going to fire

somewhere) and the condition is summer with a lot of wind, then you will see a lot of coal being emitted in the air. So even storage can be a major issue. Let us complete and fill up this board with examples: material handling, storage, smoking, refuse burning, industrial activities and loading and unloading. We should also not forget the emissions that may come out from the industrial area in terms of leakages. What leakages? There could be valves that may leak, there can be joints that leak and cause air pollution and there could be flanges that can cause serious problems. I again repeat that it is difficult to write down all these – it is a matter of one being smart enough to observe these sources and to say that these are the sources.

Another example I will give you, which was very interesting, is the source emissions from lawn mowers. Sometimes, in huge gardens and parks, people cut grass and use lawn mowers, which have engines and are motor-driven. A lot of emissions occur from there. Most of the time, it is found that the lawn-mowing engines are of bad quality and the emissions can be very very large sometimes. We will get into more of these specific to the industry to give you a feel of the industrial non-point or fugitive emissions, but let us also see why we are putting in so much time and efforts in trying to understand fugitive emissions.

I can also add some more important fugitive emissions. What these emissions could really be is the emissions related to auto exhaust. What I mean by auto exhaust is that if there is a tire on the road, there is also tire wear. Whatever is inside the tire can also come out and that can be another significant source. I can also give you some more idea about non-point emissions from a sewage treatment plant, for example. You all know that wastewater treatment takes place. Wastewater treatment plants are a good source of $H_2S$. They are a good source of volatile inorganic compounds and odor-causing substances. It is just a matter of you yourself realizing what the sources are.

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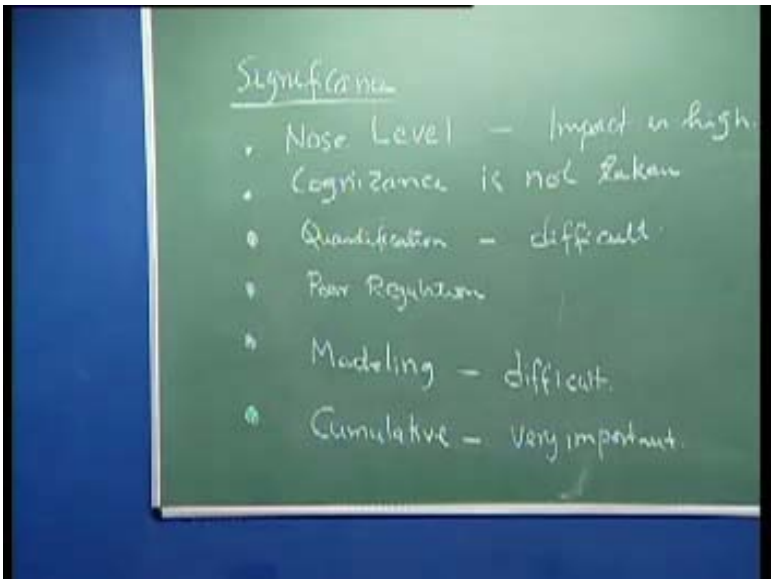


Before we get into more details of this, let us see what is so significant about non-point sources. One of the most important things about these sources is that most of the fugitive emissions will be at the nose level. It means that wherever you are, the emissions are at the breathing level. You would be likely to breathe that emission much more than probably the emissions that are occurring from chimneys or from tall stacks. At the nose level, the impact is high. The other major problem is not taking them seriously – cognizance is not taken.

The problem is that we are born with the sources. As we grow up, we seen these sources and so we do not find them any different from what we see every day. We do not recognize them, we do not even take them seriously and cognizance becomes very difficult. We have the tendency to look at chimneys and that is the problem. We have to take a serious view of fugitive emissions. The other importance of this is that the quantification of the source is a little difficult. They occur in large areas and you do not know where to go and measure and say that so much is the quantity of the emission because for controlling the emission, you first need to know how much the emission is. So quantification is difficult.

