Industrial Instrumentation
Prof. A. Barua
Department of Electrical Engineering
Indian Institute of Technology, Kharagpur

Lecture - 37
Pollution Measurement

(Refer Slide Time: 00:44)

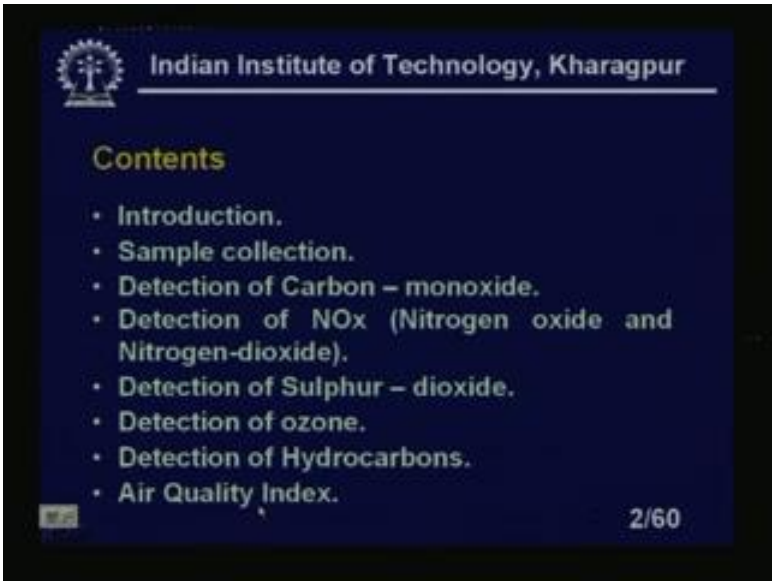
Welcome to the lesson 37 of industrial instrumentation in this lesson we will study the pollution measurements when we will talk of the pollution basically, we are talking about the environmental pollutions or the air pollutions or the type of gases. That brings the carbon monoxide, nitrogen oxide all these of type of gases how it is making the air polluted, and we must measure it. Because you know the certain I mean if it crosses some limit that is and it is not safe it is hazardous for the human being. Pollution will be there we cannot in industrial industrializations you know there will be pollutions you cannot avoid pollutions, you have to live with pollutions, but what is the level? We must know. Because if you I mean stay in some in forest or that is; obviously, the pollution will be less.

But if you live in a city; obviously, there will be some pollution because of the exhaust of the cars and truck all these things burning of the fuels burning of the waste. Because if you know the waste is the big problems in a, I mean cities or metropolis they can on dump it and the usually they burn it because that will reduce the volume of the waste. So,

that will cause the pollutions the factories the power stations all this thing will make the air polluted. Now, we must know what is the concentrations of the different gases and if it is within safe living fine otherwise you have to check it or you have to warn our goal is to warn the public or the. So, that they will also know that type of pollution they are going through and what is the, what should be the safe level of content?

Now, in some countries we will find that the forest fire that also will cause the pollutions. Some countries where there is a I mean where if the I mean like Australia when it is very dry weathers. So, there is a pollutions like means, when the wind blows; obviously, it will pollute now you see some of the pollutions. I mean some of the exhaust of the gases like I mean you can 1 can see either by suits it is nature or by it basic. I mean colour when it is dark in colour, but some are, so small that you cannot, it is very difficult to see in the I mean this I mean without any microscope. So, that, so this are the all different type of pollutions we are not concerned the pollutions of ((Refer Time: 03:06)) on this particular measurements and I mean lessons we will consider the only the pollutions in the air, right. So, let us look at the contents pollution measurement.

(Refer Slide Time: 03:15)

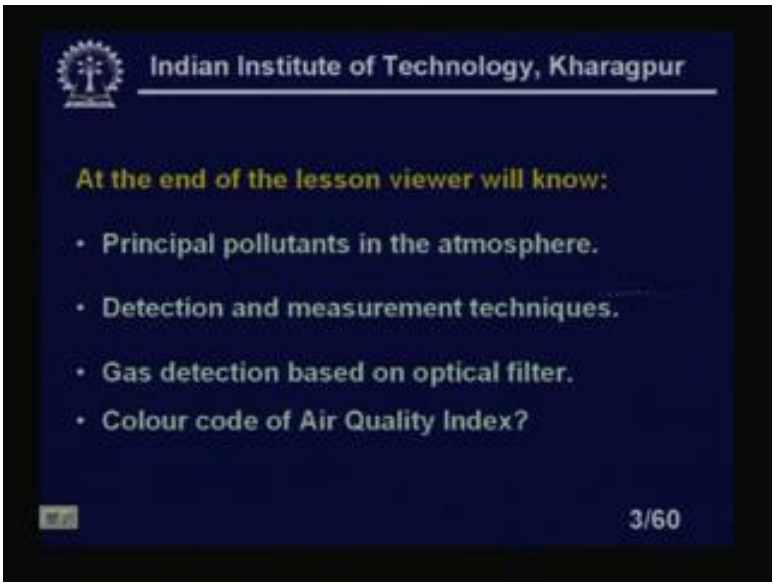


Introduction, the contents or introduction, then we have a sample collection because sample is most important, because you will know we will collect the samples from air. Excuse me and we will how what is the type of container that should be and what type what type of I mean how long will you store it? So, those are very important for the, for

this type of measurements. Then the detection of carbon monoxide, because carbon monoxide is the one of the I mean extremely it is extremely poisonous gas. So, that it is contains it is I mean it is presence in the air always is harmful for the public or for the human or for any animal being. So, it is concentration should be below some limit. So, that we must determine then we have detection of the nitrogen oxide and nitrogen di oxide which is called as NOx analyzer.

NOx analyzer is not only common in the streets. I mean we are also in the environment also in the in the in the many industries they measure this one, because to have a safe I mean good environment for the workers or the people those who are working in the industry or the plant. Detection of sulphur dioxide; this is another pollutions we must measure it then detection of ozone, detection of hydrocarbons. This hydrocarbons also is a like methane this are very I mean it is not good for the human being. So, this contains or you must know the concentrations of the methanes also and air quality index air quality index means visibility. Then what is the PM 10 concentration particular matter 10; that means, the particular matters with the diameter of 10 micron and less. So, that it can detect, and this type of thing we will study in this particular lesson, right.

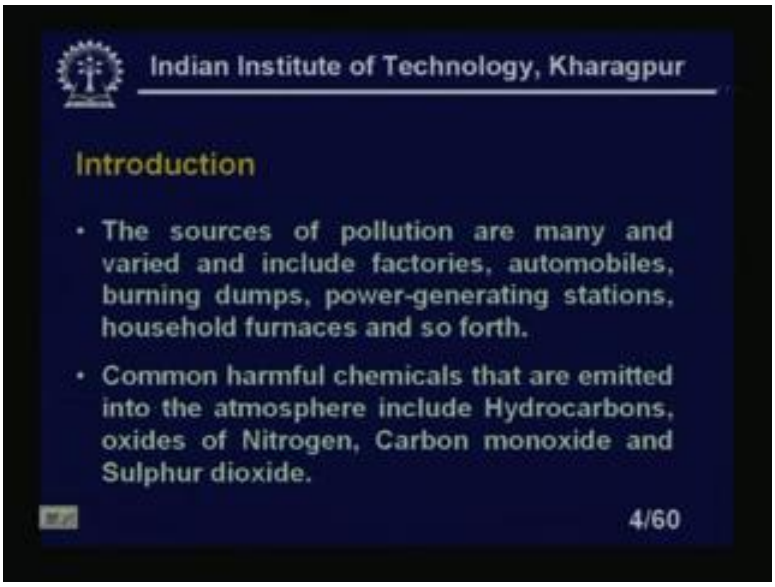
(Refer Slide Time: 05:03)



At the end of the lesson the viewer will know the principal pollutants in the atmosphere, then the detection and measurement techniques. What are the different detection measurement? Please note that in all the cases the most of the cases the detection

techniques based on the based on the optical system. So, there is a some filter. So, we will take out the output and measure it. So, basically it is optical method of measurement in all the cases of the gas detections. Then we have gas detection based on optical filter as I told you earlier. Then you have colour code of air quality index we have a colour code. So, the looking at the colour I can say the, what is the quality index of the air or the air or the environment? So, this all the things we will study in this particular lesson.

(Refer Slide Time: 05:48)

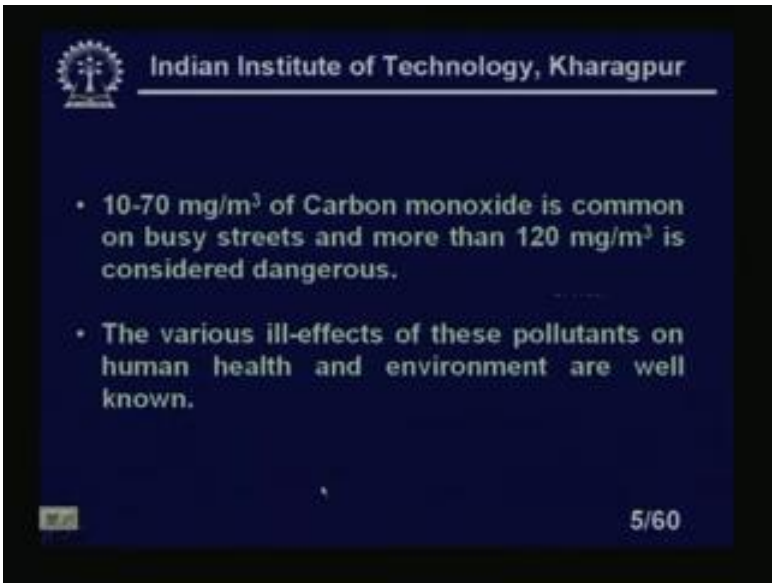


Introduction let us see, the sources of pollutions are many and varied as I told you and include factories automobiles burning dumps, power generating stations, household furnaces and so on and so forth right. These are the different type of pollutions you will get. There are many other pollutions you will find that this is the basic principle pollutions which will have the factories automobiles is the most. I mean main source of pollutions in any big cities or metropolis power generating stations even though sometimes it is remote from the area from main cities. But you will find you pollute the neighboring areas neighboring villages. Then it destroys the nearby paddy fields all those things are there.

And household furnaces though it is not very common in our country and you know that many places still the people uses the coal based stove, I mean the coal based or calcium that is also pollute the environment. So, we will study all these things. Now, common harmful chemicals that are emitted into the atmosphere include hydrocarbons oxides of

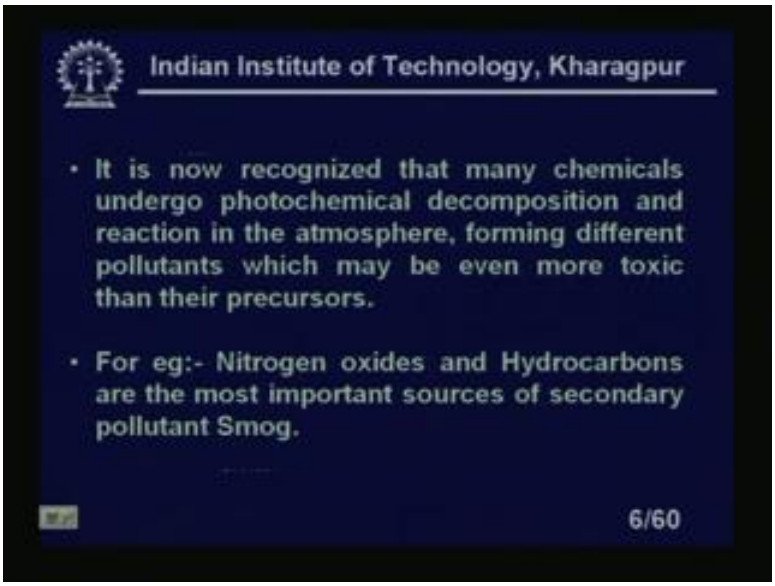
nitrogen which is called NO x or NO x nitrogen dioxide nitrogen monoxide and carbon monoxide and sulphur dioxide. These are the main I mean basic pollutions which you will get in the which are harmful.

(Refer Slide Time: 07:11)



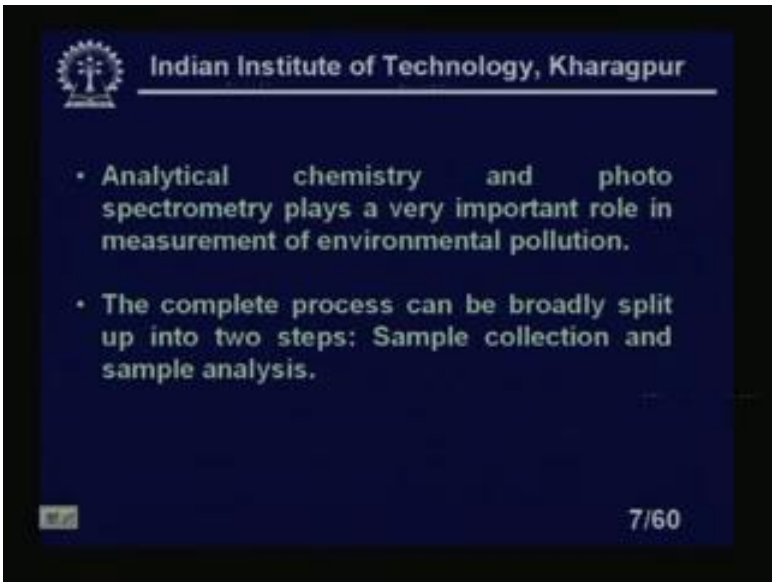
Now, 10 to 17 milligram permeter cube of carbon monoxide is common on a busy streets and more than 120 milligram per meter cube is considered dangerous. So, if it is that is why I told you cannot we cannot I mean I mean we cannot say that the they are the any environments will be totally pollution free. So, when you are living in a cities, we have to live in a city large number of people live in a city. So, there will be some pollution, but if it is within the safe limit that is fine no problem, But if it crosses that particular limit which is hazardous. The various ill effects of these pollutants on the human health and environments are well known, right. So, there are various types of there are causes of from ((Refer Time: 07:49)) asthma you know this all this pollution make the people sick So, that this content should be less and less.

