Fundamentals of Environmental Pollution and Control
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Lecture No. # 29
Health Effects of Air Pollutants

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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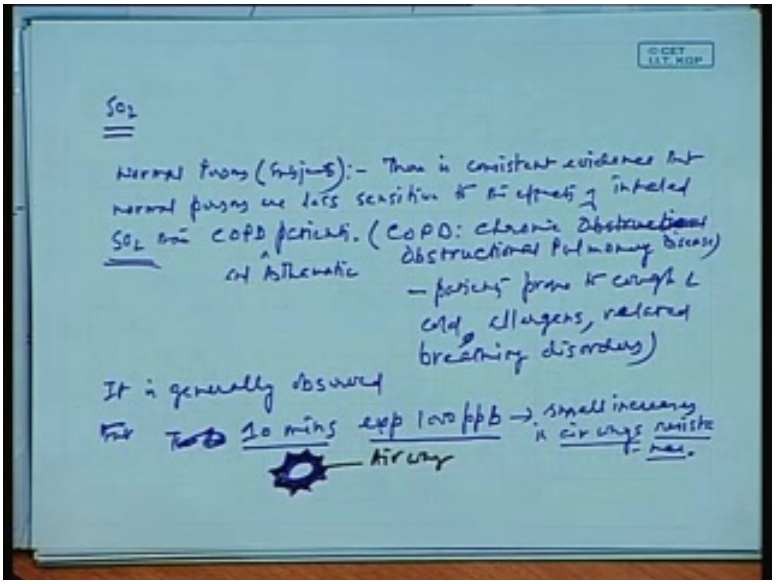

See, this sulphur dioxide, sulphur dioxide as a pollutant so you know say this is on normal, normal, normal persons here, normal persons or subjects, normal persons or subjects you know so what we see here is that that you know for a normal person you know this, this is the challenge studies is this 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, inhaled SO 2. This sensitive to normal inhaled effects of a inhaled SO 2 than, than, than a COPD, COPD patients. COPD means here is chronic COPD and COPD and asthmatic patient, asthma, asthma, asthmatic patients. COPD is chronic obstructional, chronic obstructional you said write this you know obstructional let me write it again. Chronic obstructional pulmonary disease, pulmonary disease COPD, this is are so inhaled SO 2 than COPD or a asthmatic patients, a asthmatic patient. This COPD let me explain this COPD a little bit. This COPD you know what I began by the discussion is that you know the studies, what the studies reveal for the normal person there is a consistent evidence that normal persons are less sensitive to the effects of inhaled SO 2 than COPD or asthmatic patients. This COPD patients are you know chronic obstructional pulmonary disease, this, this is like you know all kind of cough and cold the patients prone to, prone to cough and cold, cold, cough and cold, cough and cold allergens related breathing COPD I mean as you can explain this COPD patient

you know is a basically chronic obstructional pulmonary disease, the patients prone to cough and cold, allergens and related breathing disorders.

Now, these are, this is what is observed is you know it is generally shown, this generally is, generally observed that that 10 minutes, 10 minutes, this is a 10 minutes, sorry 10 minutes exposure, exposure, 10 minutes exposure at say 1000 ppb, 1000 ppb level, 10 minutes exposure at 1000 ppb, would lead to, would lead to you know increases, small increases in air ways resistance, air ways resistance, small increases in air ways resistance. See, let me explain you this part of this, part here what happens is small increases in air ways resistance. See, is the case is clearly like you know, you know that you know that if you are, if you are in a particularly say in a wintery night, wintery night if you are running a bike or anything like that with no cover at the throat.

So, what happens is after the, after the bike ride you will find that you know the, your throat is choking I mean you know usual case of cough and cold. What are usually happens, what essentially happens? The essential things that happen is you know we have if we just try to explain it little bit here say in most cases you know say if we just see this respiratory tract, see if you see the respiratory track is like this you know you see this is about a multi, multi-layer structures of you know of multi fibers structures here in the, this is what is a throat through with this the air passes. What happens on this is, what happens on this is if this, if this is the air way that is the air way so through which the throat air way you can see is a, this is the air way, this air way, on this air way if you just see here there are you see this a liquids, a liquids mucus here, mucus and you know mucus likes I mean liquids here. These are mostly the liquids you know which generally come to saliva also, many a time come to saliva just like you know if as you find in the saliva itself.

