Fundamentals of Environment Pollution and Control
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Air Pollutants

Today, we will start this air pollution and their, the effects of air pollution and in this you know we would discuss about the difference types of air pollutants but let me before I go into explain this you know let me introduce to you to the subject and the importance of the subject as such. See, air pollution is over the years you know for last 10 years or say for about, say for about 2 decades now, there has been a tremendous growth of air pollutants which are, many of which are in the circulation. As you know, you know as I was discussing you know in the beginning also in many cases you know the natural processes which generate this air pollutants and the artificial processes like the manmade processes that generate air pollutants both have some similarity but the only difference is the, in the, in the matter of quality of the pollutants as well as the quantity, the quantity being you know in a natural stream you know natural situation, the quality quantity is much less, quantity is you know and the quality is also relatively better because you know I will discuss more and more on what are the types of pollutants we are producing now.

Many of them we have never heard before you know many of the air pollutants, the critical air pollutants today were not heard before say only up to 10 to 15 years back they were not heard even, those kind of pollutants we are now generating and they have tremendous serious impact on the health and the life of humans. We will mostly discuss this as I have said air pollutions you know with the, we would deal with the mostly with the related to the effects on human, we will not be in a position to know more about the effect on the other animals like you know the cows, the dogs and the cats you know what are the other effects but you know we can the similar studies are now being found where the impacts of this pollutants on the, on the other animals are also being studied and it has categorically shown that you know this has there is an effect, there is a serious impact on the air, on the air pollutants like you know I let me tell you, you know very visible examples of air pollution and other related pollution effects is you know in most of the cities now you will not find small birds anymore. The small birds that you see here in Kharagpur may be particularly if you, if you wake up about say 3.30 in the morning or say when if you are, if you just observe at the afternoon say about 5.30 you will find lot of small birds around, I mean the mostly these small birds are no longer seen in the cities, no longer seen in the cities. The reason being is, one of the reason being is mostly say, mostly the, most of these birds and the creatures like that they have a very small blood volume.

So, the mass of blood in them is very small, so you know they react very fast with the, with the change in the air pollutants. So, they are, a small absorption by the, by the blood stream of the small animals can alter their style, life style, alter their you know living pattern. So, you will find mostly it is with the, with the damage in the of the habitats of the birds and other animals as well as, as well as along with as well as along with the typical, typical aspects of you know air pollution, we find today that you know the most of the birds are not seen in the cities anymore. So, similarly only you will find the crows or you know some larger birds but small birds like sparrows you will now hardly find sparrows in cities anymore because of, because of tremendous

growth in air pollution, there is a tremendous growth in air pollution. In trying to understand this I mean what are the typical impacts on human, if the impacts on human you know without you know without having to know much about air pollution you can still say that you know say there are more breathing disorders in the, in the city population today. Many people suffer from asthma or asthma related diseases, bronchial cardial diseases. Many people suffer from you know say typical say like allergens related diseases where the allergies take place you know different types of allergy, cold allergy, irritational allergies like you know skin irritation, eye irritation all this kind of things take place you know and they are actually growing in number and their effect has been wide across. More importantly particularly you know in the cities areas likely you know where there is a dense pollution, as well as there is a dense traffic and also there are say particularly in those areas you will find that you know combustion of fossil fuel is also more. In such situation mostly the children who are born of this situations, they are likely to be born with retarded brain growth, retarded brain development.

So, there are direct and indirect effects, you know some of the effects of air pollutants are clearly visible that you can see before your eyes and there are some, many of the effects which are not visible, which might be apparent say 10 or 15 years after a person is exposed or consistently exposed. So, we have, we do briefly study about them the typical types of you know this kind of pollutions and their effect. To sum it up you know since we do not have much time left you know to discuss about this air pollutants, let me go straight into the, straight into the aspects of air pollutants. So, here you know will briefly discuss about the typical types of say the sources and the typical sources and the type of common air pollutants.

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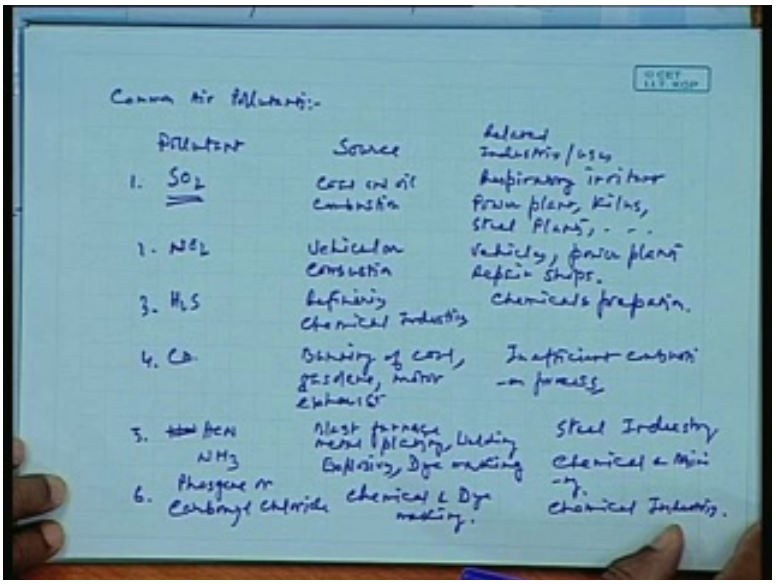