(Refer Slide Time: 08:00)



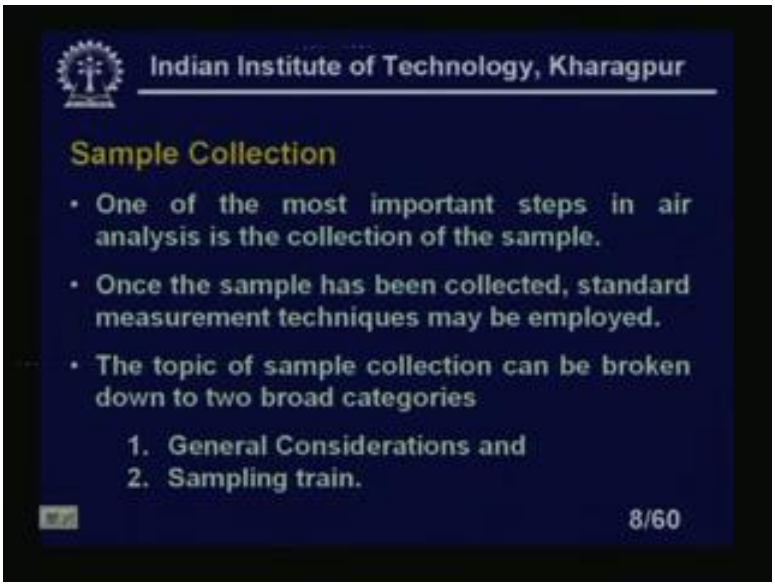
It is now recognized that many chemicals undergo petro photochemical decompositions and reactions in the atmosphere forming different pollutants which may be even more toxic than their precursors. So, this is another problem, because you see to it will react. So, it is a photochemical decomposition. So, it will make some other pollution pollutants which is more dangerous. The nitrogen oxides and hydrocarbons are the most important source of secondary pollutant smog. Smog is now it is called as smoke and fog. So many cities you will finds in the morning this is full of smog; that means, visibility is extremely poor. So, the I mean it is very difficult for the persons to drive in the street or the very difficult for the air aircraft to land very difficult for the train to move, so due to this smog. So, this is also very important sort of pollutions.

(Refer Slide Time: 08:50)



Analytical chemistry and photo spectrometry plays a very important role in the measurements of environmental pollutions. So, these are the most important things, we are usually measuring this type of as I told it is. Basically photo spectrometry plays a important role in measurements of pollutions or quantify the pollutions we are talking of just in qualitatively. But you must quantify otherwise how will you know whether it is 10 to 17 milligram per meter cube. Whether it is not it has it does not cross or did not cross the 1 20 milli milligram per meter cube. The complete process can be broadly split up into 2 steps sample collections and sample analysis. So, obviously, you will first the collect the sample of the air which I want to analyze, which I want to know how much the pollution there then the sample analysis sample collection.

(Refer Slide Time: 09:40)

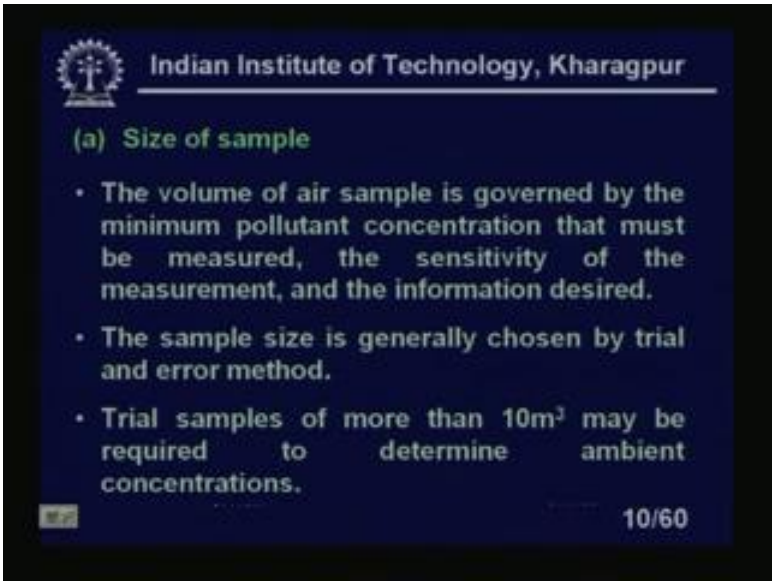


One of the most important steps in air analysis is the collection of the sample. Once the sample has been collected standard measurement techniques may be employed. The topic of sample collection can be broken down into 2 broad categories. General consolidations and sampling train. So, what is the different precautions we will take for sampling collections? What is the velocity of such making the suction from the environment, and all these things.

(Refer Slide Time: 10:14)

General considerations; the following are the points which must be kept in the mind before going for sample collection.

(Refer Slide Time: 10:22)

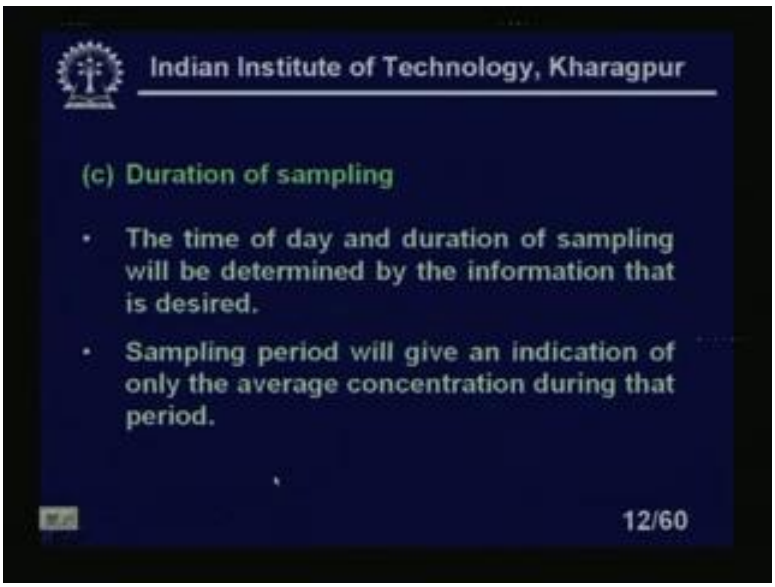


Size of the sample; the volume of the size I am talking about the I mean the size of the dust particles of the size of the sample how much will how much air you will collect from the environment to analyze it? That is I am talking about the size of the sample. The volume of air sample is governed by the minimum pollutant concentration that must be measured. The sensitivity of the measurements and the information desired. The sample size is generally chosen by a trial and error method. And trial samples of more than 10 meter cube may be required to determine ambient concentrations sometimes we need large meter. I mean volume to know the ambient concentration or an average concentrations instead of taking very small, but we may need very small, but we take a large then; obviously, that is also will be on average we can average over a particular area.

(Refer Slide Time: 11:13)

Rate of sampling: The useful sampling rate will vary with that sampling devices and should be determined experimentally, that we have to determine experimentally. The most sampling devices for gaseous constituents have permissible flow rate as I told you we have to, I mean collect it with some suction pump. So, that type of thing. So, velocity will be 0.003 to 0.03 metre cube per minute.

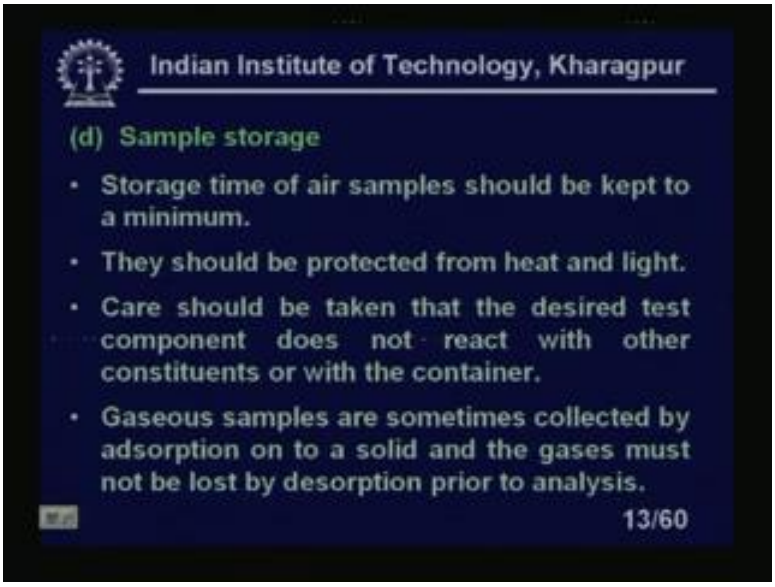
(Refer Slide Time: 11:43)



Now, duration of sampling that is also important. Time of the day and the duration of sampling will be determined by the information that is desired. Because the time because

if you go to a busy streets if you take a sample at the 5 o clock in the morning there is no use hardly that time in pollutions, but at the 10 o clock in the morning if you take something you will get the estimate. You will get the exact the how much the pollution is there or what is the worst case pollutions in the streets in the evening or in the morning?. Sampling period will give the indications of only the average concentration during that periods means suppose, I am taking for 1 hour, so that means, I am collecting over averaging over 1 hour. So, that is that is the good measurement.

(Refer Slide Time: 12:26)

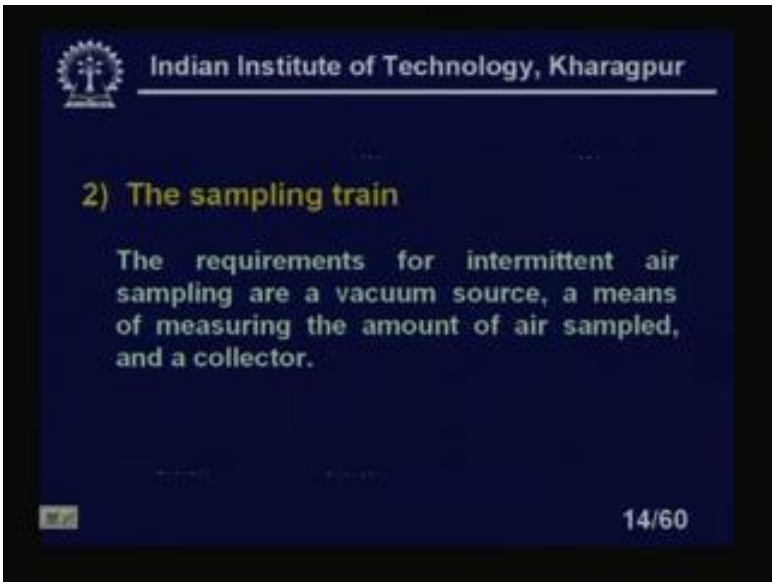


Then, storage time of sample storage; this is one important storage time of the air sample should be kept to a minimum. This should be because in some cases it can be decomposed. So, that should be after making the collections you should make the quick analysis. They should be protected from heat and light this is another important thing. Care should be taken that the desired test component does not react with the other constituents or with the container.

So, the container should be I mean sort sort of inert some minute probably made of glass or stainless steel. So, that it will not whatever the pollutions or the like the gases that should not react with the container those are those things should be considered. Gaseous samples are sometimes collected by the absorption adsorptions on to a solid and the gaseous must not be lost by desorption prior to analysis. Many samples you know collected by adsorption; that means, it will be on the solid material and it should not be

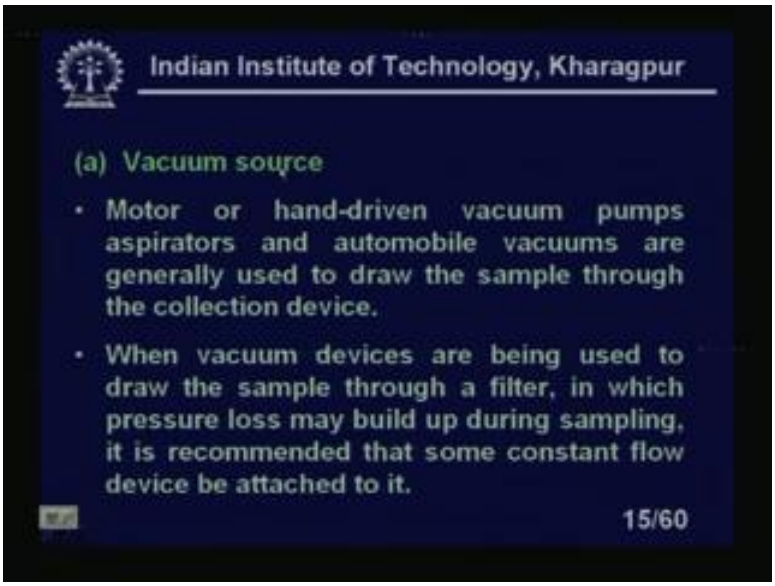
released or desorption prior to the analysis. So, because if I do that if it desorbs before the analysis; obviously, that particular gas will be lost we cannot analyze. Even though it will be showing there is no that type of gas is there, but actually it was there by that time it is lost.

(Refer Slide Time: 13:41)



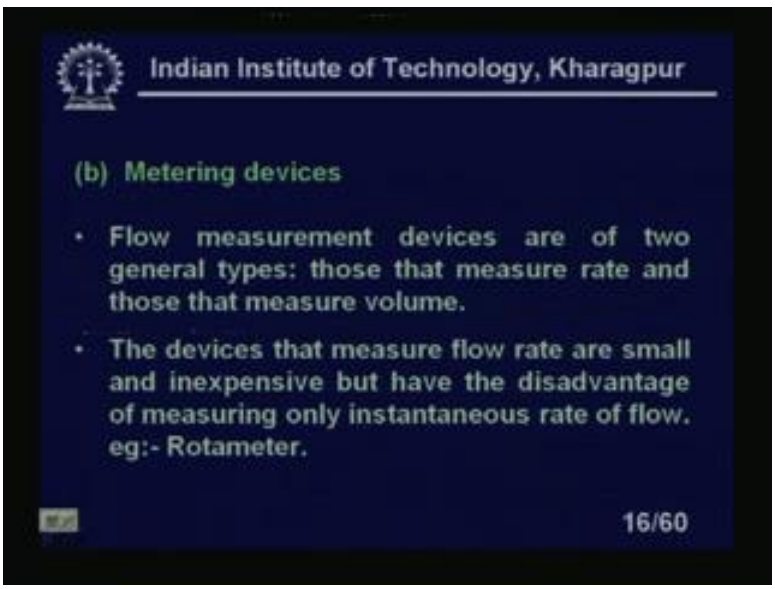
Sampling train, the requirement for intermittent air sampling are a vacuum source a means of measuring the amount of air sampled and a collector. So, you have vacuum source. So, that and the means of measuring the amount of air sample and the collector. Because if there is no vacuum source that we cannot collect the sample, right.