These are, these are in the liquid form, these are in the liquid form mostly a very liquid form so that what it does is it reduces, it reduces the air resistance as a result of which you know otherwise what would happens is the air that we are breathing in we would have worn out or we would have impacted our surface. So, you know the surface needs a certain kind of lubrications so that you know the air when it is, when you are drawing in air and living air, this needs a certain kind of lubrication in the respiratory tract itself. So, in the respiratory tract when it is this lubrication reduces the resistance and as a result of which we can comfortably breath and we can exhale air, inhale air like this. Now, what happens is when there is a certain kind of temperature differential or there kind of some kind of dust is entering into this area, this particular surfaces you know they are, they begin to, they are very sensitive, they are sensitive to allergens particularly this substances say a sulphur dioxide or say dust or any kind of this things would be actually an allergen which would deal with this is they would immediately the response would be from the throat side response would be as a means of resistance again to solidify this one and this the mucus which is generally in the liquid form would be semi solid by that. So, this mucus, this semi solid mucus is basically you know it’s irreversible, it cannot again go back to the liquid formation again.

So, what happens is if we have developed a cough here, the cough has to come out somewhere or you have to send it to the digestive channel or you have to make use of a certain medication so that that particular this stiffness gets reduced. So, what happens is this as a result of this

stiffening of this mucus, this air way begins to constrict, begins to reduce, the air way which was this, the total surface area begins to reduce. So, as a result of which you know the new surface area may be only about this much, only about say reducing to this much. So, if this is the surface area through which only the, through which only the air can pass then you very well understand the lung require a certain capacity of air all the time. So, for the same capacity of air it has to breathe more, it has to pump more so that is the typical effect of cough and cold, starting of cough and cold and particularly this becomes very severe for those people who are extremely allergic to this kind of substances like those who are suffering from asthma or those who are suffering from chronic COPD's like not asthma but they are very sensitive to allergens.

There are many people who cannot tolerate dust at any, at any point, is when a small dust is you know is a very harmful for that you know some pollens are very highly allergen to them say they we live in this campus you know for a people like us you know this pollens when they come out they have of no consequence but there are some people you know for whom the pollens when they come out, the pollens from the flowers they become extremely allergic, they become extremely allergen. There are many people who suffer from months together due to this, this a allergic causing substances. So, here also the same thing takes place. So, you as such is this is what is so said here. This as I said is at 10 minutes exposure for say at 1000 ppb concentration we can see small increases in the air ways resistance. This is the start. In a normal subject at 1000 ppb when the SO 2 concentration is at 1000 ppb and if it is an exposure for 10 minutes we generally observe a particular small increases in the air way resistance but this is also, this is also very temporary. As soon as you go out of this environment, it can clear off because the effect is not magnified till that point of time but this effect begins to, begins to magnify, begins to magnify with you know with as we can see for 10 minutes exposure, 10 minutes exposure, so similar exposure 10 similar exposures at 4 ppm, 4 ppm or greater, greater, clear, clear increased reduction of air ways passage leading to, leading to increased resistance, leading to increased resistance, right.

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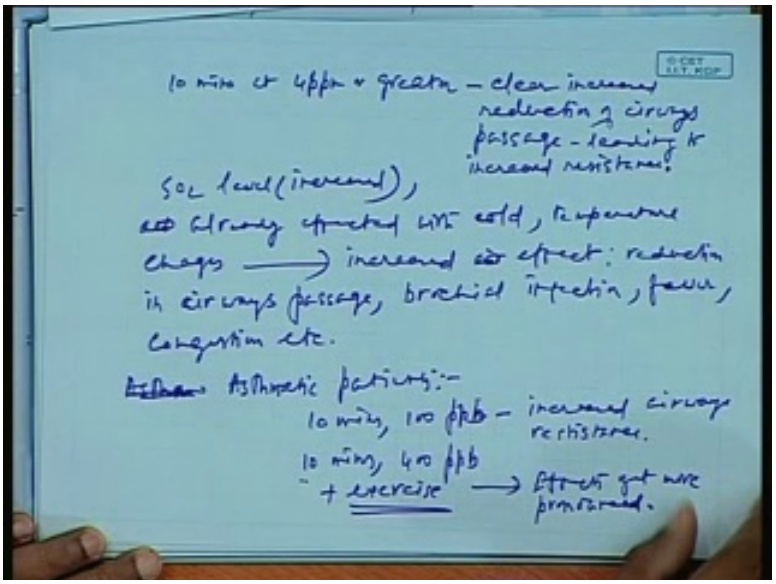