The other thing is poor regulation for the control of these sources. The environmental laws pertain more to chimneys and to larger sources and no one would talk about dust being emitted – there is no regulation. If there is no regulation, the industry and the people do not take it

seriously. So we need to have good regulation to even talk about fugitive emissions. Let us also talk about one more important point. You have learnt and you will learn that the idea is to see how they disperse and how they go and impact people. The process of describing the emission, its transportation and its impact on people is what you call modeling. When the sources are not well defined, the modeling to find out the impact becomes very difficult (here, I am referring to air quality modeling) and that is another problem.

In my opinion, the major problem of this is that in a cumulative sense, there may be five thousand small sources that we do not take seriously but when put together, they may be larger than, for example, a large power plant. So in a cumulative sense or in the total sense, this is very important. Now, what we would do is as we are discussing the sources, I will very quickly write a few points about what we can do to control these sources.

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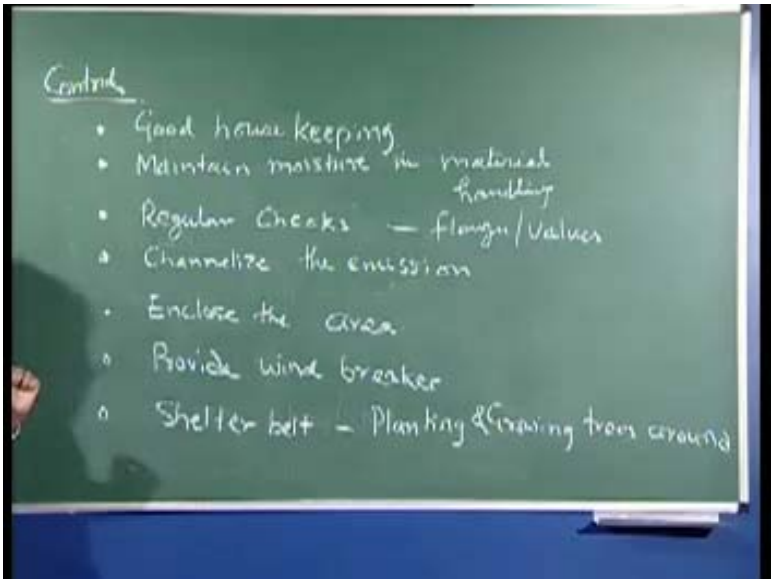


Control. We talk of simple options. What are the simple options? What it really needs is good housekeeping – keep things clean and do not let such things happen. Good housekeeping means…. If you are constructing a building and you have all the building materials covering the whole area, those emissions are not going out. If possible, the other options can be to maintain a little moisture level in the raw material that you are handling – that is a big help; maintain moisture in the material that you handling.

I am not necessarily saying maintain moisture in everything that cannot contain the moisture. For example, when you are handling cement, I am not saying please maintain some percent of moisture – that will be disastrous. Maintain the moisture in the material handling and then, regularly check your flanges and valves, because these fugitive emissions are sometimes simply not pollution. It is your own resources and your own raw material and your own product. If that is being lost, then you are economically doing a very poor job. What else can be done? Channelize them if you can, somehow.

If you channelize them, then there is a good possibility that it can be controlled. Channelize the emissions. Enclose the area where you are doing such operations – simple thing. One more option that you have is to provide what you call as windbreakers – something that will slow down the speed of wind and as a result, the emissions from their storage area will sometimes go down. Provide shelter belts. I will explain to you what a shelter belt is. A shelter belt is smartly putting the trees around the area where you are likely to have emissions. A shelter belt is largely growing trees around the area of operation where you have this serious problem.

Shelter belts include planting and growing trees around. Some of you might have gone to Taj Mahal now or twenty years ago. There are no trees, there was no forest area and in fact, a very important decision was taken to grow a lot of trees around the Taj Mahal so that some of the pollution will be prevented by the trees that grow there. I am not necessarily saying that the trees will absorb the pollution or that trees will filter the pollution, but what really happens is that as the pollutants encounter the trees, they are lifted up and pass from that area and then go away. Let us not get the feeling that shelter belts will absorb the pollution. They do, but not to the extent that you can decide that there is a major mechanism of pollution control from shelter belts. There is neither absorption nor filtration but it simply moves the air mass with dust to a higher level and disposes it far away.