(Refer Slide Time: 14:06)



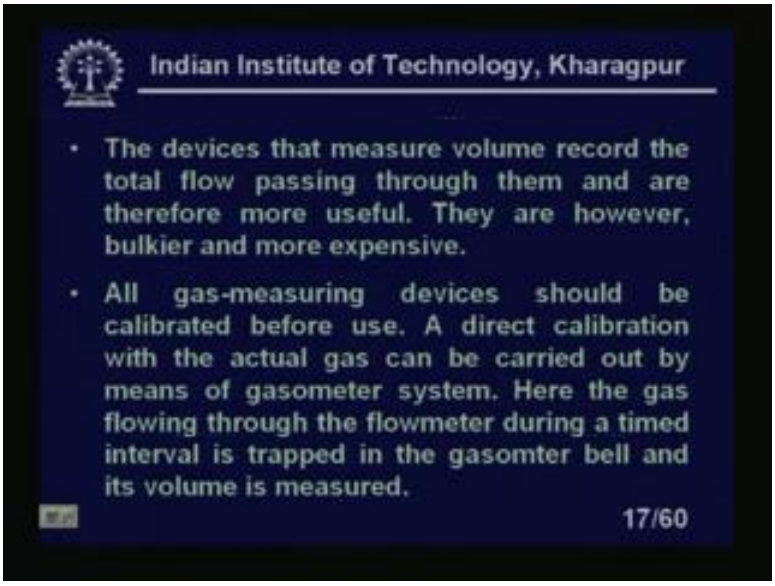
Vacuum source; what are the vacuum source motor or hand driven vacuum pumps aspirators and automobile vacuums are generally used to draw the sample through a collection devices, clear. So, this is a basically pump, by which you will collect the sample from the environment and store in a collector. When vacuum devices are being used to draw the sample through a filter in which the pressure loss may build up during the sampling it is recommended that some constant flow devices to be attached it, right. Some constant flow devices should be there. So, that the, because if I use a filter, so obviously, there will be some pressure loss across that filter.

(Refer Slide Time: 14:43)



Now, metering devices, flow measurement devices are of 2 general types we have seen this we have studied this flow measurement devices in this particular course of industrial instrumentation. Thus some I will make as you know some will make the rate measurement, some will make the volumetric flow measurement, some will make the mass flow measurements. We are more interested here instead of the rate measurement on the volumetric measurement, right. Flow measurement devices are of 2 general types those measure the rate and those measure the volume or you can make the total volume also. This devices the devices that measure the flow rates are small and inexpensive, but have the disadvantage of measuring only instantaneous rate of flow 1 is rotameter. Rotameter is just you make the instantaneous rate of flow it will not make the total volumetric flow of a device over a certain amount of time.

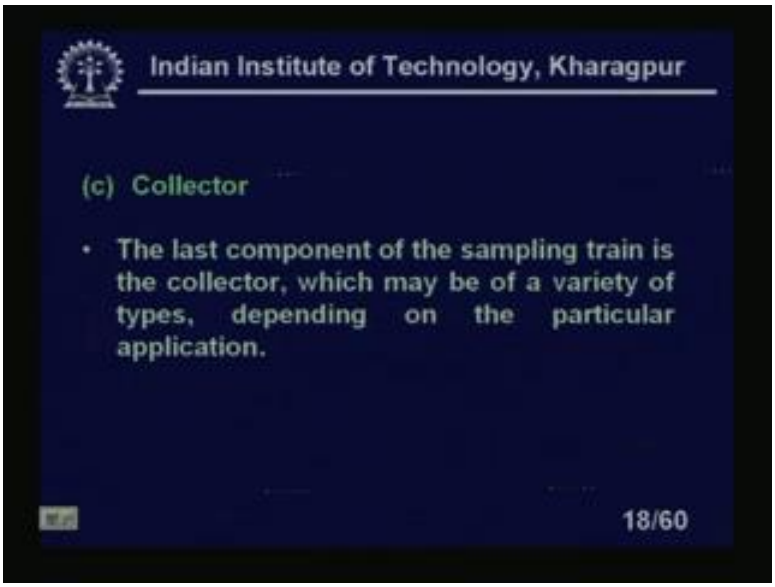
(Refer Slide Time: 15:31)



Devices that measures the volume record that flow passing through the, them through them and are therefore, more useful they are; however, bulkier and are more expensive. Rotameter is a very simple devices as you know it is a very I mean indicating sort of instruments, we have studied this in details in the in the flow meters. But other devices where we can suppose a flow meters like a turbine flow meters. And all these things or any other gas flow meters you can measure this one like orifice meter also, because that is bulkier obviously. All gas measuring devices should be calibrated before use because the you are measuring the volumes. So, how much collections we are taking? So, it should be calibrated before. A direct calibrations with the actual gas can be carried out

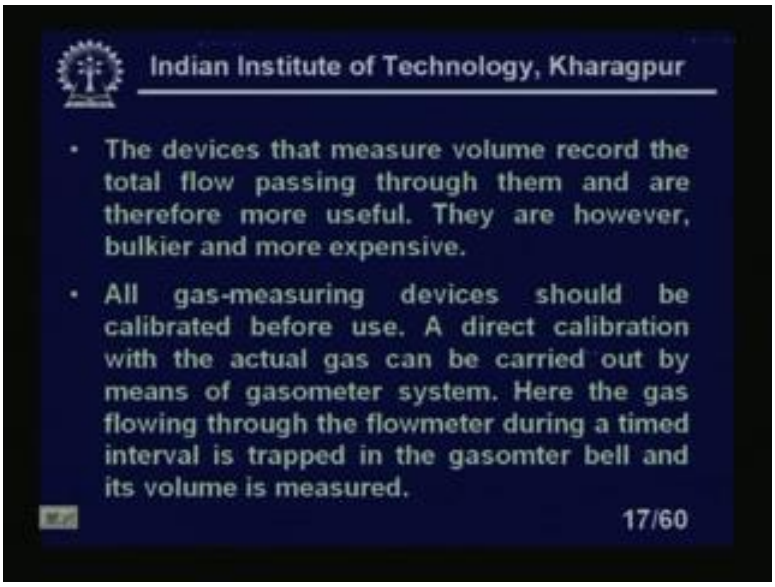
by means of gasometer system. Here the gas flowing through the flowmeter during a time interval is trapped in the gasometer bell, and it is volume is measured a gasometer bell is there and the volume is measured.

(Refer Slide Time: 16:32)



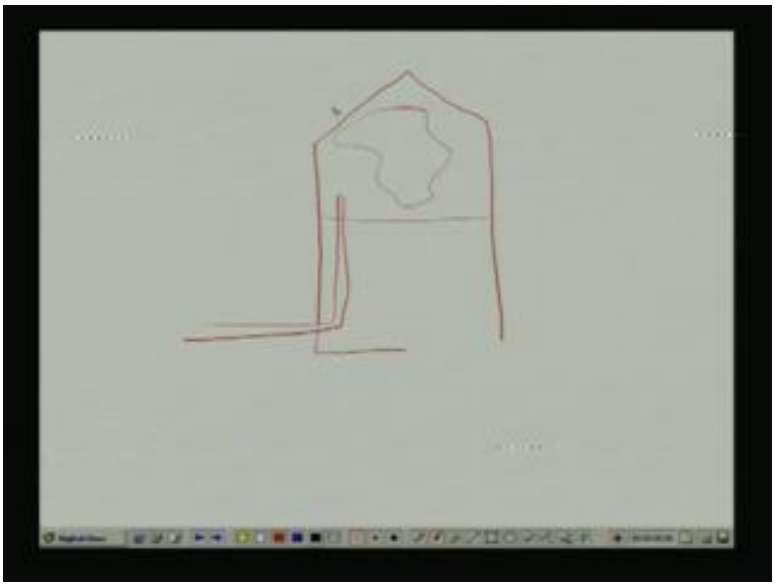
Collector the last component of the sampling train is the collector which may be of variety of types depending, on the particular applications right. So, these are the very important thing. So, for consideration…

(Refer Slide Time: 16:55)



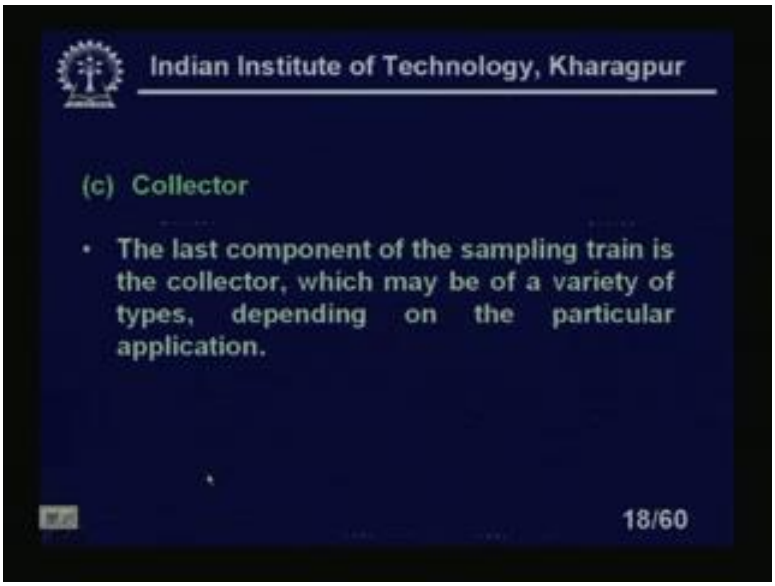
Basically, if you look at the gasometer basic principle is something like that this gasometer is basic principle is that it has a known volume of I mean device direct calibrations. So, the actual gas can be carried by means of gasometer system and the gas flowing through the flow meter is trapped in the gasometer bell and that it is volume is measured, right. It is a like this one it is a I mean if you look at it will be like this, one is a, if I take a new page and new color.

(Refer Slide Time: 17:26)



So, it is a bell sort of thing over this 1 and water is there. So, that it is trapped and going like this. So, the bell will come now this water also gas will be trapped here in this. So, that the volume will be known us, it is as simple as that that is it is called basically gasometer.

(Refer Slide Time: 17:54)

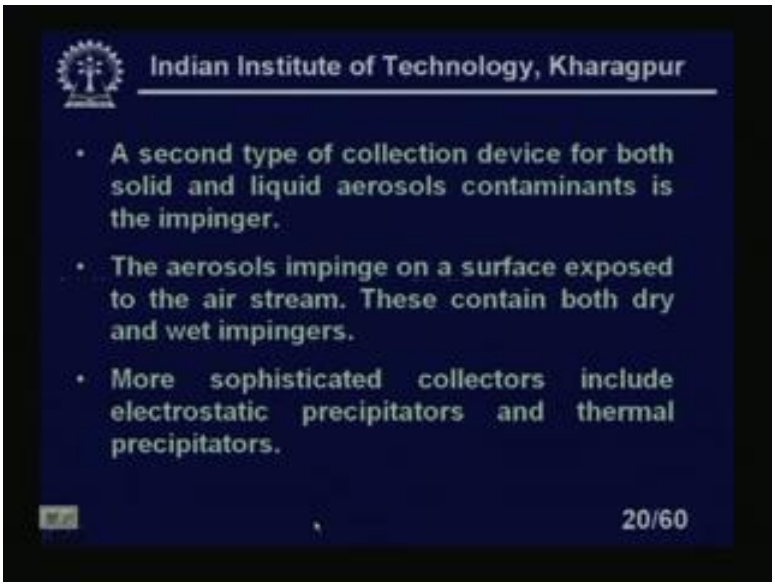


Collector: The last component of the sampling train is the, a collector which may be variety of types depending on the particular applications.

(Refer Slide Time: 18:04)

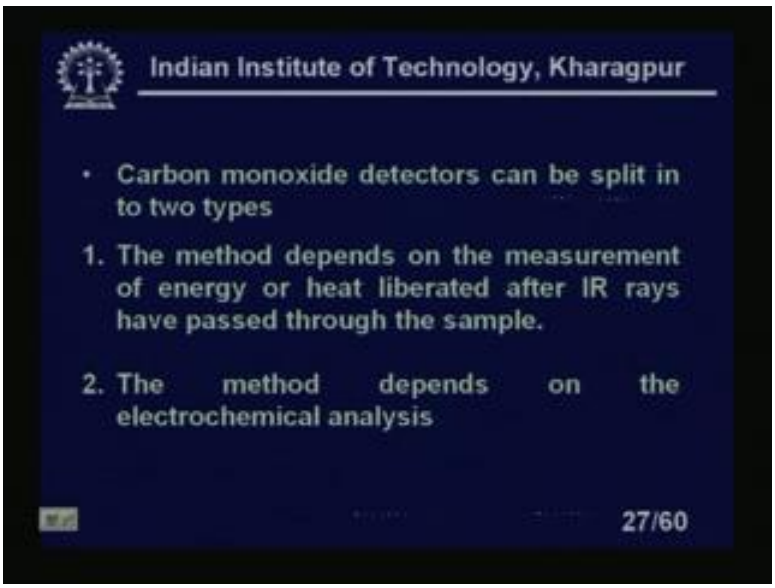
Aerosol contaminants; one of the most commonly used means of collection aerosol contaminations is a filtration. So, fiber filter wood fiber paper glass fibre asbestos these are granular filter glass or metal or porous ceramic sand and membrane filters are used, cellulose ester. So, these are the different types of filters which are used commonly mean of aerosol contaminants in the filtrations.

(Refer Slide Time: 18:30)



A second type of collection device for both the solid and liquid aerosols contaminants is a impinge, right. The aerosol impinge on a surface exposed to the air stream and those contain both dry and wet impingers. More sophisticated collectors include electrostatic re-liberate ((Refer Time: 18:50)) that energy in the form of a heat when they recompress.