When we see this in asthmatic subjects you know particularly the effects of SO 2 as you know particularly as you can see as the exposures become more and more, as the exposure become more and more the, there would be further reduction in the air ways resistance and there would be some quasi permanent you say effects like you know the effect might remain for 10 days, 15 days like this. So, at more than that you know this is so as such when happens is say related to this, this has, this is particularly increase in SO 2 level, SO 2, SO 2 level increased plus already, already effected, already effected with cold, already effected with cold temperature changes can lead to, can lead to increased, increased effect, increased effect reduction, reduction in air ways passage, air ways passage, bronchial infection, fever, congestion, etc.

So, you can see this the, this is the effect of SO 2 I mean say the in an asthmatic substance, asthmatic subjects, asthmatic patients you write asthmatic patients, asthmatic patients the is air way changes you know where is the first one is you know first one is say at hundred, 10 minutes at 100 ppb, at 100 ppb, at 100 ppb increased air ways resistance takes place. What started as you know for a normal subject at 1000 ppb can be observed at 100 ppb for asthmatic subjects, asthmatic patients would start as an earlier time say they are more, they would be more directly affected by this sulphur, presence of sulphur dioxide. When you can see this, so this effect another very interesting aspect of this you see 10 minutes, if you just observe this 10 minutes 400 ppb, 400 ppb plus, plus exercise, plus exercise you know physical exercise, this the effects become effects more pronounced, effects gets more pronounced so that is what you know one reason for which you know if it is a heavily polluted traffic way or heavily you know slightly polluted traffic way particularly say during the time when there is a vehicular pollution is more that time one should not run across mostly along the road sides.

One should not run along the road sides because you know in such cases you are the possibility that you know you can catch cold or you know you can, you have some kind of infection, breathing related infection due to the allergic response remember all this. These are mostly the allergic response. Allergic responses are like this, it's not, it's not a bacterial or say you know fungal reactions like this. It's an allergen that is also an allergen related but you know relatively different.

Here, what happens is that the, this particularly this, this substances a high dose of is relatively high dose of sulphur dioxide can initiate irritation in the, in the air passage in the throat, in the air passage in the throat by means of, by means of you know this particularly this mucus and the surface become, they become sensitive, something like quiet like if you are, if you have some kind of say you know whenever you have say you know sometimes if you are cleaning say a cleaning a, cleaning a room you will find that you know if you are if some way your hand comes in contact with a say this spider web or something it begins to, irritation begins to take place. The similar kind of things takes place here. 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 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, now as I said exercise relatively you know prompts far more effects.

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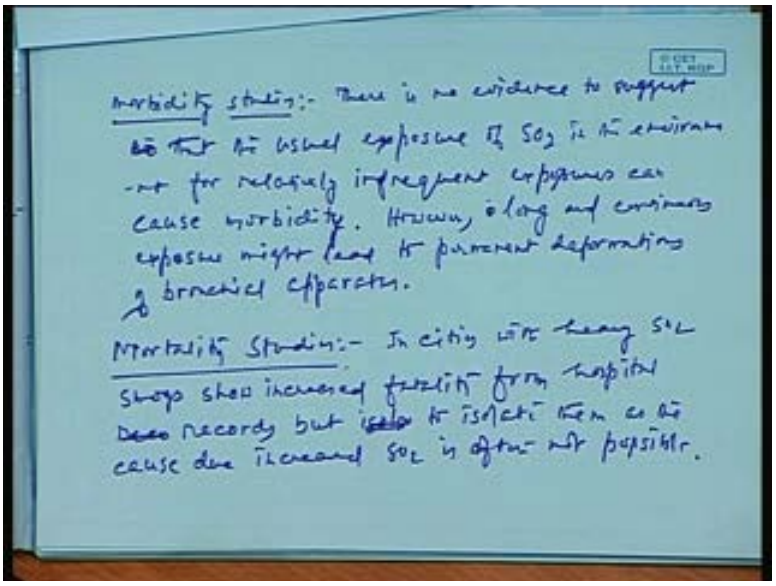

See, the something to related to this is the morbidity study, say this is the morbidity studies that we have generally is morbidity studies. So, the conclusion in the morbidity studies, this is morbidity studies say increased exposure these are the temporary effects, the temporary effects, the increased effects is there is no evidence to suggest that the usual exposure, usual exposure of SO 2 in the environment for infrequent exposure, there is no evidence to suggest that the usual exposure of SO 2 in the environment for relatively infrequent exposures can cause, can cause morbidity, can cause morbidity. There is no evidence to suggest that the usual exposure of SO 2 in the environment for relatively infrequent exposures can cause morbidity.