Let us know start from say you know common air pollutants, common air pollutants. I will also discuss this you know with aspect to different industries say you know is pollutants. This is pollutant source say related industries, industries or uses or typical uses that we can deal with say you know one of them, one of the large you know say a largely effecting pollutant is sulphur dioxide So 2 that you know this is a colorless gas produced say due to from coal combustion,

coal and oil combustion because you know coal and oil combustion as you can see mostly you know say coal and oil naturally would contain some sulphur. As I was discussing in the case of limestone or in the case of many other minerals that we know there will be a, always a some sources of sulphur. So, sulphur when it is being smelted, when it is put under a, in a smelter when it is fried and burnt, so this sulphur would easily convert into sulphur dioxide and that would be, this is the respiratory, respiratory irritant, respiratory irritant. See, all this kind of power plant, kilns then you know say, say all this other energy producing say power plant, kilns you know wherever there is a steel plants, steel plants, so almost all, almost all kind of industries somewhat related to sulphur dioxide it brings out a certain level of sulphur dioxide.

Say, this is similarly is nitrogen dioxide, some of you might be knowing say the most important say the vehicular pollution, vehicular, vehicular, vehicular combustion, vehicular combustion say as you can see this mostly all these vehicles, vehicles, power plants, power plants and also whereas you know particularly a different other sources like say refectories say now here say any other wherever we are using say liquid fuel, we would create nitrogen dioxide anywhere say any other say repair shops, etc so you can see all this places, this kind of nitrogen dioxide would be produced. Remember one thing nitrogen dioxide, all these you know as see as this sulphur dioxide has a potential to become sulphuric acid or sulphurous acid and sulphuric acid, nitrogen dioxide has a capability to form HNO 3 which is also acidic in nature.

So this a, this all this you know particularly when it is formed they have one important aspect is NO 2 particularly, NO 2 particularly has you know a work in synergistic effect in sometimes with atmospheric ozone. So, you know specifically related to, related to this two together, the effects of two together is more than the sum of each individually, right. So, it is basically is equal to 1 plus 1 is more than, 1 plus 1 is more than 3, more than 2 like this. So, here that effect of two together synergistically is more than 1 individually say more than the sum of each individually. So, this is, this has you know great effects, we will study some of those say H 2 S sulphur dioxide say this refineries, mostly refineries, refineries you know all this chemical industries, chemical industries, chemical industries, chemical industries, so it's a refineries and chemical industries are particularly related to you know so all say chemical, chemicals preparation all wherever this chemicals preparations is generally done H 2 S will be obtained.

Say it's a carbon monoxide, carbon monoxide as you know say burning of coal, burning of coal, burning of coal, gasoline, gasoline means petrol or diesel say then motor exhausts say any inefficient, inefficient combustion process, combustion process will have, apart from this you know we find hydrogen cyanide HCN refined ammonia, ammonia then we can find say this aldehyde they known as phosgene, phosgene or carbonyl chloride. See, this is a blast furnace, blast furnace we find them in blast furnace, this is almost all this metal plating, metal plating, welding we find a great amount of you know HCN being produced say you know creation of explosives NH 3 explosives, explosives and you know dye, dye making say phosgeneous chemical.

See, all this you know this blast furnace you know steel industries you can see mostly steel industry you would be related to this, say this explosives you know dye making explosives industry, chemical and mining industries, chemical and mining say this phosgene mostly in the chemical industries, mostly in the chemical and other industries, chemical industries. So, we

have 1 here, 2, there is 3, 4, 5, 6, this are mostly where they are from or mostly where they are from say related industries which are generally, this is for a general class as I have said, so just to you know start the course here, what are the sources mostly the what are the air pollutants we are generally discussing about.