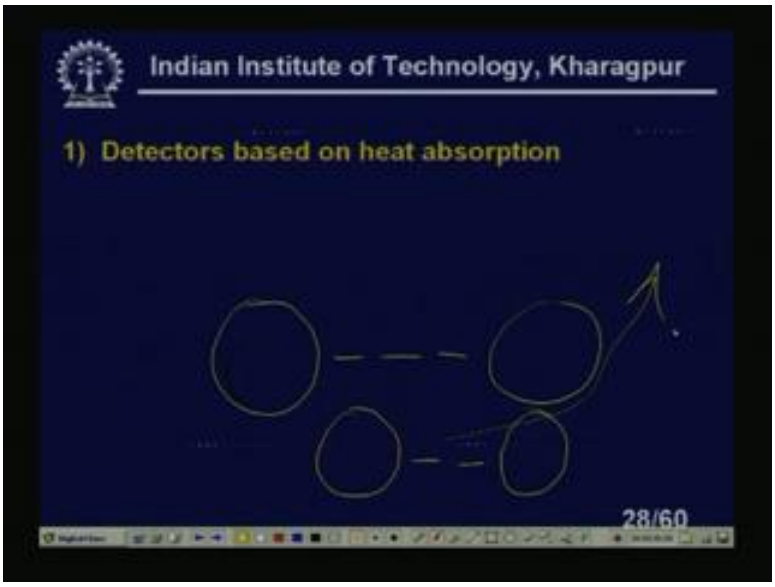
(Refer Slide Time: 22:30)



Carbon monoxide detectors can be split into 2 types the method depends on the measurements of energy of heat liberated after IR rays have passed through the sample. After the heat I mean after the IR rays pass through the sample. So, that is one method

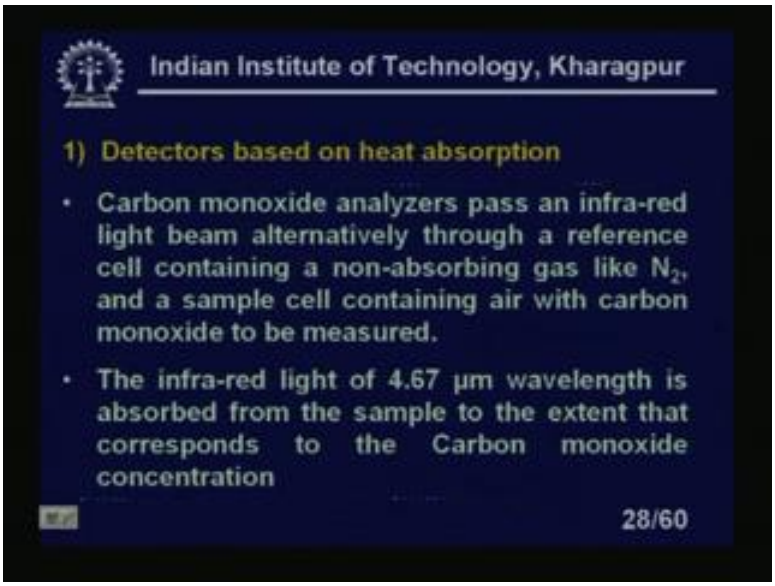
next method is; that means, the as you as I told you; that means, I have a atoms I mean it will delete will show you. The method depends on the electrochemical analysis, these are the 2 methods; one is the total I mean optical method another is electrochemical method right.

(Refer Slide Time: 23:05)



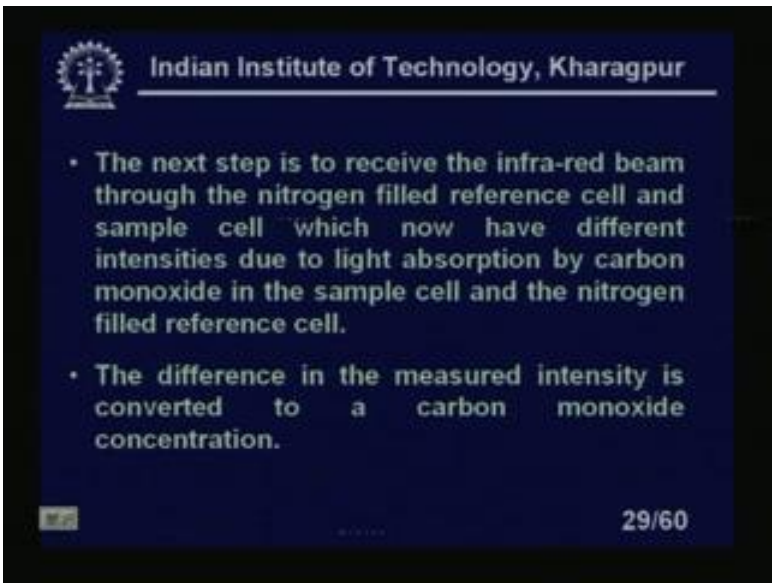
Now, detectors based on the heat absorptions; that means, it looks like you see the what will happen? That means, it will have like this one. So, I have here. So, we have like this one. So, after light energy it is bonds like this one. So, it is going on like this one excited after one the when the, if it is infrared passed. So, this will be detect liberate the light energy that will be detected, right. That is a basic principle.

(Refer Slide Time: 23:41)



Carbon monoxide analyzers pass an infra red light beam, alternatively through a reference cell containing a non absorbing gas like N 2 nitrogen and the sample cell containing air with carbon monoxide to be measured. The infra red light of 4.67 micron wavelength is absorbed from the sample to the extent that corresponds to the carbon monoxide concentration, right.

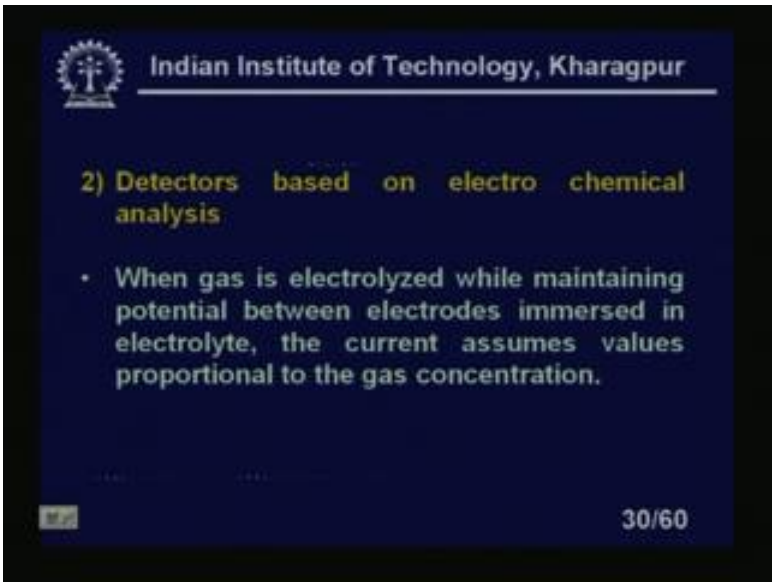
(Refer Slide Time: 24:10)



The next step to receive the infra red beam through a nitrogen filled reference cell and a sample cell, which now have a different intensities due to light absorptions by carbon

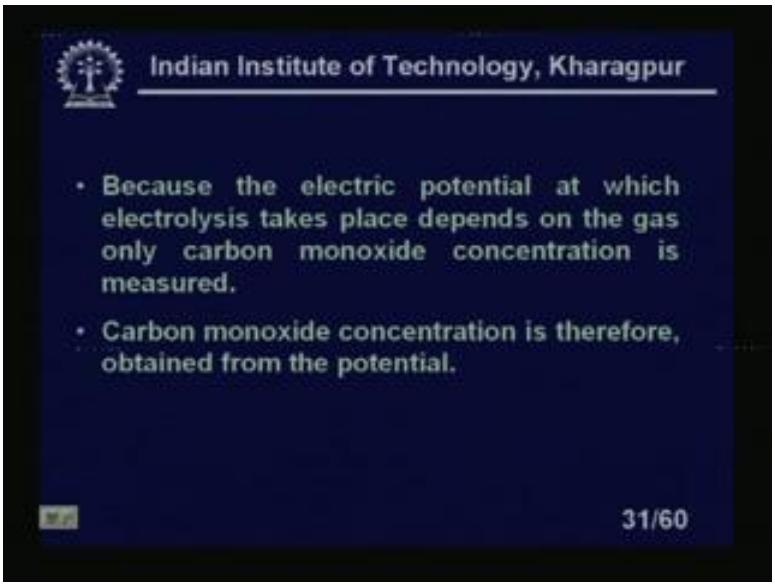
monoxide in the sample cell then nitrogen filled reference cells, right. So, this is the thing. The difference in the measure intensity is converted to a carbon monoxide concentration, right. So, these 2 difference; one will be without carbon monoxide and other is with carbon monoxide. So, be the difference.

(Refer Slide Time: 24:38)



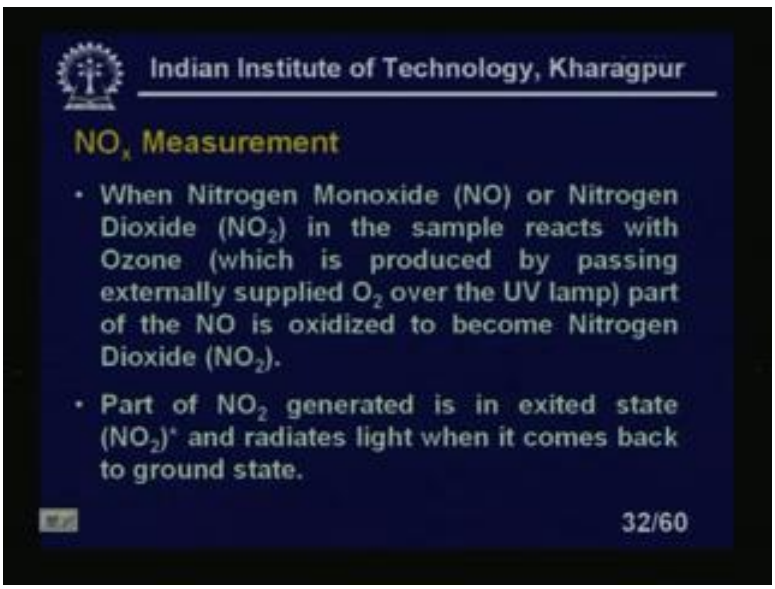
Now, detectors based on the electrochemical analysis looks like this, when the gas is electrolyzed, while maintaining the potential between the electrodes immersed in electrolyte the current assumes values proportional to the gas concentration, right. The gas is electrolyzed maintaining the potential between the electrodes immersed in the electrolytes the current assumes value proportional to the gas concentration why you see?

(Refer Slide Time: 25:03)



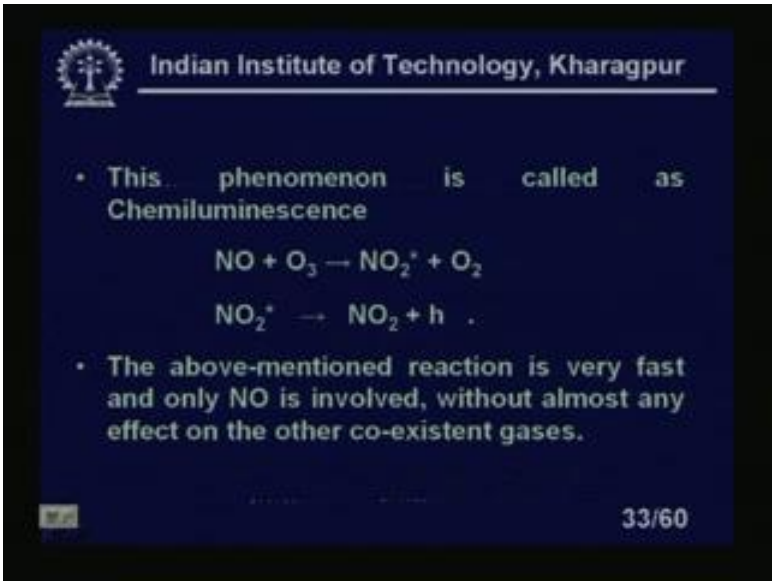
Because the electric potential at which the electrolysis takes place depends on the gas only carbon monoxide concentration and the carbon monoxide concentration is measured. The carbon monoxide concentration is therefore, obtained from the potential. So, if I measure the potential that potential can be calibrated in terms of the carbon monoxide concentrations in the gas because electric potential at which the electrolysis take place depends on the gas only. So, depends on the concentrations of the carbon. So, if that voltage is calibrated in terms of you can directly calibrate that voltage in terms of carbon monoxide concentration.

(Refer Slide Time: 25:39)



The NO x measurements; it is a very common not only in our environment, but also in industry NO x; that means, nitrogen oxide and nitrogen dioxide this 2 types of pollutions. I mean gas we are calling it the NO x NO x analyzer NO x measurement NO x gas. Whenever we are talking about we have to I mean of this NO x means NO x it means NO subscript x it means that the nitrogen oxide and nitrogen dioxide. When nitrogen monoxide sorry I was not instead of nitrogen oxide nitrogen both are nitrogen oxide. So, NO is the nitrogen monoxide and nitrogen dioxide is NO 2. When nitrogen monoxide or nitrogen dioxides in the sample reacts with the ozone which is produced by passing externally supplied O 2, over UV lamp part of the NO is oxidized to become a nitrogen dioxide, right. Part of NO 2 generated in is is in exited state exited states actually we are defining it by this one please note.

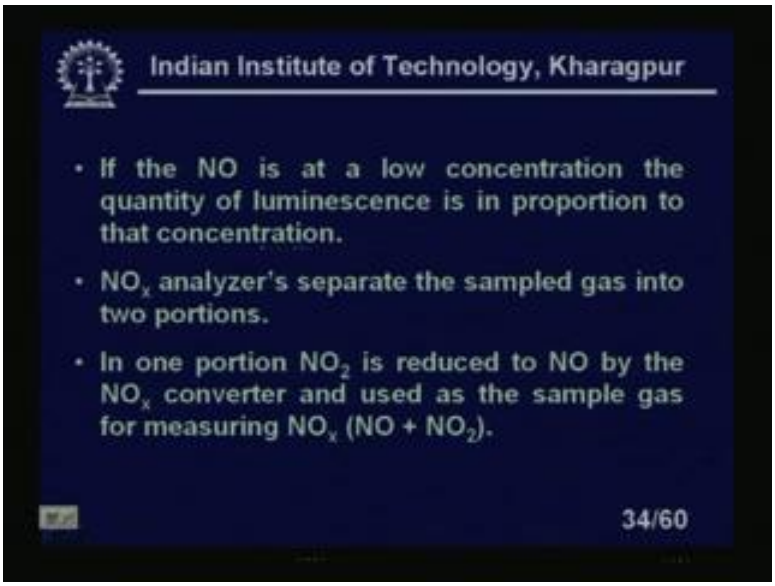
(Refer Slide Time: 27:01)



This phenomena is called the chemiluminescence actually you see here we are defining this NO 2 this asteric means it is in exited state I am sorry is in exited state NO 2 asteric if it is exited it is plus O 2. So, it is NO 2 exited state it is I mean liberating the actually this will h mu I am sorry this will be h mu NO 2 second equations if you see NO 2 asteric which goes to NO 2 plus h mu right. We can this will be if I this will be h mu right. So, the light will be emitted. So, above mentioned reaction is very fast and only NO is involved without almost any effect of the other co-existent gases. So, this also you should remember because it should not react with the other a gases other concentration of the gas cannot be detected by that type of method. So, the phenomena is called the

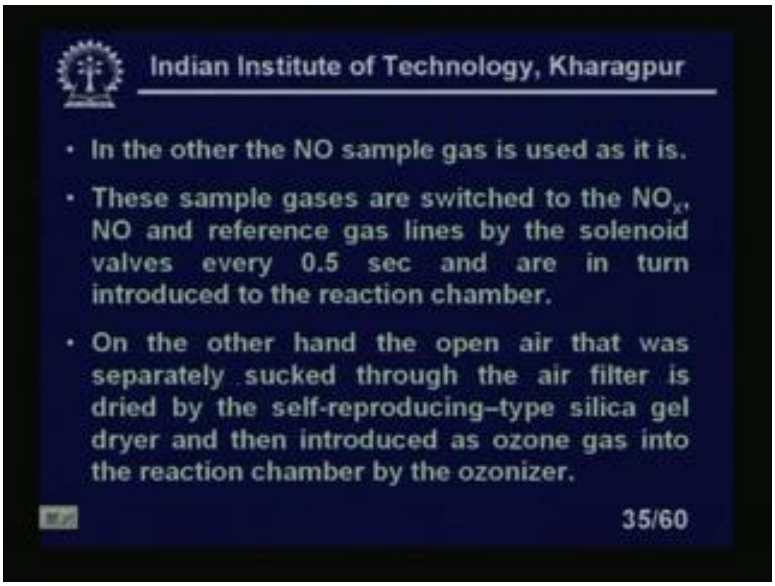
chemiluminescence. So, by this it is a nitrogen oxide reacts with ozone it is making nitrogen dioxide which is in exited state it will go back to the normal nitrogen dioxide state or nitrogen dioxides liberating light, right. So, the, this method is very fast and only NO is involved without almost any effect on the other co-existent gases.