However, however, however long continuous exposure might lead to, how a long and continuous exposure might lead to permanent deformations of bronchial apparatus, long and continuous exposure might lead to permanent deformations of bronchial apparatus like you know something like say those people you know something like you have seen in your house hold like you know their grandmother or even your mother also say you know those who were burning coal say for their you know for their hearth or something like that say and all these kind of substance. So, here if they are consistently exposed you know suppose they are they, they work in a closed room, they work in a closed room where there is a good amount of sulphur dioxide and they are exposed for a long, long time, quiet long time say you know usually over a day over a long time and particularly if the concentration of sulphur dioxide is pretty much say something like as you can see here itself as we have seen sometime about 4 ppm or even say you know if in 4 ppm or say even 10 ppm like this in such case a consistent exposure might relate to some kind of permanent morbidity, morbidity can resulting in the sense like you know a certain part of the bronchial apparatus might be completely damaged say if the lung may be not working in the same capacity, the capacity has reduced.

So, the permanent deformation has taking place. So, there may be other kind of disorders that can take place due to that kind of situations. So, this morbidity, these are the morbidity studies you know which is says that you know SO 2 can impact that. Mortality you know mortality

studies you know just to mortality studies, mortality studies you know that there are no… In cities, in cities with heavy, heavy SO 2 smogs, heavy SO 2 smogs show increased fatality from hospital records, in cities with heavy SO 2 smogs show increased fatality from hospital records but isolation but to isolate them as the cause but to isolate them as the cause of, as a cause due to increased SO 2 is often not possible, often not possible.

So, you can see but it says that what is same is that what is observed is that you know in case if there is higher SO 2 in the cities, mostly in the cities having a consistently high SO 2, SO 2 show generally increased fatality, something like this. Let me explain you something like this. Suppose if you, if you just say, if you just observe say Mumbai or and say Mumbai and say Kolkata or even say Calcutta compared to Kharagpur it's okay, let us compare these two cases. If it is, if there are higher SO 2, generally you say the concentration of, concentration of sulphur dioxide in the city areas in both the cases Calcutta and Kharagpur, if you find that Calcutta has more sulphur dioxide, what one can see is say for every lakh of population, for every lakh of population the death cases may be say every day may be 20 or 30 in Calcutta whereas in Kharagpur it may be 10.

Now, but the only important thing we know that you know is the increased in the death may be due to the air pollutants but which air pollutant is again a difficult question. So, whether it is because of sulphur dioxide or because of carbon monoxide or because of nitrogen dioxide separating them from one cause to another is extremely difficult, that is not always possible. So, here in cells, so the mortality studies you know this is I took up this because you know in many cases you know we have to go into studies like this where you know we would be mostly dealing with this kind of studies in different areas. So, we must know first of all this remains one great problem of environmental movement, environmental say regulations is that to separate the causes. It is now becoming somewhat possible over a long exposure say voluntary studies where the studies you know where the people voluntarily take part say suppose something like in a, in a chamber like this you are routinely exposed to sulphur dioxide, another 10 or 15 subjects are routinely you know subjected to sulphur dioxide and then over the years the records are being taken and then finally after 10 or 15 years of study, one can suggest whether there is an effect of SO 2 say SO 2 dosage that is that one gets in the room has any effect with their health.

So, this kind of segregated cases are not possible always and there is no such study currently undergoing you know we has to suggest that you know sulphur dioxide related of or sulphur dioxide influenced mortality okay. So, this, this kind of uncertainties consistently remain, so there are few more cases like you know there are many cases like nitrogen dioxide.