These are the various options people try and more engineering options are also there, but these are the general things. If you are near a shop where there is a lot of dust, what you can do is put a little bit of water all around, if you have water. You do not need to have very high quality of water. Spread that around and you must have observed that shopkeepers are the ones who are exposed so much to the dust because vehicles are moving, somebody is moving around and there

is dust. On a periodic basis, what they do is a simple thing – put a little water around the shop. It gives a good smell as well. It also prevents a lot of dust emission that can possibly come because of this. These are small things but important things. Sometimes, the smaller options are better options and more doable. What we will do is stop this discussion of fugitive emissions. Everyone should observe and do something about this because they are significant, they are important, they cannot be ignored and moreover, they occur at the nose level and in the cumulative sense, they can be really a very significant and large source.

The idea is that we go to an industrial process and talk about industrial emission as well as a little bit about fugitive sources because as I said, fugitive sources can occur not only in the urban area but can also occur in the industrial area. We will move to the industrial sources and then what we are going to discuss is what you call as thermal power plant. We have all seen the plant that produces power and there are a lot of environmental issues related to emissions that are through chimneys and emissions that are fugitive in nature.

We will move to the next topic and I will take the help of some computer graphics to talk about that. Now, what we will do is talk about the industrial air pollution sources. One of the major air-polluting industries is the coal-based power plant. We will focus on coal-based power plant and it is also important to study this industry as we are a growing economy.

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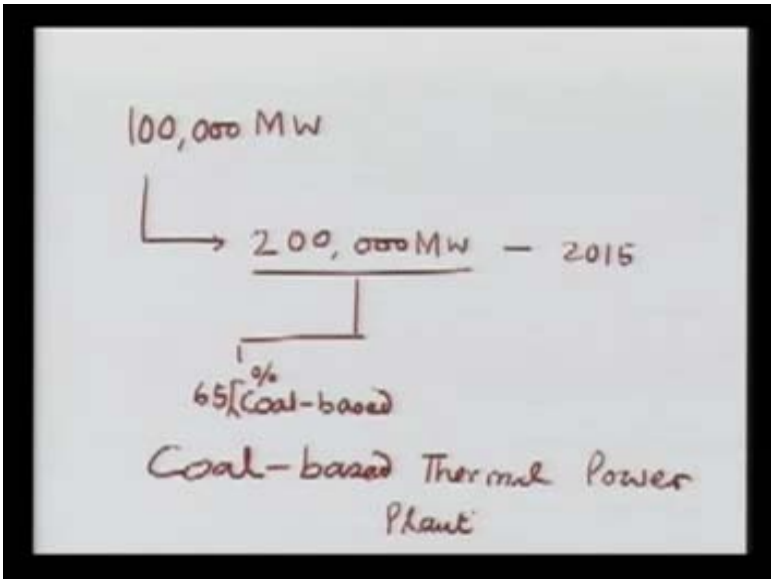

We are producing right now about 100,000 Megawatt of power – the installed capacity is a little over 100,000 Megawatt. We are also planning because we all need energy and electricity. The government is planning that this capacity should be doubled to something like 200,000 Megawatt – that would be a major effort. The plan is by 2015, we produce or we have power plant capacity or generation of about 200,000 Megawatt. It will be interesting to know that almost around 65 percent (of course, this number can vary) can be coal-based and the rest can come from other sources.

Coal-based power plants form 65 percent; let us use the word percent here; 65 percent will be coal-based power plants because we have a lot of coal and we want to utilize the coal for power generation. The issues related with coal-based generation are many, especially air pollution. We all have seen tall chimneys and in fact, in the country, the tallest chimney that you see is from large power plants. You would be surprised that a power plant of 500 Megawatt capacity will have a stack height or chimney height of 275 meters. What I would do is go through the process and try to identify the sources as we proceed in the case of a coal-based thermal power plant. What we are going to discuss now is the coal-based thermal power plant. Let us move to what the power plants look like.