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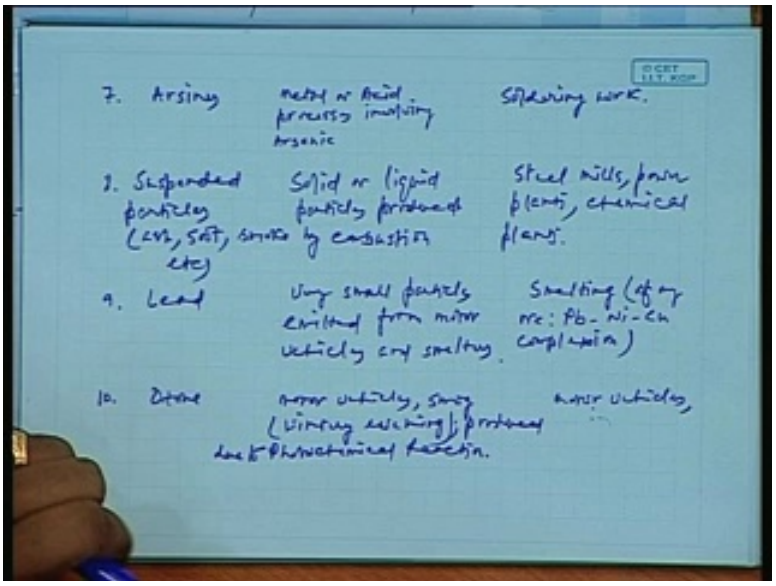

Say, the 7 is the seventh is the arsines, arsines are mostly say this metal or acid processes metal or acid processes involving, involving arsenic, involving arsenic. Say, it's a mostly say this soldering industry, soldering work wherever there is a soldering work arsenics or arsines should be used, would be exposed. This suspended particles, suspended particles, suspended particles ash, soot, smoke etc, smoke etc then solid or liquid particles produced by combustion, liquid particles produced by combustion mostly you know from different say you know this mostly from say power plant, steel mills, steel mills, steel mills, power plants, power plants say and say chemical plants, chemical plants etc.

So, here this is the suspended, I will come back to in greater detail on this, the effects of that you know say lead, this is lead earlier use to be you know very small particles, very small particles emitted, emitted from motor vehicles, emitted from motor vehicles and smelters. I think I have referred to this things you know in a introductory class, if you remember earlier in the classes you know when we started this course but more and more you know we just since we are coming to these areas particularly, so you know would be smelting, smelting of any ore, of any ore actually is that there is almost all ore, almost all ore they have smelting of any ore. This is most of this ores they have whatever may be the primary mineral, whatever may be the primary mineral of interest there would be some complexion of lead, nickel and copper, lead, nickel and copper. So, you know whatever may be the mineral finally lead would be released I mean in the case of you know and particularly say elemental lead, elemental lead can be produced you know say you know say these are they generally forms you known in the from a say their the temperature at which the evaporate is relatively less than the other metal. So, you know they go immediately transmit in the air, they become you know evaporator and finally come into the air.

So, this are, so this lead is known to be is likely to be a potential carcinogen is which is likely to be a carcinogen and but also it helps damaging you know the nervous and blood forming streams. Then the final is the ozone, ozone is a particularly motor vehicles, motor vehicles you see motor vehicles you say where as a smog, most of the smog particularly wintery, wintery evenings, wintery evenings you know particularly this ozone which is formed as a, as a means of photochemical reaction produced due to, produced, produced due to, produced due to photochemical reactions and this as you can see this motor vehicles mostly this motor vehicles, motor vehicles say all this you know photochemical reactions particularly see it's a nitrate, see this nitrogen and oxygen radical finally forming during a photochemical reaction process forms this, forms this you know ozone which is highly reactive you know in such cases ozone is highly reactive which can actually lead to, lead to some kind of irritational, some kind of irritation.

Contrary to the popular belief you know is that you know as we have known stratospheric ozone is helpful for our health but this ozone which is formed due to, which is remains in a combination of other gaseous, gaseous and dust particulates they can be toxic they can be reactive, so in such cases so whatever you know many cases if ozone is obtains say you know generally all people say is you know if you go to the sea side, the concentration of ozone increases but that ozone is helpful when it is in isolation, when it is not connected in the form in the reactive manner with other elemental gaseous. When they are particularly in the, particularly in the high speed, high road junctions say during particularly during the winter evening time you know when there is a dust, dust aerosols are there you know you find ozone's there, you find several other substances like nitrogen dioxide then you find some sulphur dioxide, all of them form a smog. There in combination of all these gaseous and particulates, ozone can be highly reactive, ozone can be highly reactive. So, you know we can yeah any ozone is near the sea side yeah and it is not harmful but no ozone is harmful. Suppose, even in the sea side if you are just near the sea shore, if you are on the sea shore, ozone is not harmful but suppose you are in a sea side you are standing near a road crossing which is very busy, extremely busy and there is no atmospheric air movement like you know there is relatively calm, relative calm in that particular area and high sunlight in that cases, ozone can be harmful. Ozone in combination with other gaseous, reactive gaseous can be harmful.