(Refer Slide Time: 28:32)



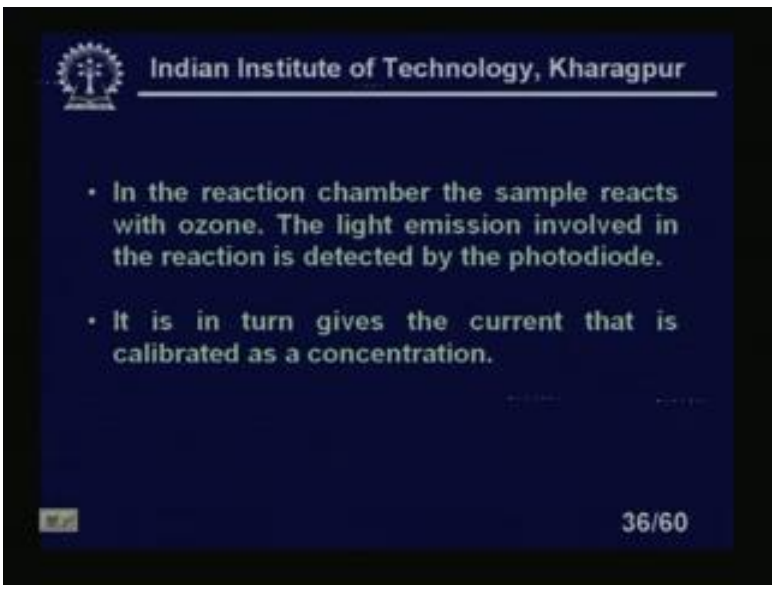
If the NO is at a low concentration the quantity of luminescence is in proportional to the concentration. The nitrogen monoxide is at low concentration the quantity of the luminescence is in the proportions of that to that concentration. Now, NO x analyzers separate the sample gas into the 2 portions in 1 portion nitrogen dioxide is reduced to NO by the NO x convertor and used as the sample gas for the measurement of NO x which is NO plus NO 2 nitrogen oxide and nitrogen monoxide and nitrogen dioxide.

(Refer Slide Time: 29:05)



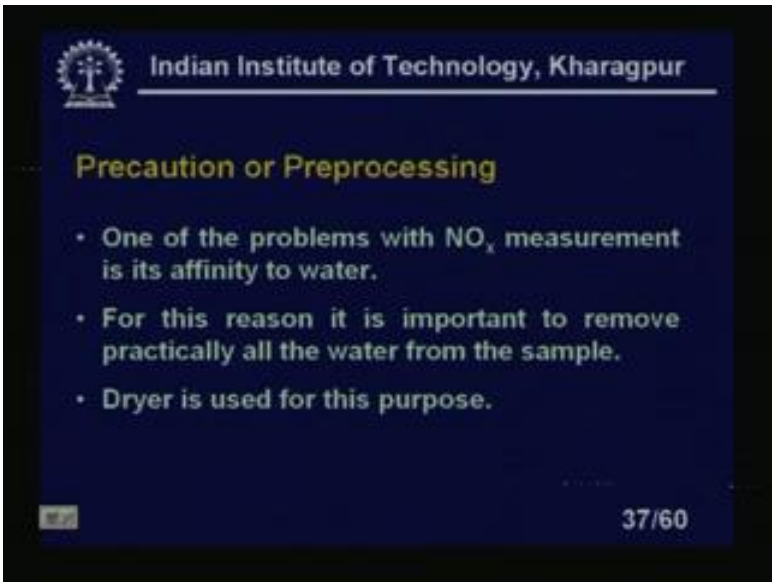
In the other the NO sample gas is used as it is, these sample gases are switched to the NO x NO and reference gas lines by the solenoid valves every .5 seconds and are in turn introduced in the reaction chamber. On the other hand the open air that was separately sucked through the air filter is dried by the self reproducing type silica gel dryer then introduced as ozone gas into the reaction chamber by the ozonizer. On the other hand the open air that was separately sucked through the air filter is dried up dried by the dried by the self reproducing type silica gel dryer ad then introduced as ozone gas into the reaction chamber by the ozonizer.

(Refer Slide Time: 29:51)



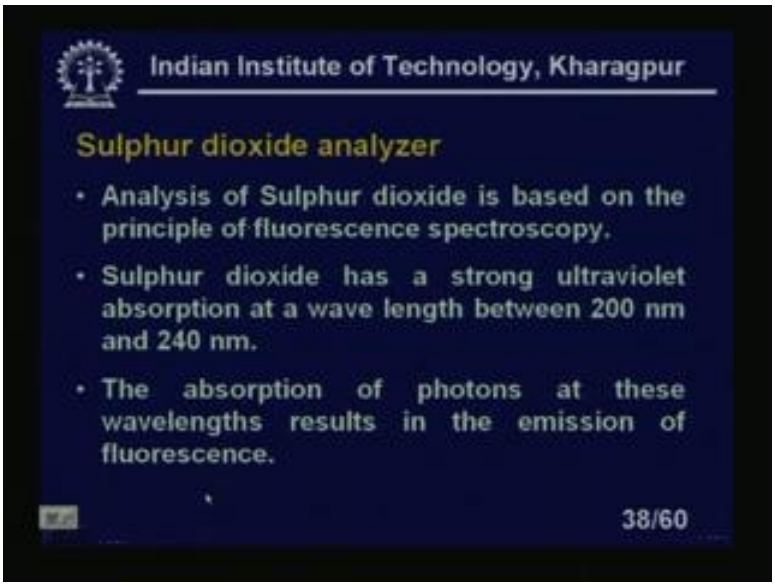
In the reaction chamber the sample reacts with ozone. The light emission involved in the reaction is detected by the photodiode. So, whatever the light detection is coming out is detected by the photodiode. It is in turn gives a current that is calibrated as a concentration. So, photodiode output can be I mean photodiode output will be current. So, that can be you know the photodiode always can be used for detection of some lights. So, that can be calibrated in terms of concentration.

(Refer Slide Time: 30:23)



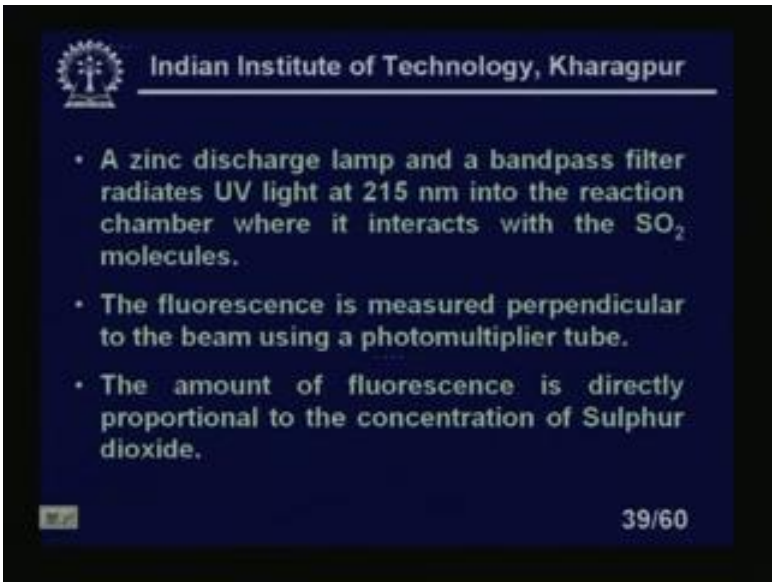
Now, what is the precautions and preprocessing of these that we must note one of the problem with No x measurement is it is affinity to water. So, any water, so immediately it will be absorbs and you cannot find the NO x. So, that a container should be totally air or water free that is most important thing for this reason it is important to remove the practically all the water from the sample because when it is in the sample. So, it may have other ah, so that, so the when before analyzing. So, this from the sample before analyzing the sample the all the water should be removed. Dryer is used for this purpose because silica gel dryers and all these dryers. Obviously, it will remove the moisture context in the NO x keeping the NO x as it is for analysis purposes because ultimately we have to make the analysis of this NO x.

(Refer Slide Time: 31:14)



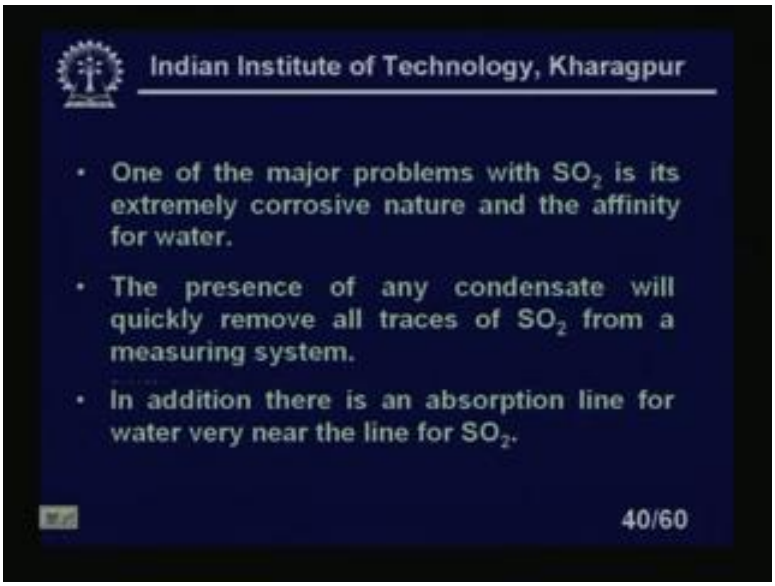
Now, sulphur dioxide is another form of pollutions in the environment. So, we must look at what is the this type of I mean pollution this is a very hazardous . So, we must know the contents of the sulphur dioxide in the air. Analysis of sulphur dioxide is based on the principles of fluorescence spectroscopy as I told u mostly these are basically depends on spectroscopy. So, this is also fluorescence spectroscopy. Sulphur dioxide has a strong ultraviolet absorptions to wavelength between 200 nanometer to 240 nanometers within that it has strong ultraviolet absorptions. The absorptions of photons at these wavelengths results in the emission of fluorescence because where this energy will go it cannot just get lost. So, that this energy will the consumed in the sulphur dioxide atom and it will release the fluorescence, right. We will measure that fluorescence and calibrate the by spectroscopy and and calibrate that in terms of the sulphur dioxide concentration.

(Refer Slide Time: 32:14)



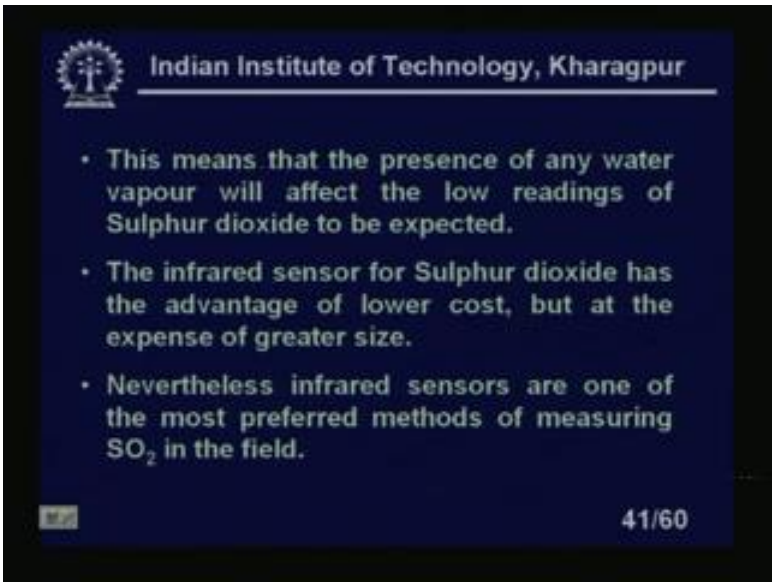
A zinc discharge lamp and a band pass filter and a optical band pass filter; obviously, radiates ultraviolet light at 215 nanometer into the reaction chamber where it interacts with the sulphur dioxide molecules, right. The fluorescence is measured perpendicularly to the beam using a photomultiplier tube. Photomultiplier is nothing but is a series of I mean instead of now a days instead of photomultiplier tube you can use a photodiodes also or photo transistors. So, photo multiplier tube is just it multiplies the it increases the output current as simple as that nothing more you must learn it in increases the current at the output. The amount of fluorescence is directly proportional to the concentration of sulphur dioxide which we are measuring by the photo multiplier tube.