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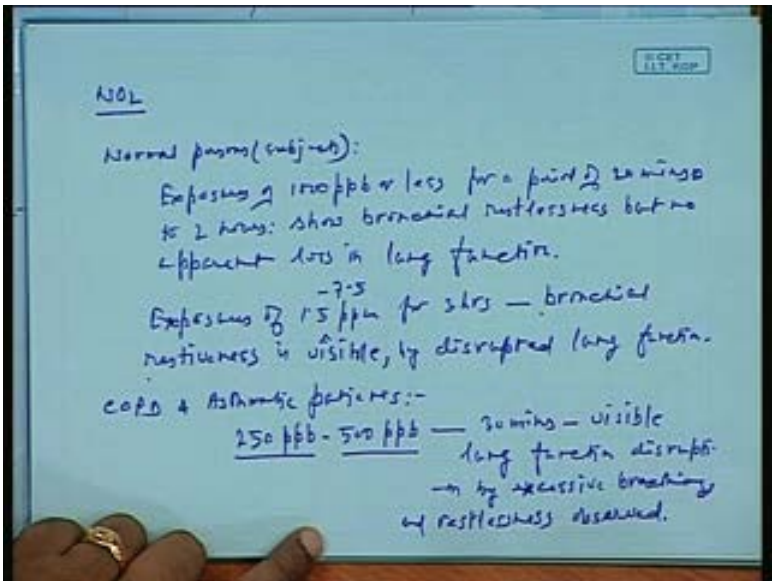

I just begin discussion about nitrogen dioxide NO 2. Normal subjects, normal, normal persons or subjects exposes of or less for a period of 20 minutes, exposes of 100, 1000 ppb or less for a period of 20 minutes to 2 hours show bronchial, bronchial restlessness but no apparent, no apparent loss in lung function. However exposures, exposures of 1.5 ppm for 3 hours, 1.5 to 7. 5 ppm for 3 hours, exposure of 1.5 ppm to 7.5 ppm for 3 hours. Bronchial responsiveness is visible by disrupted lung function. See, here in the first case you know in SO 2, I never refer to lung actually is general in case here it is we are referring to lung. So, nitrogen dioxide at this concentration can you know have effect on the lung and here you can see the visible, if it is exposure 1.5 to 7, 7.5 ppm for 3 hours, a bronchial restiveness that is you know some kind of uneasiness bronchial something like you cannot breath well, you cannot you know you are having some restiveness in it is visible by disrupted by lung function. So, but before that as you can see 1000 ppb or less and 2 or 20 minutes to 2 hours show bronchial restlessness but no apparent loss in lung function.

There would be some uneasiness but there is no loss of lung function. Say, this is what is the effects patients with you know say COPD, COPD and asthmatic, asthmatic patients, COPD and asthmatic patients two point, 250 ppb, 250 to 500 ppb, 500 ppb for say 30 minutes, 30 minutes visible lung function disruption by excessive breathing and restlessness, visible lung function disruption by excessive breathing and restlessness observed, right. This is generally this is 30 minutes you know just as COPD patients as you can see, this is a 250 ppb to 500 ppb for 30 minutes visible lung function disruption by excessive breathing and restlessness and restlessness observed, okay. So, here is this is about the nitrogen dioxide, nitrogen dioxide and increase nitrogen dioxide and increased, increase nitrogen dioxide has effect on morbidity say morbidity effect.

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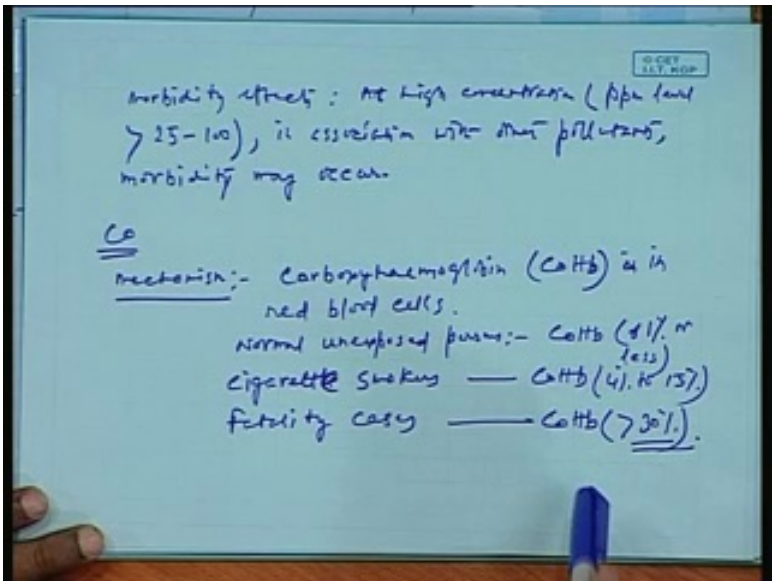