Sir, but generally ozone is stable or not. Ozone is, ozone is stable but you know as I have said two conditions I said, one is that increased sunlight and also increased in this particularly say stable atmosphere, stable atmosphere and increase sunlight together, together this can form you know due to this carboxyl group and also related to other presence of other substances oxygen, this ozone can be, ozone would be produced. This ozone in combination with other would be reactive ozone. And ozone is not essentially as you said it's reactive also because it's a metastable substance, it is not stable substance at all. Ozone immediately breaks, ozone would immediately break into oxygen under, under a is most cases you know in the atmosphere you know it but when it's combining together, when it's combining, it does not get dissoluted so fast, okay. So, here this is, this is what you know the mostly this common air pollutants, let me also further explain you know some of those say this particulates and other you know just for your case you know some the particulates. One very important thing you know which is not necessarily always clear is that in this the particulates. I will come back to this again and again but you know let me explain this one first particulates.

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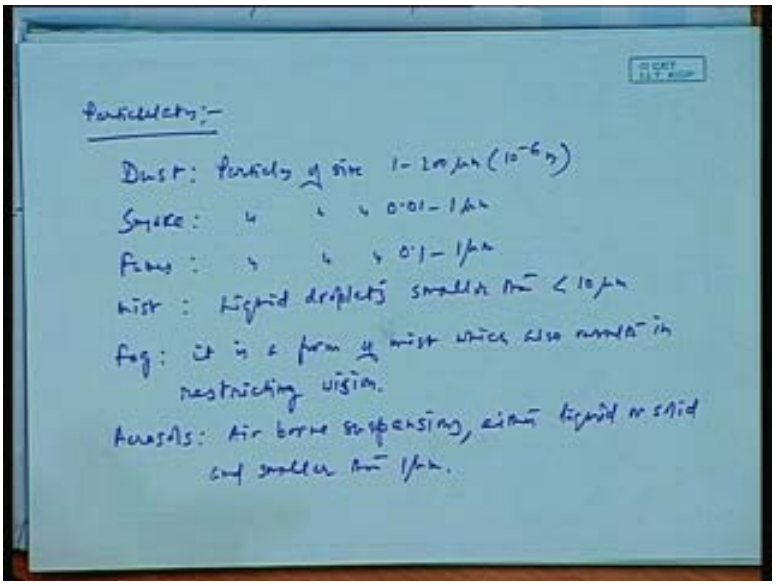

What are these particulates? Mostly the dust. What is called dust? The dust is the particles of size, particles of size 1 to 200 micrometer that is you know 10 to the power minus 6 meter, particles of size belongs to this category form. So, this is the dust that is generally popularly we consider as a pollutants smoke. Smoke is the particle size, particles of size point zero, 0.01 to 1 micron, smoke. Fumes, fumes are between particles of size between 0.1 to 1 micron, fumes. Mist, mist is a liquid droplets, liquid droplets smaller than, smaller than 10 micron, not so much classified. Fog, fog is, it is a mist, is a form of mist which also results in, which also results in restricting, restricting vision. The aerosols, aerosols, air borne suspensions either liquid or solid and smaller than and particle sizes smaller than and particle sizes smaller than 1 micrometer. So, here you can see this you know these are mostly this you know there are another distinction, I would make here is that you know about the dust part, we will again come back to this but for the time being let me explain this particulates are you know most of this dust today, dust today is the critical dusts that we generally discuss about.

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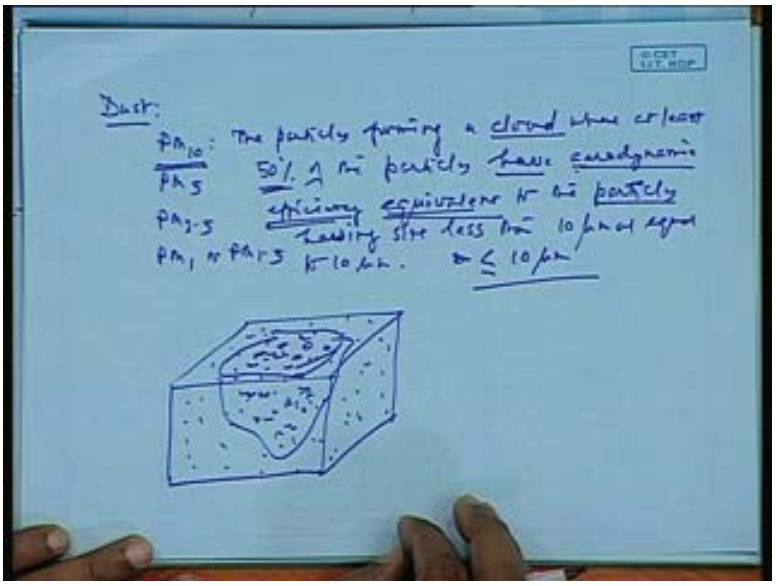

The critical dust is you know the dust we generally discuss about is say this particulate matter, particulate matter 10, particulate matter 5, particulate matter 2.5, particulate matter 1 or particulate matter 1.5. What is this means is PM 10. The idea of PM 10 is, idea of PM 10 is like this you know that the definition part needs to be explained a little bit. The particles, particles forming a cloud, particles forming a cloud where at least, where at least 50% of the particles have aerodynamic efficiency, aerodynamic efficiency equivalent to, aerodynamic efficiency equivalent to the particles, equivalent to the particles having size, having size having size less than 10 micron. The cloud where at least 50% of the particles have aerodynamic efficiency equivalent to the particles having size less than 10, having size less than, less having size less than 10 micron and equal to 10 micron. So, equal to 10 micron, so equal to, equal to or less than, so this is equal to or 10 micron.