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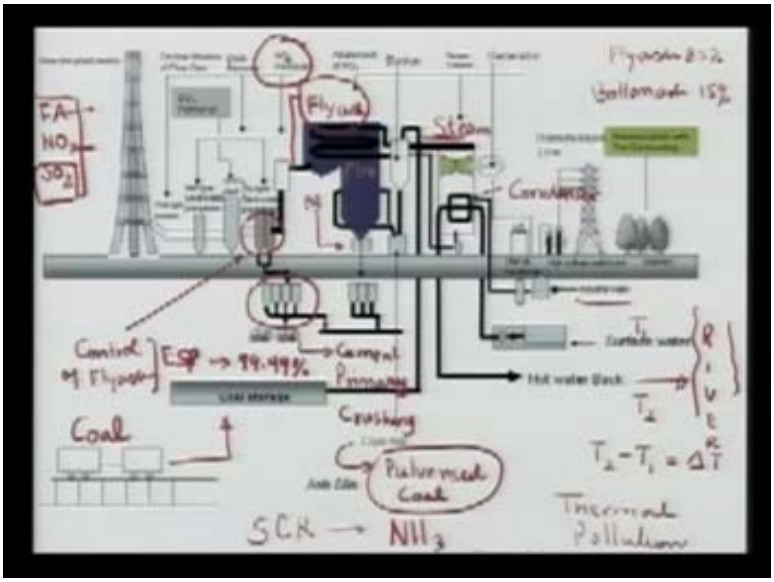

You see the little thing there on the top – how the plant works. Let us go through the process of power generation. This is the baseline I am showing. First of all, you see a little thing that is coming on the corner of the screen. It is bringing the raw materials that are required. This raw material is largely coal and it can come either from the shelf or from the mining area where the mines are. This coal is brought to the power plant through railway wagons.

You would also see that this coal is immediately dumped and stored – coal storage. The next step in the operation is that there is some kind of coal storage and some primary crushing. I can say here that primary crushing is done and the coal is transported through the conveyor belt. What you see here, the strip that is going here is essentially the conveyor belt that will take the primarily crushed coal to what we call as the bunker or storage of the coal. Then, what we do from storage of coal is further take it to what we call as the coal mill, because we now want to make the coal still finer.

How we make the coal finer is to take it to the ball mill or the coal mill. Most of the time, it is a ball mill. It uses huge steel balls and put it into the large container. The whole thing is rotated and the balls keep falling on the coal. In the process, the coal becomes very fine. Once the coal is fine, of the size let us say anywhere between 20 to 100 micron, the coal is sufficiently fine because we are not talking a great deal about combustion engineering, but what we are saying is that once the coal is powdered, what we get from the coal mills is what you call as pulverized coal.

This pulverized coal can be now used for combustion to obtain energy. How it happens is… What you can do is… the coal from the coal mill, the outlet from the coal mill will go to the boiler or the little firing area that you see. Apart from the coal, air is supplied and the pulverized coal burns very well giving high temperature, high energy and then what we do with this energy is to have a system of water tubes. You cannot see very clearly here but you can see here the tubes that are filled with water and the heat that is generated from the boiler is the….

This is a kind of water tube boiler. The water is heated here and then steam is generated. The steam is passed through this area. What you can say is that this is the outlet of stream. Let us write this as the steam that is going out. What happens is the steam is [36:59] and runs a turbine. You can see the turbine here with a steam jet. It hits the turbine and the turbine is rotated and in

the magnetic field, what you get is electricity. It eventually produces…. You can see the generator here. After having done the job, the steam, which had a lot of energy, must be cooled down as you can see here. How the cooling is done is through condenser cooling. What you see here is a condenser.

How does the condenser work? This also has environmental issues. You take the surface water or it could be the water from the sea. Suppose there is a river here, you are pumping water and then providing a large surface area. The surface water is relatively cool and it comes in contact; it is not the water but the surface that comes into contact with the steam and as a result, the steam will condense and make the water here. This cooling water is in the closed circuit here. It does not come into contact with the steam. It is taken out and is disposed of back to the source that was there.

One of the issues that you see here is that the surface water was at temperature $T_1$ and by the time it has done the cooling operation, the temperature goes up and this temperature becomes $T_2$ and we can call $T_2$ minus $T_2$ as delta T. It is the rise in the temperature of the cooling water. This also causes what we know as thermal pollution of the receiving water body. As you can see here, there will be a rise in the temperature and in fact, it affects the ecology here and the [39:10] and the other important ecological functionaries would tend to migrate away from there and change the ecology there. This is one of the issues.