Morbidity effects at high concentration, at high concentration say in about, at high concentration say at ppm, ppm level more than say 100 that is more than 25 to 100 ppm at high concentration in association with, in association with other pollutants, at high concentration in association with other pollutants, in association with other pollutants at high concentration ppm level more than 25 to 100 in association with other pollutants, in association with other pollutants morbidity may occur, a morbidity, morbidity may occur. So, you know mortality studies you know almost relate to almost similar to say similar to SO 2. There is no distinct evidence to suggest this the mortality has resulted, if from specific nitrogen dioxide cases like you know increased level of nitrogen dioxide has not caused any mortality as such, I mean you know with its individual effect, so but it is a combined effect it can certainly have that much of related aspects like you know this says as you can see okay carbon monoxide. This one is another is CO carbon monoxide one of this method as you know that say the mechanisms is a, mechanism is, mechanism.

So, let me tell the mechanism first. As you know CO, CO poisoning, what is the effects of CO poisoning? Fainting and death that is clearly the CO poisoning. What happens see is mostly as you know this CO carboxyhemoglobin, carboxyhemoglobin, COHb, COHb results in red blood cells light, just see this standards you know the typical values you see normal persons, normal unexposed persons. We have all normal persons you know particularly suppose in a room like this, in a room like this all of us have certain level of carboxyhemoglobin because this is an environment where it is the air flow is somewhat restricted. So, in a basically an air condition rooms, so CHb the normal CHb levels are 1% or below 1%, 1% or less, normal this one is like this. Cigarette smokers, cigarette sorry cigarette smokers, cigarette smokers this can rise up to say COHb is 4% to 15%. Just one minute, this is… So, here it is a cigarette smokers mostly about that you know this the cases of fatality cases, fatality cases generally when it is COHb normally the fatality cases started, normally in this most cases the fatality cases start is at 30% of fatality cases when carboxyhemoglobin related fatality is begin to take place at level more than 30%. See, the typical thing is oxyhemoglobin. So, oxyhemoglobin is the when the oxygen

combines with hemoglobin, so you know oxygen combines with hemoglobin is just to for a transfer of oxygen from the air to the blood. So, this the hemoglobin becomes a medium by which it can the blood carries the oxygen across the veins to different cells, okay.

Now, on the other hand when this carboxyhemoglobin what is happens is in the presence of, in the presence of carbon monoxide, in the air the red blood corpuscles RBC's have a tendency to prefer, to prefer carbon monoxide against oxygen. So, they would form carboxyhemoglobin. So, this carboxyhemoglobin should be you know what happens is they would be carried through the blood. So, as they would be carried through the blood, there would not be any exchange of oxygen across the cells or if there the exchange of cells would be reduced. So, if the exchange of cells is reduced, so the initial response in such cases would be fainting because you know there would be not sufficient supply of oxygen but if that can continue for some time, if that continues for some time, the morbidity takes place, this the mortality takes place where the it can be fatal in such cases. This takes place you know particularly one usual cases you know very recently I'll let me tell you a small example of that.

Recently, there was you know a suicide committed in a, in a Japan, in a Japan you know some 8 or 9 people committed suicide. What they essentially did is a very simply what they did is that you know inside a car, inside a car they have kept a earthen, earthen fire Chula kind of thing and let that Chula burn. So, what happened is the air was completely circulate, there was no passage of air. So, essentially first it was carbon dioxide then in preference to so since there is layer lack of air, so carbon monoxide began to be formed. The persons you know in a, they were chatting together as if they are talking together then finally the poisoning begins to take place. So, a one by one they fell unconscious and then the Chula begin to go on like that and as at the end of that you know this the concentration level increased so much that all of them died. So, it was you know this is what is a typical case you know where this, the fatality cases can begin to rise you know about more than 30% of the carboxyhemoglobin. Sir, that was a accident or suicide case? Suicide case, it's a typical suicide, is a, is a, the way you know it committed the many people, this way many people do that where this is what is a carboxy, say particularly one important thing of carbon monoxide poisoning is a that you know people do not get to know, yes sir, that they are being poisoned they are, they are suffering.

In many cases simply because there would be reduced oxygen in their body they would try to exert more, they would try to exert more and as they try to exert more they become conscious at a relatively lesser time. Sir, another one very good particular characteristic of carbon monoxide is that your face will looks pinks and you will yeah that is an looks very, very, very, is very he was very smart energetic and things like that, a glowing, glowing, your face would be glowing. So, is another important aspect, no but that glowing you know, you know I tell you know in very, very many cases I have seen say the mostly who those a people who suffer from say cases like diabetes, cases like you know other exposes like that you will also find that you know their face is glow.