So, here what it means? See, this the distinction is this, the distinction is this, this is about the cloud. What it means by this cloud here is this is of great importance because you know most of the today, most today you know what is the dust in terms of dust, no longer it is known as the silica dust or anything like this. We generally though steel contained with you know the silica the percentage you know in mining generally, we generally when you wherever we refer dust as you know particularly the dust size which is generally say about say 10 micron or 5 micron whatever you say but we do not refer you know what is the situation in which the particle is, there it is the cloud. What it means by this is just to explain this, this particular this thing PM 10. Try to understand in a box. Suppose, you have a box, you have a box of you have suppose you have a this is a box containing all this say suspended particulate matters, suspended particulate matter, suspended particulate matter. So, you know if you just can say that out of this if this cloud, if this is the cloud this is the cloud contained in a box, if out of that the 50% say you know here, say here say if you can say a 50% of this volume contains particles which are equal to 10 micron and less they would be referred as 10 micron cloud that is or we would refer them as particulate matter 10, okay. So, not merely the size, not merely the size it should also talk about the cloud, 1 or 2 particles do not matter much.

So, you know it should have if the particles forming a cloud where at least 50%, 50% of the particles have aerodynamic efficiency equivalent, equivalent to the particles having size less than 10 micron meter and equal or and equal to 10 micrometer less and less and equal. So, here this is aerodynamic efficiency equivalent. What is this aerodynamic efficiency in equivalent? You know aerodynamic efficiency equivalent that means you know say this that the physical parameters like drag then you know say velocity then viscosity of this all this particles should be equivalent to that of a particle of 10 micron size. It may be some particles may be say if it is not silica, it may be of some other say coarse particles or others say silica is certainly a coarse particles but say you know other classified particles which has a, the size is more but the surface is so plane that in this drag is equivalent or similar to a 10 micron material of silica.

In such cases the that would also be included as a 10, the efficiency you should have a, efficiency should, the efficiency aerodynamic efficiency would be all important and it would deal with if this the cloud contains particles which have particles, which have aerodynamic efficiency equivalent to 10 micron meter or less they would be referred as PM 10 cloud. So, this is similarly PM 5, PM 2.5, PM 1.5 so as you know PM 5, 5 micron is as less than say you know is today it's being considered that you know what is important is more than 10, PM 10 more than PM 10 it would generally come out with the saliva, it would not enter into the bronchial column, it will not enter the bronchial column you know is a, it's not this it will not enter to your lung but anything of PM 10 and less PM 10, PM 5, PM 1.5, 2.5 all these has a potential to enter into the lung and reside there. So, anything more than that is would be physically obstructed by our you know typical resisting mechanism and they would not be included.

So, for us the particle size which are less than, less than 10 micron you know PM 10 configuration as we have said they would be all of importance. Anything more than that will be restricted in the, in the physiological system that we have. So, the saliva would arrest them, the nozzle you know the fluid would arrest them the say that the bronchial tract would arrest them, … would arrest them. So, you know they would not be entering to the lung at all but rest of them can enter into the lung and can remain in the lung. So, these are all the things you know which would be of great importance to us. Anyways, so here as you can see this you know we have more or less explained you know this that the typical things that we would discuss about this most of this particles and their effects most of the particles and their effects. So, you know here in such cases you see this well… Another is, another important thing that one needs to know is you know is a, the background emission, a background emission, background emission.

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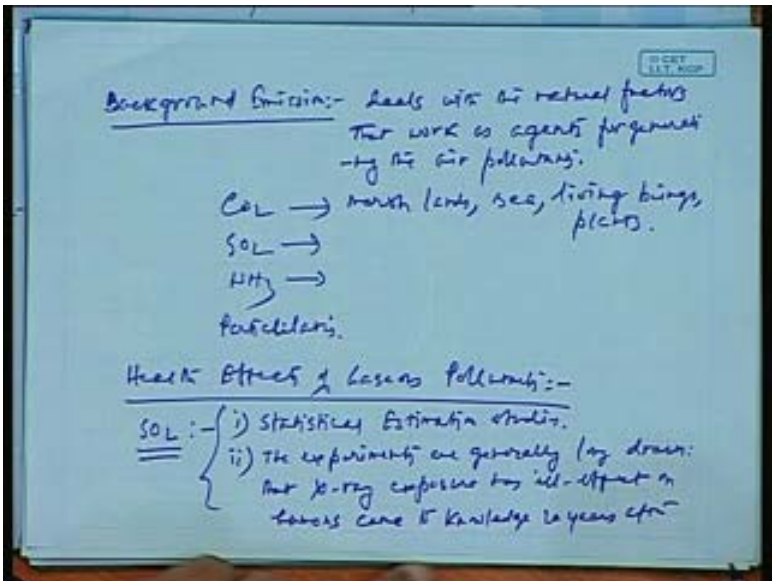