(Refer Slide Time: 33:07)



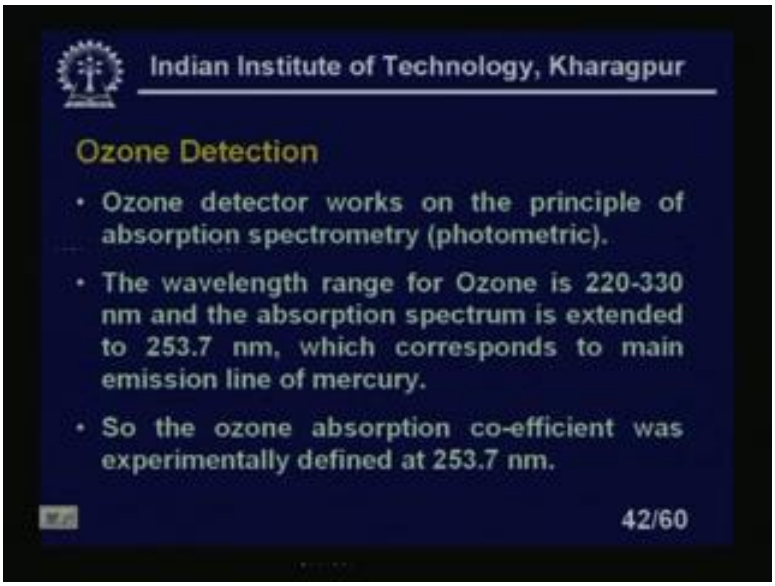
One of the major problems with the sulphur dioxide is extremely corrosive nature and affinity to water same as the sulphur dioxide as I told you. But sulphur dioxide I mean sorry nitrogen NO x not that corrosive, but sulphur dioxide has is corrosive in nature as well as it is affinity to water. So, both you have to take it is more I mean we should take higher precautions for analyzing the sulphur dioxide then nitrogen nitrogen dioxide if I remove all the water that is fine. So, there is by some dryer or some other means no problem, but here that we have to think that whatever containers we take that is that should not react to the sulphur dioxide. The presence of any condensate will quickly remove all traces of sulphur dioxide from a measuring system. So, all this if there is a little of presence of any water; obviously, it will remove all the traces. So, ultimately while we are analyzing you would not get any SO 2 giving you a wrong measurements or wrong indication that is un-desirable. In addition there is a absorptions line for a water very near line for the SO 2, this is another problem.

(Refer Slide Time: 34:16)



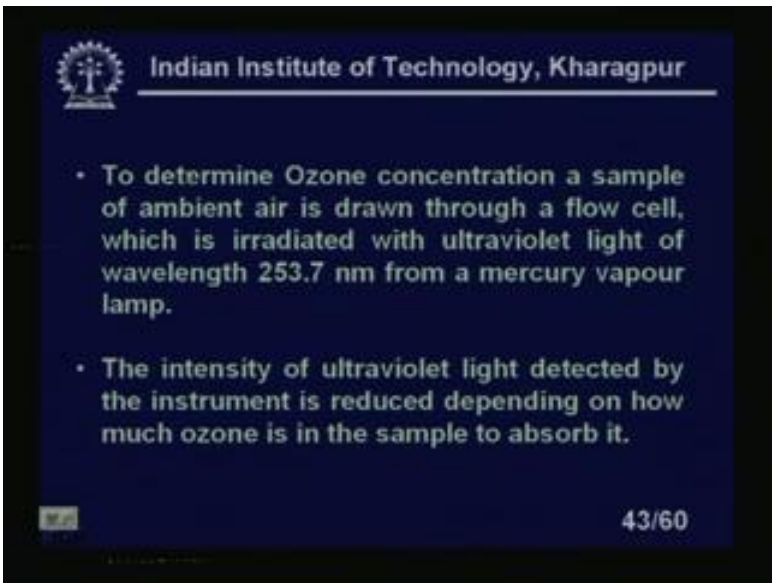
This means that the presence of any water vapour will affect the low readings of sulphur dioxide to be expected, there is another problem. So, not only the reaction, but this is line also lies very close. So, that there will be low reading of sulphur dioxide in presence of the water, right. Water vapor or water I mean the steam whatever you call. Infrared sensor for sulphur dioxide has the advantage of lower cost, but at the expense of greater size infrared sensors are there, but it has a has a advantage of the lower cost, but; obviously, the sizes will be quite big in this case. Nevertheless infrared source sensors are 1 of the most preferred methods are measuring SO 2 concentration in the field nowadays, right. Because of those advantages of his I mean that that line corresponds to a very close to the line of the water vapor.

(Refer Slide Time: 35:13)



Now, ozone detections you see the how it will detect the ozone zone detector works in the principle of absorption spectroscopy or spectrometry or photometry right. The wavelength range for ozone is 220 to 330 nano meter and the absorption spectrum is extended to 253.7 nanometer, which corresponds to the main emission line of mercury. So, the ozone absorption coefficient was experimentally defined at 253.7 nanometer.

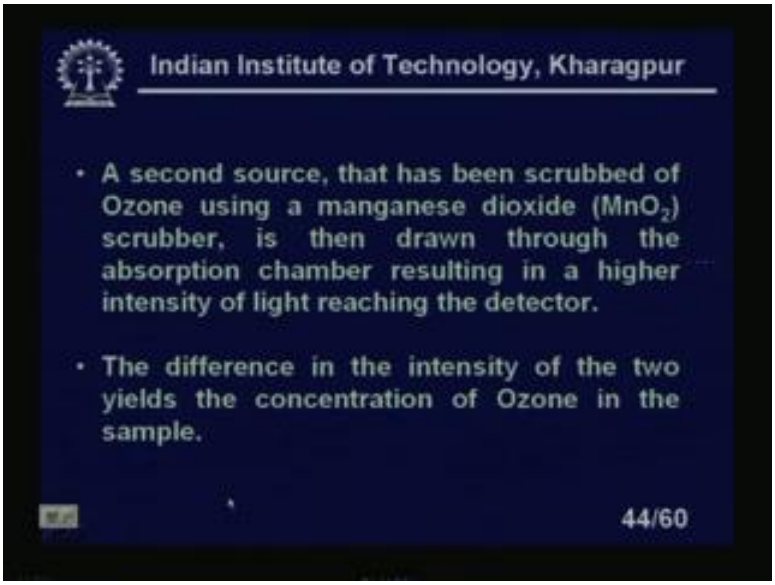
(Refer Slide Time: 35:45)



To determine ozone concentrations a sample of ambient air is drawn through a flow cell, which is irradiated with ultraviolet light of wavelength 253.7 nanometer from a mercury

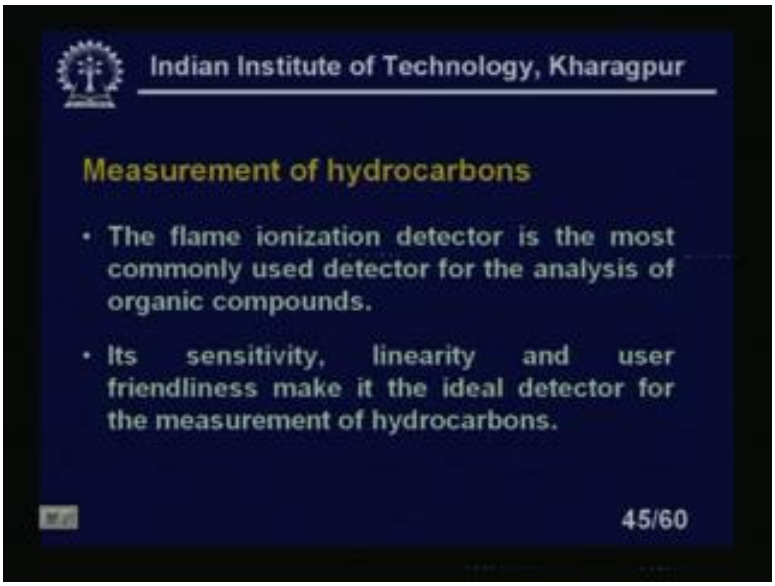
vapour lamp mercury vapour lamp will make a particular wavelength this 253.7 as I told you it is a line is same as the mercury. So, it will produce that particular wavelength stable wavelength. The intensity of ultraviolet light detected by the instrument is reduced depending on how much ozone is in the sample to absorb it if there is more ozone; obviously, it will absorb more. So, the intensity will be reduced. So, that is a intensity ultraviolet light detected by the instrument is reduced depending on how much ozone in the sample to absorb it, if there are more less ozone. So, we will get more better higher output if the more ozone I will get less output. So, that is the indications of the concentration.

(Refer Slide Time: 36:37)



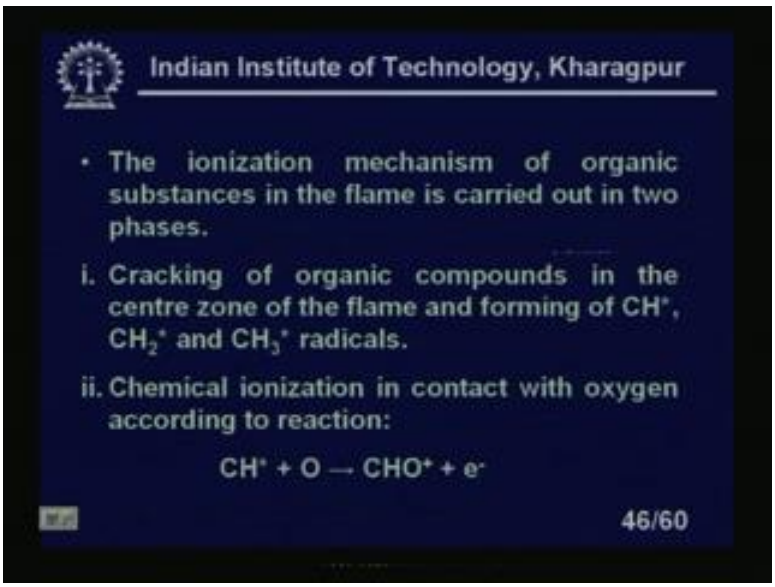
A second source that has been scrubbed of ozone using a manganese dioxide scrubber is then drawn through the absorption chamber resulting in a higher intensity of light reaching the detector, clear? The difference in the intensity of the 2 yields the concentration yields the concentrations of the ozone in the sample difference of these 2 intensity will give us the sample.

(Refer Slide Time: 37:04)



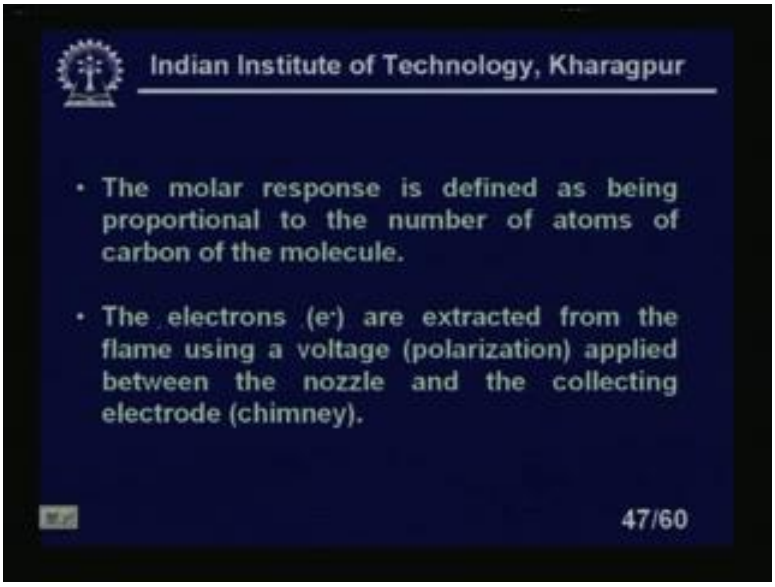
Now, measurement of hydrocarbons as I told you hydrocarbons means combinations of me at this methane ethane. All these things are basically we are calling a hydrocarbons no petrochemical industries sometimes we call it hydrocarbon industry also. Now, the flame ionization detector is the most commonly used detector for the analysis of organic compounds or hydrocarbons in the both in the environment as well as in the factory. Its sensitivity linearity and user friendliness make it the ideal detector for the measurements of hydrocarbons.

(Refer Slide Time: 37:36)



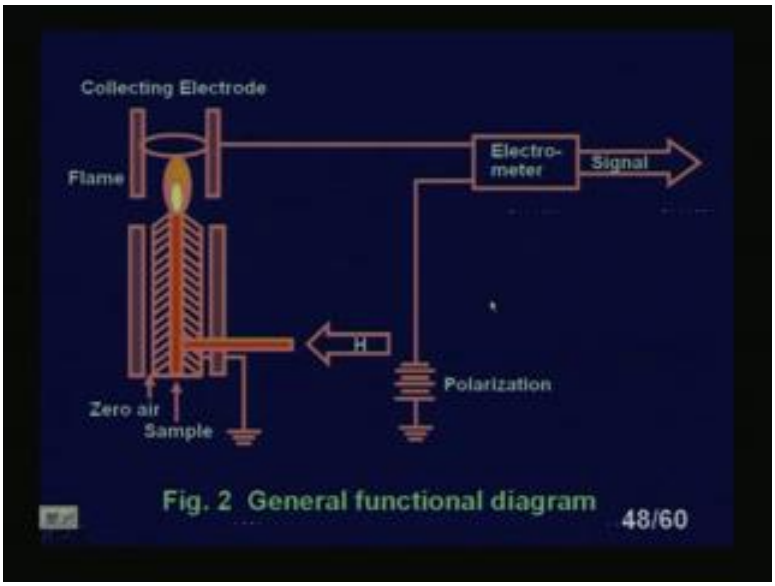
The ionization mechanism of organic substances in the flame is carried out in 2 phases, what are the 2 phases let us look at. The cracking of organic compounds in the centre zone of the flame and forming the CH CH 2 CH 3 radicals, CH radical, CH 2 radicals and CH 3 radicals by cracking these all ready compounds in the centre zone of the flame and forming of this type of hydro radicals. Chemical ionization in contact with the oxygen according to the reaction CH radical I mean plus O which will give you CHO plus plus electron 1 electron.

(Refer Slide Time: 38:18)



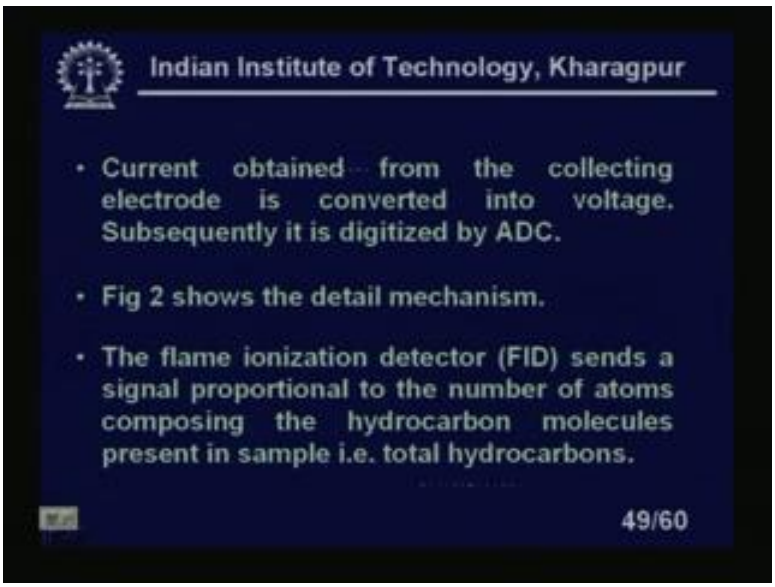
The molar response is defined as being the proportional to the number of atoms in the carbon of the molecule. The electrons are extracted from the flame using a voltage polarization applied between the nozzle and the collecting electrode between the nozzle and collecting electrode it will be.