We should try to ensure that the rise in temperature is not very high or we do some kind of treatment to bring down the temperature $T_2$ to something very close to the receiving water body, which may be a river or even a lake or it can be seawater. This is a little portion of the water pollution problem. Let us see what happens further in the power plant. As you can see here, sometimes, you also need makeup water because at some point, all this steam will not be enough.

You see here the word industrial water. Industrial water needs some cleaning especially to make it deminerialized, take out the hardness, bring it up here and prepare the makeup water. Industrial water is makeup water as you can see here. After the steam has cooled down and condensed into water, this is further pumped from here and back to the boiler. Again, it goes through the process of heating for the boiler and the entire water becomes steam with a lot of super-saturated steam or rather super-heated steam so that it can again produce power for us.

This cycle goes on and power is generated. You can also see that eventually, the power is transmitted various transformers. But that part is okay. Let us talk about something else. Almost all power plants will have a green belt around them, as we were discussing, largely to tackle fugitive emissions or to give a better ambience to the power plant. Let us go further. Let us come to this side and see what else is happening. What you would see here in the boiler is that when you are burning the coal, ash will be generated because ash is something that you cannot really burn.

What will happen is that some ash will immediately fall down here (Refer Slide Time: 41:30) and we call this ash as bottom ash. Why bottom ash? It is because it is at the bottom of the boiler. What happens is that the ash that does not settle here or does not fall down here will be emitted from the process and will go to another process, which we will discuss. We call this ash as fly ash. As I said, the ash from the bottom of the boiler is called bottom ash. Maybe I can call this as BA – what you are referring to as bottom ash.

The bottom ash should be immediately collected at some intervals and stored in [42:21] and then needs to be disposed. The disposal is a little important because as you will agree with me, in the coal apart from the carbon and hydrogen that you can burn, you also have the ash that is largely silica, which cannot be burnt. You also have many metals present in the coal. Most of these metals that are present in the coal will eventually stay with the ash. Disposal becomes an issue and fly ash is a major component. To give you a little feel, the fly ash generally for such power plants is 85 percent of the total ash and the bottom ash, which I call as BA, is around 15 percent.

Fly ash is really very fine. The particles are very fine, much finer than the particles that we had created at the first place through the ball mill or through the pulverized coal. If you see the particle size, especially what you had fired in the boiler, the size of particles that are created or formed during the fly ash are much smaller and more problematic from both the public point of view as well as control point of view. Let us see what is the control mechanism that we have. Apart from the ash, you would recall from the combustion process that some insignificant from the air pollution point of view NO or $NO_2$ is also.… in fact, it is mostly NO, so we should really call this $NO_x$, $NO_x$ is also emitted. The first thing we would do before fly ash is that $NO_2$ is controlled.

We call the process of control of $NO_2$ as SCR – selective catalytic reduction and we will see that a little later when we talk about control. At this stage, it is reasonable to know that the $NO_x$ must be controlled through selective catalytic reduction, because $NO_x$ is a serious problem. What you mostly use for selective catalytic reduction is ammonia. [45:00] is based on using the ammonia to reduce the $NO_2$ or $NO_x$ into nitrogen and oxygen.

You do the first part but let us not forget that we still have fly ash. The rest of the process is then…. Once the $NO_2$ is controlled, then you can bring it to the control of the particle matters. All the fly ash is controlled here. I can say here control of fly ash. What do you see here? Once the fly ash is collected…. The [45:46] through which you collect the fly ash is what you call as ESP – they are called electrostatic precipitators. You can also use bag filters. We will talk a little later about these technologies but let us understand the process, ESP, more so the fly ash.

You will be surprised to know that the amount of fly ash that we can control is of the order of or sometimes even greater than 99.99 percent. As a result, you do not want to see your chimney emitting anything – your chimney should look very clean. Fly ash is collected here and once it is collected at the bottom of the hopper of the ESP, it is again collected in the [46:38]. You see here that this is the fly ash [46:43]. Then, it is put into trucks or these can be put into railway wagons and can be transported back.