So, background emission is, background emission is like this you know there would be always you know that there are some natural factors. Background emission deals with, with the natural factors, natural factors that work, that work as agents for generating, generating the air pollutants, generating the air pollutants. See, many of this, many of these substances, many of these substances are also naturally produced say carbon dioxide, carbon dioxide, sulphur dioxide, ammonia then you know this particularly some particulates, particulates, they are also naturally formed. What is the importance of this is carbon dioxide not necessarily is generally produced by manmade actions. Carbon dioxides are forming due to different other reasons also say you know most of say carbon dioxide is also produced from say marsh lands.

Sea is a great contributor of carbon dioxide, sea is a great contributor of carbon dioxide say this animal this, this living beings, plants as you know living being, plants, all the, all of them produce carbon dioxide. Similarly, there would be many other sources of sulphur dioxide also say natural reactions in which say the soil is getting oxidized and when the soil is getting oxidized, some of the sulphur dioxide would also come out from the soil and that is the, that is the background emission part. So, there are two things to understand, one is the that you know there would be always some emission resulting due to natural causes which do not depend on any human action, they are independent of human actions right even if, even if you, even if you do not do any man made activities carbon dioxide would still be produced, sulphur dioxide would still be produced, a particulates would still be produced say you know particularly in a desert area say when the wind blows the particulates come out in the, in the environment come out in the surface level. So, there is nothing to do with perhaps with manmade activities.

So, these are the background values. So, when you are dealing with this kind of subjects, you must try also find out what is the background value existing. So, finally what you are measuring is the total value that is the background value plus the manmade effect or any other kind of agents that are causing it. So, you must be able to calibrate for the say this for the background emission, the background emission should be deducted. So, the background emission has a, so

it's just to emphasize this, one important aspect is that not only humans produce many of this gaseous which are, which when in excess, which in when in excess is extremely allergic or toxic to human health, right. So, there may be other sources also, there are particularly say you know during say, during say a particularly say during a volcano eruption, during in the case of volcanic eruption you will find lot of sulphur dioxide being produced, lot of you know this H 2 S is being produced. So, these are, this would all relate to the background values. So, you know this is what the background emission part should also be known in the say you know to understand this kind of pollutions.

So, here is as you know there are different sources but before that you know going to different sources, let me start the topic on this the health effects of say health effects of, health effects of, health effects of gaseous pollutants. Why I am discussing this you know before the standards is the reason being is why I am discussing say know you might be health effects of gaseous pollutants, you might quite ask me why you know the health standards, the standards, air pollution standards are not being taught before this, the reason being once you understand the health effects then only you establish your health standards, air pollution standards, so you know one comes before the other.

So, first of all let us have to understand in the first place we have to understand what are the health effects of different kinds of gaseous pollutants. In a, in this discussion here you know will bring in you know some of the very important typical kinds of gases like say you know this the sulphur dioxide, the sulphur dioxide, the sulphur dioxide would begin with the discussion with the sulphur dioxide. See, here begin a, before I begin to discuss with you, there are few things that I want to mention here. One is this, this, all this, most of this experiments, most of this experiments which lead to explain, which lead to explain, lead to explain the health effects are basically statistical studies, mostly the statistical studies, so they generally at best estimate the parameter say they cannot say they tell with say 95% confidence or say when 90% confidence or 85% confidence but not again not at any point of time with 100% confidence that this is going to take place.

There are two things different you know in a statistics and mathematics, I mean particularly for many cases you know one should try to understand this. The statistics is basically a method of estimation. Mathematics or in many cases is the cases of determination these are two, are two different aspects. These has a great role in understanding environmental effects because in all cases whenever you are discussing with the environmental effects of environmental effects, what we are essentially talking about the results which lead which are derived from a statistical study and which only points to an estimation, they cannot say with 100% confidence that this is going to take place there is no kind of yes and no situation. Say, if there is a nobody can say that if there is no pollutant and if a person regularly exercises, if the person takes very good food regularly, very remains a very balanced life that he will not have cancer, okay. So, there is that is, there is no 0 1 situation neither one can say that if a person remains a very bad life or say smoke everyday reasonably drink every day that finally at this age will he is going to land up with cancer, no. In all the studies we are just trying to understand the situation and all we are trying to, we are trying to understand that with a certain level of a, certain level of statistical significance in that, with certain level of confidence in that but never again, never again think about that you know we can say 100% situation say you know one cannot say that if a person

meditates every day or even a person listens to Amrit Bachan or any kind of you know the this kind of speeches that the holy man do that he will not land up with you know diseases or things like that.