(Refer Slide Time: 38:41)



Now, this is the figure of general functional diagram of our you see the polarizations. We have a collecting electrode we have a flame here then we have a zero air the sample is injected through E 1 and this electrometer, I am sorry the electrometer signal is electrometer is nothing but a high input impedance meter voltage meter. So, it will collect the signals and like this right.

(Refer Slide Time: 39:08)



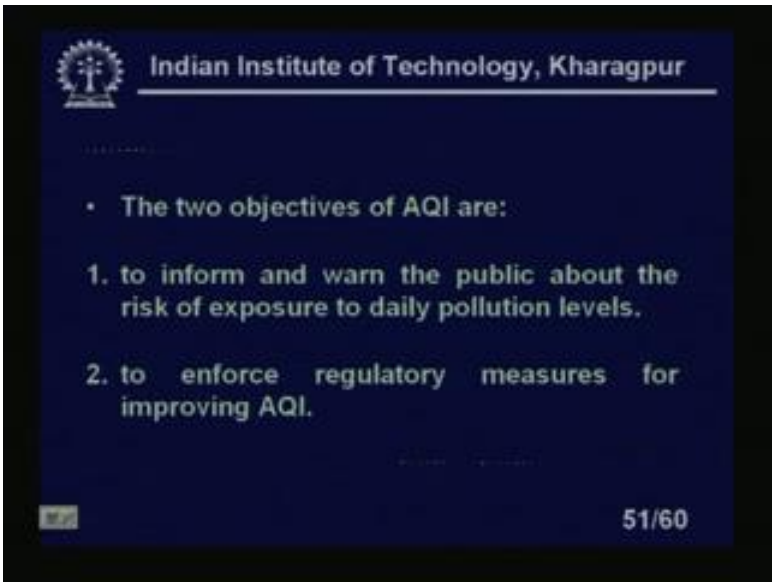
Current obtained from the collecting electrode is converted to a voltage subsequently it is digitized by ADC for further processing right, because if it is analog signals I have to

convert to the digital domain by ADC. Figure 2 shows the detail mechanism which I have just shown the detail mechanism of this type of detector. The flame ionization detector sends a signal proportional to the number of atoms composing the hydrocarbon molecules present in the sample or total hydrocarbons right. Now, another important thing is the air quality index the, what is the quality, how we will index, how we will I mean make the air safe? And all these things you must have some index because the if you look at the general I mean public they will not understand what is this concentration or what is the safe thing? So, let us better it is expressed what is the concentration of the carbon monoxide in the air what is the concentration of sulphur dioxide? Instead of that we make the air quality index it is inclusive of visibility also the also the quality of the air. So, this air quality index, now let us look at meaning and use.

(Refer Slide Time: 40:23)

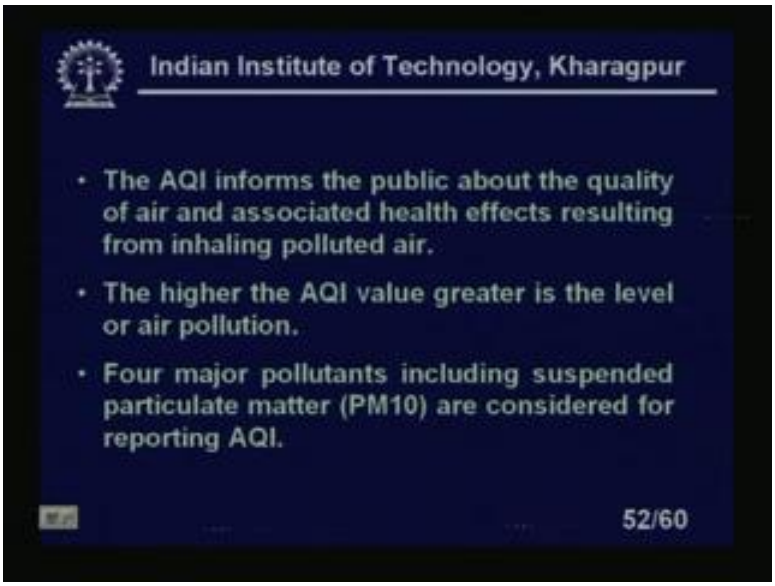
The air quality index is an index or rating scale for reporting daily the ambient air pollution recorded in the monitoring sites. So, it will usually it I mean records or it will gives you it will gives you index how the air quality in a particular site is good or bad right. So, that is I am saying air quality index is an index or rating scale for reporting daily the ambient air pollution recorded in the monitoring sites.

(Refer Slide Time: 40:47)



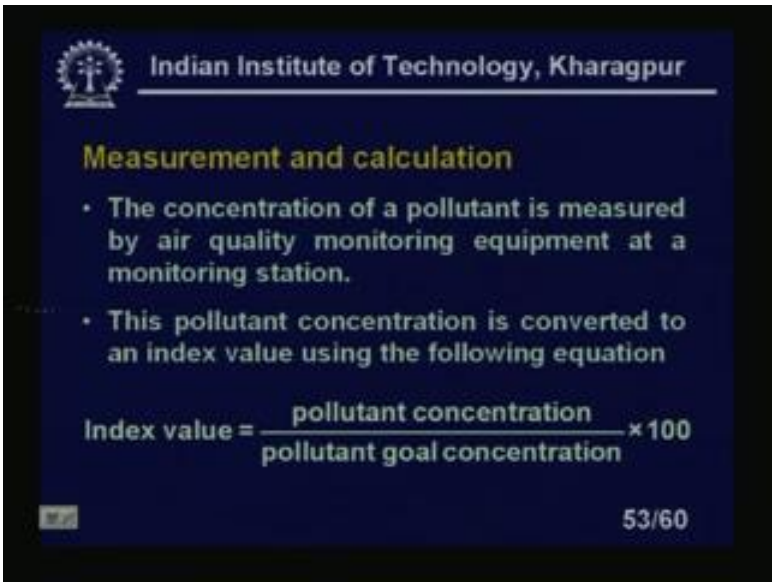
The 2 objectives of AQI are to inform and warn the public about the risk of exposure to daily pollution levels. As I told you earlier usually we will define these things; obviously, we must have a goal that we have to reduce this to some level. So, people also will know. So, there should be some protective measure to come down to bring it down to particular level. To enforce regulatory measures for moving AQI improving AQI. So, that what is the precautions we should take, what type of you know that you see that the reason is we have the air quality is very extremely poor in India and the metropolis like Delhi, because there is a lot of automobile for pollution there. So, there converted to all everything to CNG. So, which will give you less pollutions. So, this actually this type of. So, there every time they will measure the, what is the quality what is the quality of the air we are inhaling what is the dangerous level. And once they have switched to CNG all the cars all the buses were people found the air quality index improved a lot. So, this will give you some measure or the viewer with a single index people will know the, how my water how the environments of the air which I am inhaling good or or how good it is.

(Refer Slide Time: 42:07)



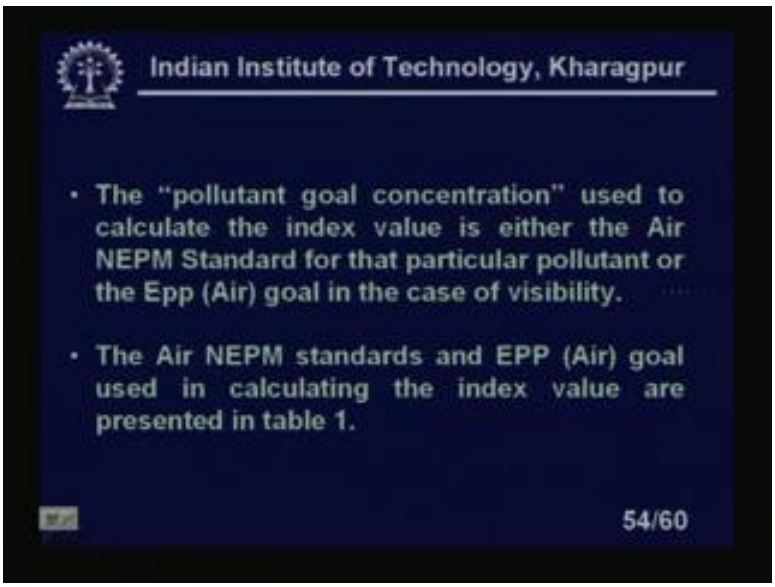
The AQI or air quality informs the public about the quality of the air and associated health effect resulting from inhaling polluted air what is the ill effects and how you can you reduce? And all this thing is to be discussed the higher the AQI value greater is the level or air pollution. So; obviously, the higher the value always the desired value should be lower and lower. So, that is most important thing for air pollution four major pollute pollutants including the suspended particular matter is PM 10 are considered for reporting AQI PM 10 is a particular matter of 10 micron of size 10 micron or less there are PM 2.5 also, but we are considering a PM 10. That means, not more than that right. So, we are considering the PM 10 particular matter of size 10 micron.

(Refer Slide Time: 42:57)



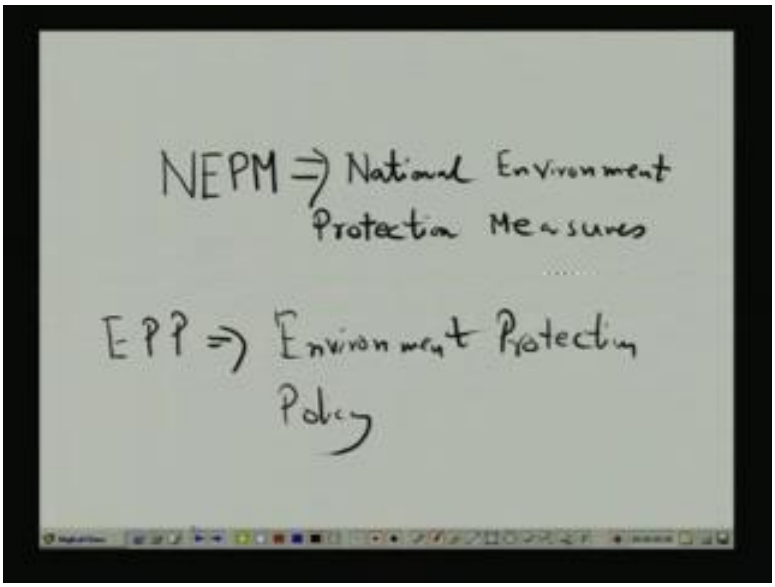
Measurement and calculations the concentration of the pollutant is measured by air quality monitoring equipment at a monitoring station. This pollutant concentration is converted to an index value using the following equations index value, pollutant concentration, pollutant goal concentration into 100. What is our goal? What is actually desired value of the concentration and what is the actual concentration now? So, that will give you the index value multiplied by 100? That is we will some quantitative measure for the quality of air people are breathing.

(Refer Slide Time: 43:37)



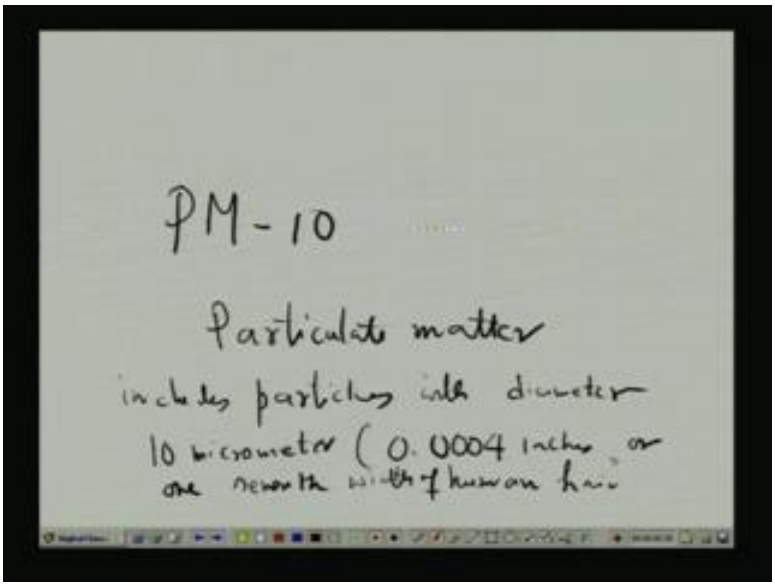
The pollutant goal concentration is used to calculate the index value is either the air NEPM standard for that standard for that particular pollutants or the EPP goal in the case of visibility. Let us look at, what is NEPM and EPP?

(Refer Slide Time: 44:01)



NEPM is the NEPM is an national environment I should take a different colour. I think this are not very good colors NEPM is a national environment protection measures every country has this thing. So, this is the national protection environment protection measures is a basically are broad framework setting statuary instrument. We find in the national environment protection council and the outline. And agreed national objectives for protecting or managing particular aspects of the environment this is basically NEPM. And also we have EPP you see there that EPP is basically is environmental protection policy environmental protection policy. So, this also we will look at all these things now. So, these are the I mean now see this PM 10; that is also we are talking about the PM 10.

(Refer Slide Time: 46:14)

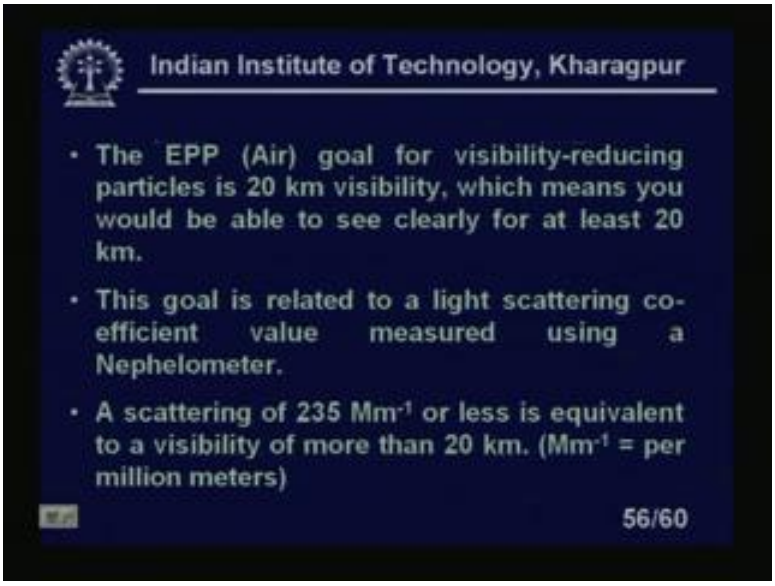


Let us take a new page. PM 10 is the particulate matter particulate matter of includes particles with a diameter includes particles with diameter 10 micron 10 micrometer which is coming as 0.0004 inches or I should say or 1 seventh width of human hair right. We have then PM 2 point five that is we are not discussing previously it has a tsp monitors that is also we are not discussing here. The pollutant goal concentration used to calculate the index value is either the air NEPM standard for that particular pollutant or the EPP air goal in the case of visibility. Visibility is most important, because you see that if the air I mean if there is a if there is a suspended particles or the if there is the PM 10 is there. So; obviously, it will reduce the visibility of a person. So, what is the goal? What should be the visibility whether it is a 10 kilometers or 20 kilometers? That we must know. So, this also we will give you some standard for particular country. So, let us look at that the air NEPM standards and EPP air goal used to in calculating the index value are presented in table one.