It might be interesting to tell you that this fly ash earlier posed a serious problem of disposal. Now, this fly ash can be used in cement plants. Cement plants are buying fly ash from power plants, blending it with the cement that they are producing and finally making the cement that is used in the construction activities. This is the story of fly ash, but sometimes, if the fly ash is not collected and not put into trucks for reuse and recycling, the fly ash is disposed of through the wet slurry. What we do is we make the slurry of the fly ash that is collected and dispose it into fly ash ponds.

Apart from the fly ash, let us not forget that emission of sulfur dioxide also takes place. In fact, I may mention here that the major source of air pollution for the power plant is fly ash – let us call that as FA. We have also seen that $NO_x$ is the other source or pollutant. The next pollutant that is again of great significance is $SO_2$. In the plant, first of all, $NO_x$ was removed – you can see here that $NO_x$ was removed, then the fly ash is removed – you can see here that fly ash is removed

and the next step is to control $SO_2$. Here, you see $SO_2$ and the plant that controls $SO_2$ is called desoxing.… I hope you can read here – desoxing plant. How we do desoxing is we use lime or use calcium carbonate and calcium carbonate will react with the sulfur dioxide and especially with the temperatures that we have and it will produce calcium sulfide and $SO_2$ will be completely removed from the process.

Dust might even come out from the desoxing plant. You again have ESPs and these ESPs will remove the particles that might have got carried over from here. Finally, once the entire cleaning processes is done, we let the flue or the flue gases out through the chimney. These are generally tall chimneys as you can see here and they can be anywhere from 150 to 750 meters tall. This is the process of power generation but here, we have just focused on boiler-related emissions.

What are the emissions? Fly ash, oxides of nitrogen and sulfur dioxide. These need to be treated before they can be sent out through the chimney. This is the process. Maybe very quickly, we can repeat the process. Coal is brought down, stored and the coal is primarily crushed. It is sent back to the bunker where it is are stored. From the bunker, it is passed on to the coal mill where it is further crushed down to the small size of microns and then it is fired along with the air. In the process of firing, you have the water tube boilers. Steam is generated, super-heated steam comes and it goes to the turbine. The turbine is rotated because of the steam heating the turbine blades. Then, it is connected to the generators and you get power.

The steam is condensed and then water is used for the condenser – cooling water. The water is normally taken from the nearby source and cooling is done. Water at high temperature is disposed of back from the source. The emissions that occur from combustion are particulate matter, which is again divided into two parts. One is fly ash and the other is bottom ash, which we called as BA. Fly ash is about 85 percent and BA is about 15 percent. Then, the flue gas is subjected to treatment for the removal of oxides of nitrogen, fly ash (which is particulate matter) and sulfur dioxide. The clean air or the clean gases are led through many tall chimneys. This is the process. We have seen how power plants generally work, what are the emissions, what are the controls that need to be done, but do not forget that we are talking about fugitive emissions. Let us discuss the fugitive or non-point sources from power plants.

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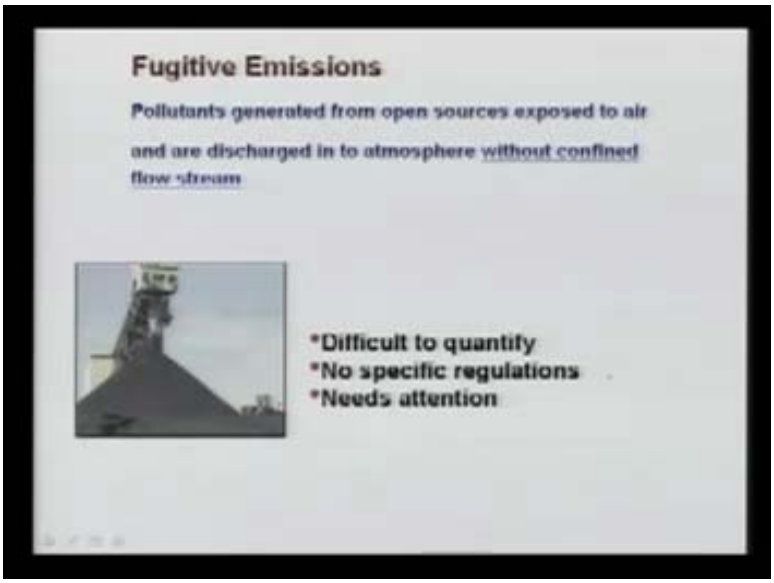


If you recall, we were discussing about fugitive emissions and then we also listed the significance and the reasons why we should study fugitive emissions. We not only observe fugitive emissions in our daily life but they are also an important issue in the industrial processes. To demonstrate one, we would take the example of the power plant because we have studied the regular or chimney emissions from the power plant. Let us talk about fugitive emissions from the power plant.