It might reduce but you know 1 in 100 or 2 in 100 or 3 in 100 cases you will find that person also is suffering from the typical diseases that the other normal people have. So, it cannot be said like that, so you know here it as this has a great importance. So, you know most of these studies or statistical, statistical estimation studies. Another great important thing about all these health effects when you are dealing with the health effects is another very important aspect is the experiment, is the experiments, experiments are, experiments are generally are, generally long drawn, generally long drawn I mean they take a long time before one can conclude something that say now just for an example that X-ray exposure, X-ray exposure has ill effect, has ill effect on humans came to know came to, came to knowledge, came to knowledge 20 years after, 20 years after the testing began, 20 years after the testing began.

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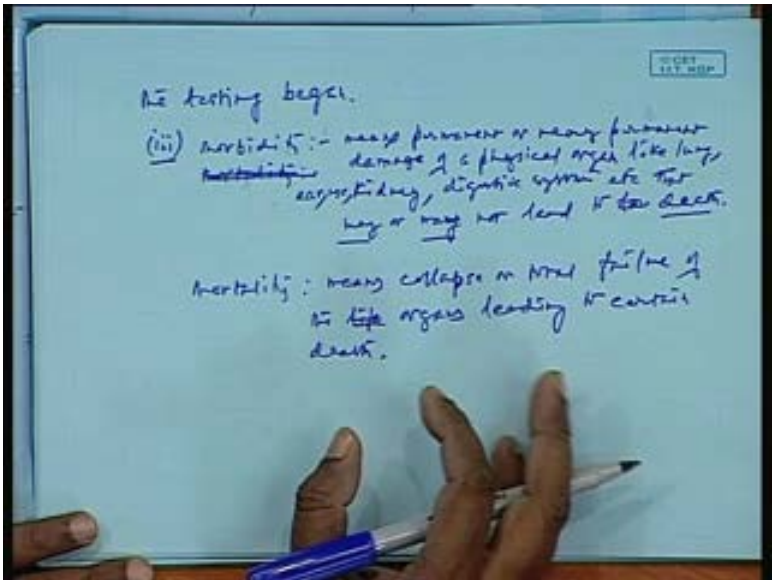

So, you know you are studying an experiment and you are trying to see the parameters, you are trying to observe and then you find that you know 20 years, it takes 20 years, it took about 20 years for people to know that X-ray can have bad impacts on human health exposure. So, next time when the doctor says that you know the X-rays are harmless, don't ever believe them because you know it's one should have minimum exposure to X-rays, minimum exposure is all important because is a, it is now quite proven that you know X-ray and nobody knows another very important thing you know generally doctors would say in many cases because doctors themselves would not be knowing this that say low energy radiation, low energy radiation or low energy exposures, they are not harmful, the people generally talk about that but this is also not correct. Repeated if low energy exposure, low level exposures can be, can be tremendously dangerous over a long time.

If a person is getting, used to getting effected over a long time he might get, he might get different kind of symptoms I mean which can result into this. So, another this is you know right okay. See, this the third one that I would also say here is you see this another that is generally the two, these are the two types you know there are health effects, when you are discussing the health effects we generally discuss two things morbidity and mortality, morbidity and mortality you know is says one can lead to another that is morbidity and, morbidity means this, morbidy means, morbidy means, morbidity means permanent or nearly permanent, nearly permanent damage of, of a physical organ, organ like lung, kidney say lung, kidney say you know say digestive system, digestive system like this means permanent or nearly permanent damage of a physical organ like lung, kidney digestive, digestive system like you know other say hormonal systems, digestive systems etc that that may or may not lead to death, may not lead to death say lung, ear, say lung, ear say nose, lung, ear, nose, physical organ like lung, ear, nose, eyes, kidney, diagnostic, digestive system etc that may or may not lead to death may or may not lead to death. So, this is called morbidity.

So, if you are not hearing suppose you know a due to a say bomb blast, if a person losses his hearing ability, it is a morbidity that has effected him or he is suffering from certain kind of morbidity. Hear, hearing loss, memory loss which cannot may, cannot may or may not I mean in most cases nobody knows for sure, I mean in many cases may not lead to death. So, this is called morbidity. When it is dealing with you know which is finally which is when it is mortality say this means, means, means a collapse or total failure of the life, failure of organs leading to certain death is called, is related to the mortality, is lead to the mortality. Say, this is so increased morbidity can lead to mortality but is not related serially correlated. It cannot be directly correlated that you know morbidity would finally lead to mortality, it’s not like that.