See, now if there would be relatively a some shine you know that is also one bad aspect of a person, you know it's just you know when you would see that the faces are somewhat swollen and they look somewhat the color looks brighter, more oily they look this is also a symptom that you know they are suffering. So, sir another important experience of Co is your brain will starts

working in opposite direction. Suppose, if there is a way you have to go there then your brain will say that you have to go in opposite direction, opposite direction okay. Then you cannot decide it, you cannot decide, you cannot decide.

Now, that happens, that happens because of any kind of you know particularly this reasonableness that you know you find out with some reasoning that you know the reasoning, the capacity of reasoning reduces mostly with all these kind of pollutants. So, will find out this carbo CO mechanism while deal with some other cases of CO mechanism also. So, okay I'll take up another gas for some time you know then we'll discuss something more. So, today you know we close at carbon monoxide, we will take up another gas on another time and…

Preview of next lecture:

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Right, we were discussing about the effects of gaseous pollutants on human health. Today, you know we have to discuss more on the aspect of particulate matters, more importantly or more specifically the mechanism of, the mechanism, the mechanism of, the mechanism of lung injury, lung injury caused by PM 10.

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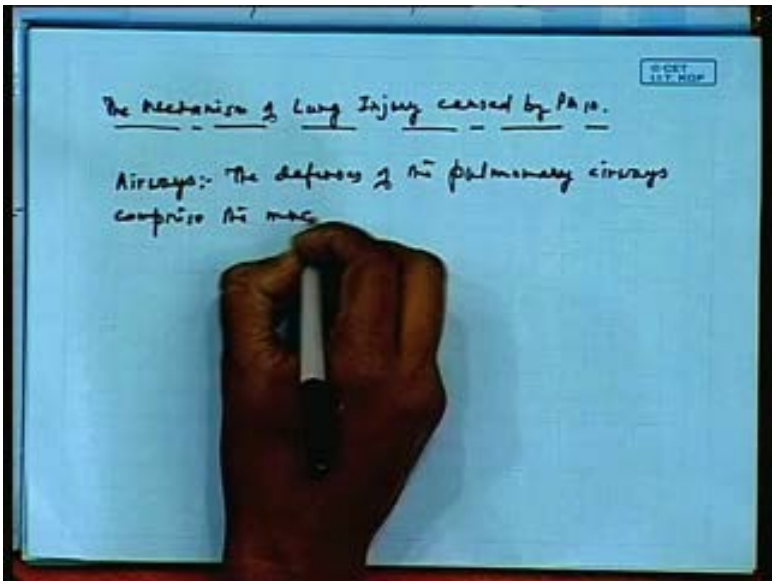

As I said you know is no, no longer necessary nowadays, it's no longer it is told as silica 5 micron or something like that. We generally consider this to be PM 10 you know this is the standard nomenclature now, nobody talks about you know silica, 5 micron silica or things like that that are usually popular you know, you know various terminologies like in mining. So, here as I think I have discussed about this PM 10, how you explain the PM 10. Now, having said this you know just let me explain you this you know how this effects take place. This is say first of all the, in the air ways there are three mechanisms actually by which this the PM 10 influences the human health. First is air ways, air ways. This is you know, as we know this you know particularly as I was discussing the defenses, the defenses of, defenses of pulmonary, pulmonary airways ways comprise the leukocytes, it's a typical leukocytes.

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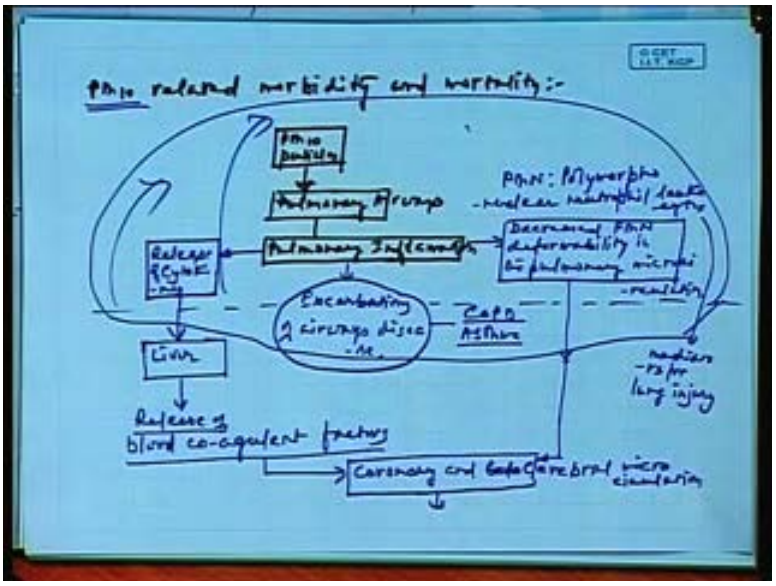