(Refer Slide Time: 48:56)

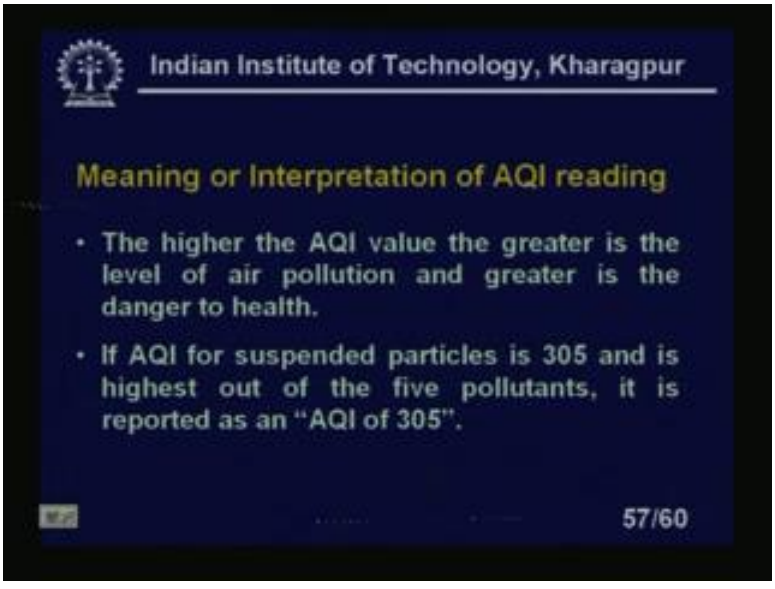
You see here that is an air NEPM standard that ozone it is 0.10 parts per million. So, we have taken the average time of 1 hour nitrogen dioxide 0.12 parts per million that is 1 hour sulphur dioxide 0.20 parts per million for 1 hour carbon monoxide. We have taken for 8 hours and the PM 10 we have taken it is 50 microgram per meter cube for 24 hour. This is the standard an NEPM standards and pollutants and the visibility is 20 kilometers. So, EPP is that air that is our goal is 20 kilometer right for 1 hours the average in time.

(Refer Slide Time: 49:45)



The EPP air goal for visibility reduction particles is 20 kilometer visibility which means you would be able to see the clearly for at least 20 kilometers. Obviously, these the sort of pollution, because some pollution we should why we have taken the PM 10 you see the this 2 are should be different because some gases are this carbon monoxide. These are not visibile ozone is not visibile that will pollute the air the 2 types we are considering one is the visibility concentration another is the health hazard just health hazard. Because visibility is also making the it is not hazardous to the I mean people or the persons or the public. But it makes the our other things difficult; that means, the landing of the aircraft or taking off or moving of the train or moving of the cars everything become difficult. That is also measurement of the pollution that is the reason we have PM 10 we have introduced this goal is related to the light scattering coefficient value measured using a nephelometer. A scattering of 235 or less is equivalent where Mm minus 1 is the per million meters is equivalent. So, a scattering of 235 millions per millions meters or less is equivalent to visibility of more than 20 kilometers. So, this is also will give you that what is the visibility? Usually in many countries nowadays they straight away will give you the visibility. So, that from that measurement they can see the visibility.

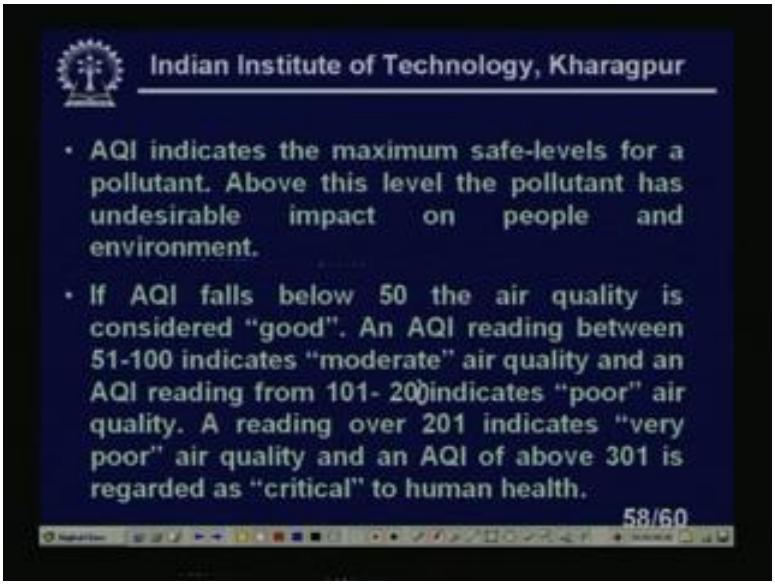
(Refer Slide Time: 51:15)



Meaning or interpretation of AQI reading the higher the AQI value the greater is the level of air pollution and greater is the danger to health not PM PM 10 is also, but that is

also considers with the visibility. AQI for suspended particles is 305 and is highest out of the 5 pollutants and it is reported as an AQI of 305 right air quality index of 305.

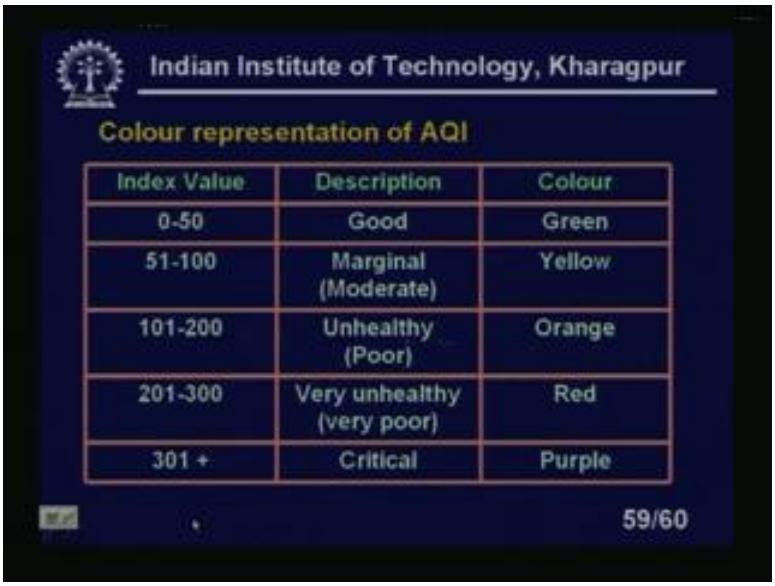
(Refer Slide Time: 51:40)



AQI indicates the maximum safe levels for a pollutant and above this level the pollutant has undesirable impact on the people and the environment. So, this will give you some indicates the maximum safe levels for the pollutants how much pollution it can cost. So, it goes above that level. So, it is not good for the health or the persons or the any animal being. If AQI falls below 50 or the air quality is considered extremely good if it is falls.

Obviously, as I told you if the AQI is higher pollution is more an AQI reading between 51 to 100 indicates that the moderate air quality and AQI reading from 101 to I think this should be 2 200 I am sorry this will be it should 200 . So, if AQI falls below 50 and the air quality is considered good an AQI reading between from 51 to 100 indicates moderate air quality. And AQI reading from 100 very poor air quality and an AQI of above 301 is regarded as a critical to human health. This is some category it depends it varies from country to country, but this is the; obviously, always we will desire that the it is desirable that the AQI should be below 50, right.

(Refer Slide Time: 53:20)



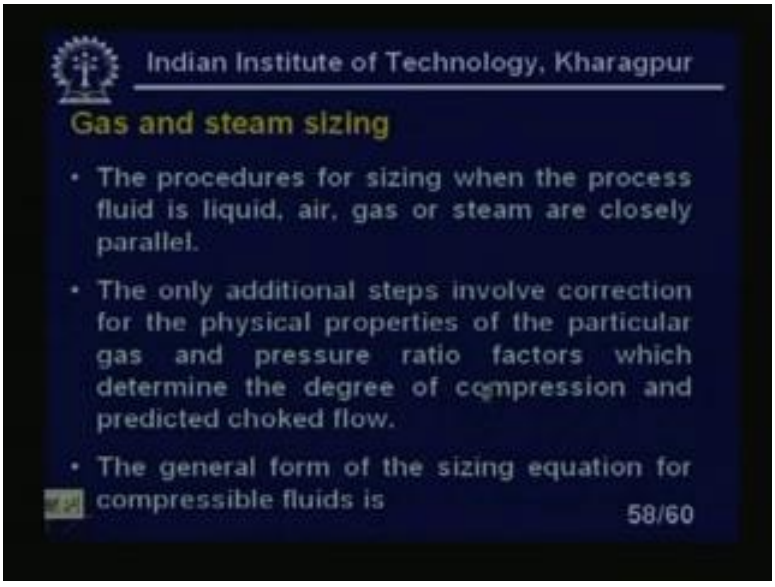
Now, you see we have then now this is a colour code of representations of AQI we have given the colour code representations that is anybody can understand. That means, green means always friendly as you know that the environment green environments we are talking about always is a good environment. So, we have given a colour of green. So, 0 to 5 I mean AQI value. So, it is green colour is good, 51 to 100 marginal moderate yellow. Well, I cannot justified why it is yellow? It is some standard is to be follow; obviously, the green means that our environment is always is green always is better for us. Then we have 101 to 200 unhealthy poor I mean orange then we have a 201 to 300 AQI value very unhealthy very poor which is once a red alert. Red means always alert and 301 plus is a critical. I mean it is a no more for consumptions of the, I mean for that air is consumption for the human being or any living animals. So, these are the things which we have considered in this, what we mean to be AQI. So, because if you give the colour, because it is very difficult to remember all this numbers.

So, instead of giving the numbers we will measure this one, but once we define to the public. So, will give you this some colors so that green is better yellow is fine orange is not that good red is quite bad and if the purple it is extremely bad right. So, with this AQI colour coating we can explain to the general public. So, that what the colour they should have in that particular area residence or a particular area, where they are working? So, with this I come to the end to the lesson 37 of industrial instrumentation. Welcome to the lesson 38 of industrial instrumentation. In this lesson, we will cover the control valve.

In fact, this lesson 38 39 both will be dedicated to the I mean control valve 1 and control valve 2. Control valve as you know it is a final control element in a process and it is most important part of any industrial instrumentation. Now, so far we have studied as you know the many sensors which actually measure the possible variable flow temperature pressure and viscosity pH of so on and so forth.

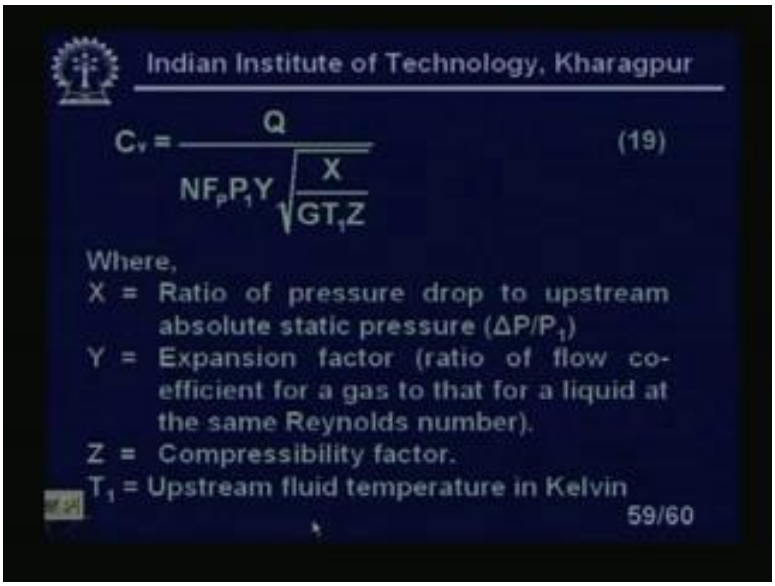
Now, all this actual measurement is basically to control some that particular process suppose in the case of temperatures or in the case of flow we have to control the temperature we have a set point. So, our goal is to I mean to make that whatever the set point I mean determine or fixed by the linears. So, our system should attained that particular value right. So, some or the other we need control valve now control valve is basically is a is a device which we which will resist the flow of the fluid either liquid or gases through a pipe right. This is the basic purpose and directly it is controlling the flow indirectly it is controlling the temperature and any other process parameters right. Suppose I have a indirect heating of any of a boilers. So, we are heating it by a super heated steam in that case by controlling the amount of steam. Also we can raise the temperature of the boiler and directly in the case of flow measurement. There is no problem I mean these are the only factors which is to be included which I have to think of otherwise not.

(Refer Slide Time: 57:07)



The general form of the sizing equations or the compulsively fluid is…

(Refer Slide Time: 57:13)



You see Cv equal to Q upon NFpP 1 Y to the power X upon G T 1 into Z equation number 19 where the legends are X is a ratio of the pressure drop to upstream absolute static pressure. Ratio of the pressure drop to upstream absolute static pressure that is the reason we are interested in P 1 the previous equation number 18. Also we have seen that the P 1 is important not the P 2. Y is the expansion factor ration of the flow coefficient for a gas to that for a liquid at the same Reynold number. Z is the compressibility factor and T 1 is the upstream fluid temperature in Kelvin. So, all these I mean I think all the legends are defined now every time you see that Cv is the most important thing in the bulk parameter. There is no other, because if you define Cv or if you find Cv all other parameters will be automatically picked there are some parameters like small d capital D.

So, first in the while you are choosing the valve first I have to calculate the, what are the desired Cv you want for a particular applications once you find Cv. So, from the selected list of the valve, so you try to choose Cv which will match very close you may not get the exact match. You may get 7 to 90 percent of the value of the Cv which we have seen that will be the desired range of the control valve. So, that particular control valve is to be chosen and is to be installed in the process. Now, with this I we will cover this in industry I mean this control valve we will continue this control valve in the lesson number 39. Also we will go further details and we will solve some problems in the lesson 39. So, at that with this I come to the end of the lesson 38 of industrial instrumentation