Again, I will quickly give you the definition. Fugitive emissions are pollutants generated from open sources exposed to air and are discharged into the atmosphere without confined flow stream. What we mean by confined flow stream is that they are not from chimneys, they are not from a duct but they are in more like an open thing. See here the picture that has come up on your screen. You will see that coal is being stored. What you see here is that coal is constantly falling down on the [52:48]. It makes a heap here and as the coal falls, there is a possibility of emissions that will occur from here. The coal dust will be emitted like this from both the sides and this can cause very significant emissions. Apart from that, if the wind is blowing like this, let us call this as W – the indicator of the wind. The wind is here and you see some dust also coming in the side here.

The problem as we have discussed is difficult to quantify – we do not really know as to how much would be the emissions. There are no regulations, the government or the system so far does not say as to how much emissions are to be controlled, how this is to be controlled and how to put up the condition to see if this is being controlled. This is the difficulty and no doubt about it, we have put enough emphasis on this in this course as we need to really give attention, understand the problem, quantify it and control it. These are the examples just to introduce you to the subject of fugitive emissions.

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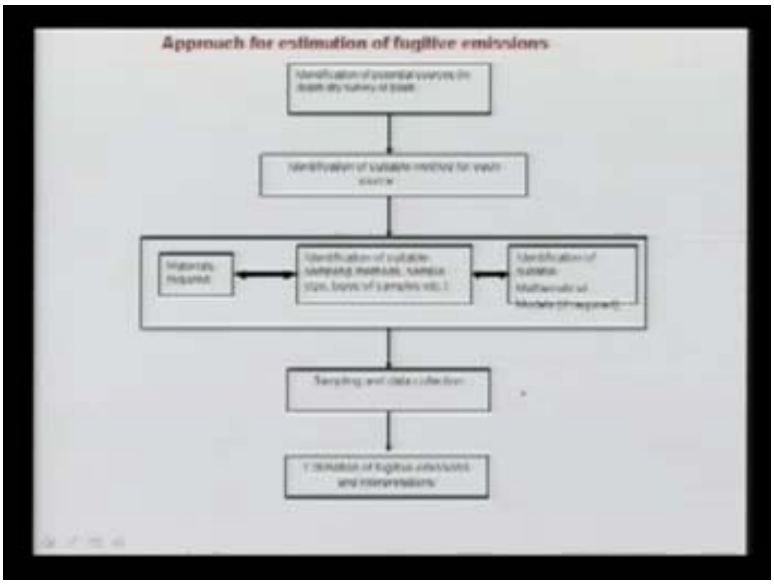


What is the approach if one wants to assess fugitive emissions? What you do is that you should identify the potential sources for the in-depth study. Go around the power plant once and look for everything and be a little observant. Go around the plant and identify the suitable methods for each source. Now, we have to quantify the source – how much is the emission. Then, we will learn to some extent the different methodologies that are required to estimate or to quantify different kinds of fugitive sources.

You also need to see what method we want to apply to quantify – what method. Once we have the suitable methods, we need to do the sampling – you can say identification of suitable sampling methods, sampling size (how much is the sample that you want to take so that it is quantifiable), type of samples – long-term samples and short-term samples and then determine

what are the materials required for the sampling. Sometime, you need to take sophisticated instrumentation to the field. You should know beforehand the kind of samplers that you need.

Then, you also need to identify a suitable mathematical model. Sometimes you will see that apart from the measurements that we do, we also have to apply some models for the estimations. We will also see what kind of models. Let us put that as a question mark because we are going to see that. Then you do sampling and data collection – that is what we are aiming at. Finally, estimation and interpretation is very important. We will see what these really mean – we will do these with some examples and hopefully, we will be clearer as to how one can handle the issue of fugitive emissions.