These leukocytes, what happens is they generally work as a mediators for lung injury that means they resist, they resist the lung injury you know whenever the dust particles are there you know they would immediately they are, they are, they are a tuned, they are tuned to resist the dust being in, dust entering the blood stream. So, what happens is consistent exposure of dust, consistent exposure of dust makes them ineffective. Their, their deformability decreased PMN deformability in the pulmonary microcirculation that is continuously this is one effect that relates to the decreased deformability, decreased PMN deformability of the microcirculation.

Here, this one finally what happening is there as a result of that, as a result of that continuously is you can see this continuously from this you know this would lead to the change, this would lead to the changes which I'll coming back you know I'll come back to this again. This one is here this particularly pulmonary inflation would release, would reveal you know a particularly is you know this part, this exacerbation, exacerbation of airway, airways disease. What happens here is just try to understand suppose you know you have already, already a patient suffering from COPD or say asthma, COPD or asthma, this would increase exacerbations means you know this would be, they a particularly asthmatic patient should be having more higher say you know this the rhythms of heart and the rhythms of lung you know where it would be, it would continuously vibrate at a higher speed or at a higher frequency that's so this is this kind of exacerbations increase. Their age would be mostly about say within 40, very few rickshaw pullers you would say you would survive say the age of 50 years or 45 years or 60 years, they don't survive.

So, the condition is this is what I am saying, it's that you know consistent exposure, episodial exposures when there are, there are large exposure for small time but over a long duration, over a long period of time they can generate morbidity in the first place and from the morbidity itself they can generate mortality. Suddenly the, that you can see the other habits are also important say you know if he is a, if he is a smoker or if he, if he drinks or you know he uses some other say the substances like tambaku and all other kind of stuff that he can take, all these situation they together can be aggravate the situation, the situation can even go worse, okay. So, these

kinds of things you know these are the likely situation that takes place, the related kind of diseases and the typical say the exposure related problems of most of this gas and gaseous particulates and the particulates, okay. So, I have mostly discussed if the, this health effects, you know I will see is generally you will have some idea about what kind of health effects that usually take place. Apart from that you know there are few things you know I would like to just this is these are the things say air quality standards.

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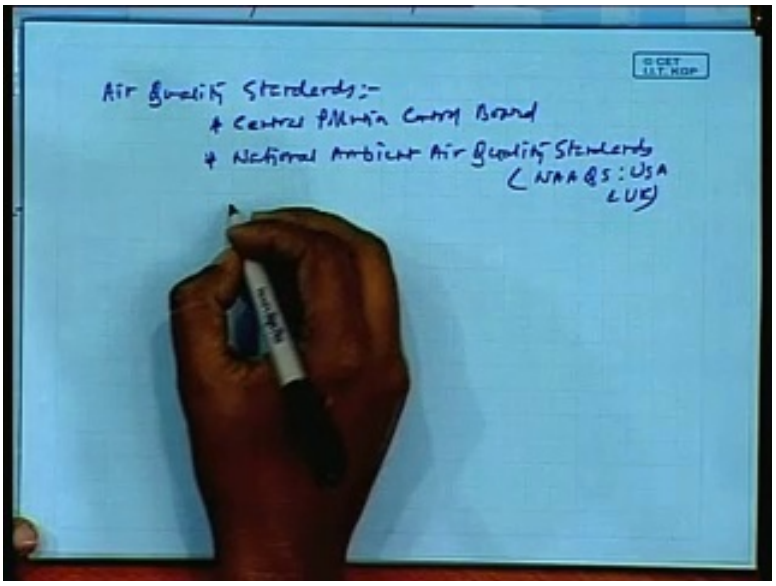

I would say you know mostly this you know you find this nowadays in the websites and any other places, this is for our country, the central pollution control board, this standards which are generally famous is, another is national ambient air quality standards, NAAQS this is which is this is USA and UK.