So, here this is you know when you are dealing with this studies, we must deal with what essentially we are dealing with, we are dealing with morbidity or mortality. In most cases say for every 300 cases of morbidity, there may be one case of mortality. So, this is, this is a situation. So, you know in case, in many cases we may not be discussing about mortality but you know it can be related to, morbidity related damages, okay. We will again take this up in the class next, okay.

Preview of next lecture:

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So, we start the next class I mean and we here we begin to study the health effects of you know most of this gaseous pollutants, some of the gaseous pollutants. Let me explain you know why you know how this studies, what these studies reveal as such.

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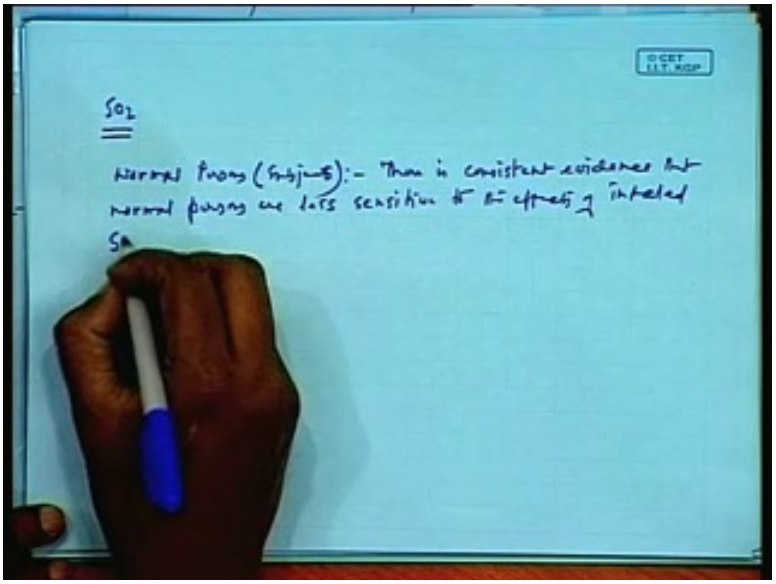

See, this sulphur dioxide, sulphur dioxide as a pollutant. So, you know say this is on normal, normal, normal persons here, normal persons or subjects, normal persons or subjects you know so what we see here is that that you know for a normal person you know this, this is the

challenge studies is this where normal subjects you know they for all these cases we can see you know there are few things there is consistent, there is consistent evidence that normal, normal persons are less sensitive to the effects of inhaled SO 2. The usual contact itself that is what is happening there, the skin is allergen to, skin is allergic to the allergen. Allergen is the spider web, the material in the spider web is the allergen and the, the skin is allergic to that particular substance. So, here as the skin has already developed an allergy, similarly the throat and the passage in the throat would also generate a certain kind of an allergy to that and the allergy would lead to the constriction or reduction in the air way passage and as the reduction in the air way passage begins, so all kind of breathing disorders begin to take place. So, as I said exercise relatively you know prompts far, far more effects.

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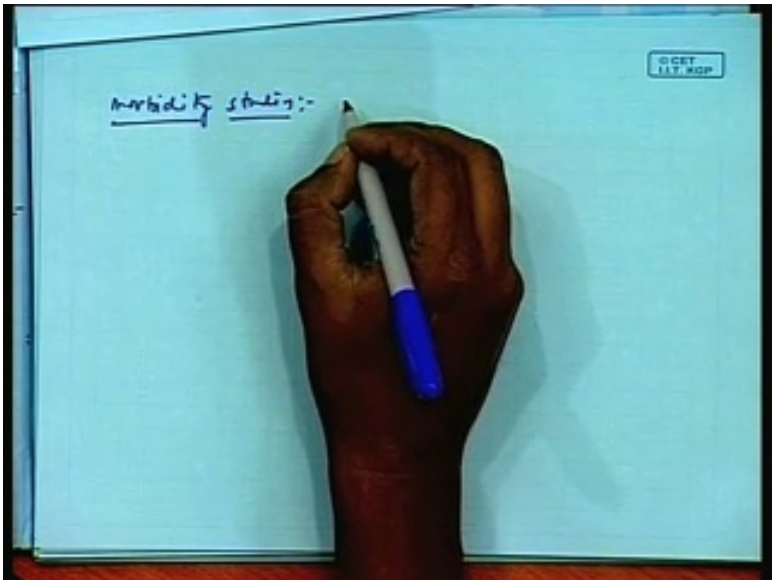

See, the something to related to is this morbidity study, say this morbidity studies that we have generally is morbidity studies. So, the conclusion in the morbidity studies is this is morbidity studies say increased exposure, these are the temporary effects, temporary effects the increased effects is…