Atomic and Molecular Absorption Spectrometry for Pollution Monitoring

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Lecture – 01
Course Introduction

Greetings to all of you. I welcome you to this course on Atomic and Molecular Absorption Spectrometry for Pollution Monitoring. This is a very important course, we would be dealing with one of the most important aspects of spectroscopy and the manage with pollution monitoring. Basically, these two are entirely different subjects, but over the years the use of spectroscopy in pollution monitoring has been on the increased because of the importance and use of operation.

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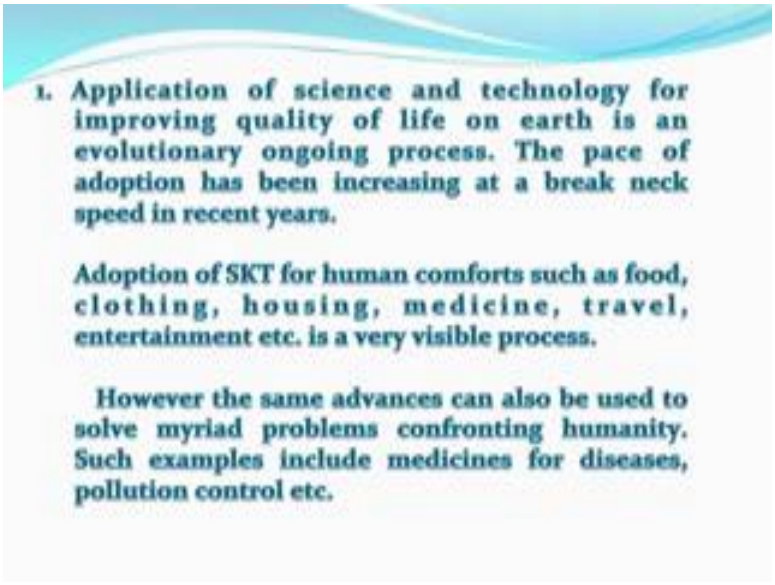

Now, what I would like to say in this regard is that the application of science and technology for improving quality of life on earth is an revolutionary ongoing process. The pace of adoption of the science and technology has been increasing at a break neck speed in recent years. Adoption of science and technology for human comforts such as food, clothing, housing, medicine, travel, entertainment etcetera is a very visible process, which is known to all of us. However the same advances in science and technology can also be used to solve myriad problems confronting humanity such as humanity. Such

examples include medicines for diseases, pollution control, and then poverty elevation and all such related activities with respect to pollution control.

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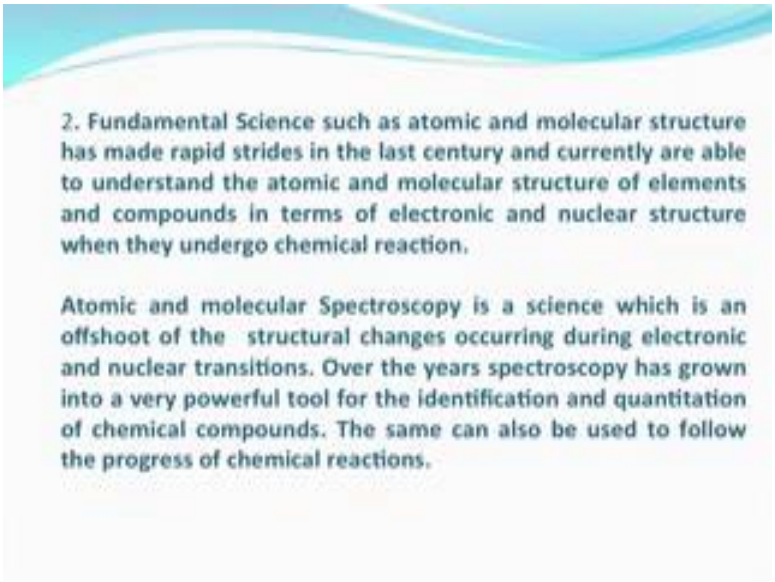

And number 2, what I would like to say regarding this course is a fundamental sciences such as atomic and molecular structure has made rapids strides in the last century and currently we are able to understand the atomic and molecular structure of elements and compounds in terms of nuclear and electronic structure when they undergo a chemical reaction. Basically atomic and molecular spectroscopy itself is a science which is an offshoot of the structural changes occurring during electronic and nuclear transitions. Over the years the spectroscopy has grown into a very, very powerful tool for the identification and also quantitation of chemical compounds. The same can also be used to follow the progress of chemical reactions this is not something new.

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But what is new is environmental pollution how we are going to interact with the two disciplines, first thing is we have to understand what is environmental pollution. Basically, environmental pollution is defined as a temporary or permanent changes occurring in our surroundings such as air water land which affect the quantity of human life quality of human life temporarily or permanently. Since last sixty years environmental pollution has been posing major threat to the survival of humanity and other plant and animal life of our plant, this is well known to most of us.

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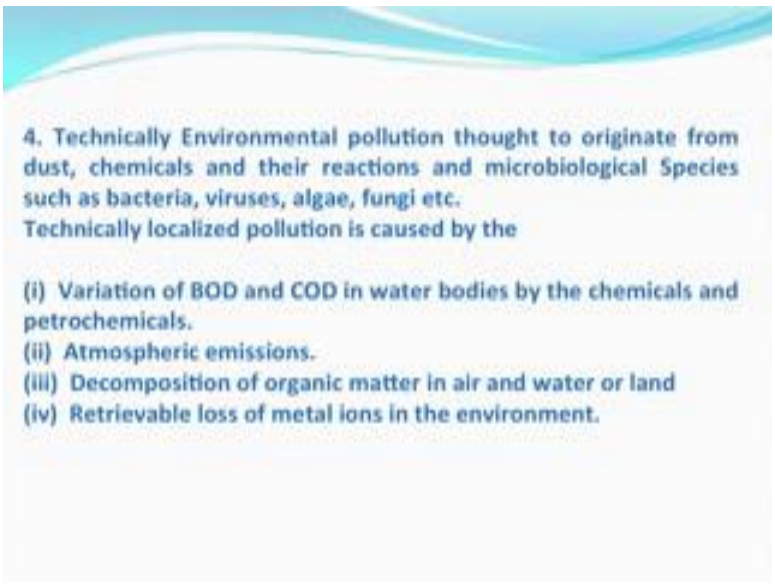

Technically environmental pollution is thought to originate from dust, chemicals and their interactions with microbiological species such as bacteria, viruses, algae, fungi and several other plant and animal species. And technically a localized pollution is also caused by the variation of biological oxygen demand and chemical oxygen demand in water bodies by chemicals and petrochemicals. This require changes the equation of the water quality in and around us.

Number 2 is atmospheric emissions. Now, atmospheric emissions can happen from several sources; one is suppose there are natural sources like volcanoes, and then those things volcanoes generally in throughout lot of chemicals in the environment including dust that is silicon, silicate particles and aluminum, iron and several other pollutants in the environment. These are all natural disaster. Suppose there metriod comes and falls somewhere, lot of dust will be generated automatically. And all these things will keep on generating the pollution with respect to natural disasters.

Then the atmospheric emissions also come from vehicles, the scooter you drive, or the car you drive, or the emissions from aircraft, ships and several other vehicles that we use in our day-to-day life, so that is another type of emission. Now, third type of emission what I look for is from industries. Suppose, you have a coal power plant thermal power plant. Now, the thermal power plant as you all know, it uses coal. This coal has to be burnt to generate heat the heat will be used to convert the water into stream and which will again intern rotate turbine, generate electricity and all this process is known. But what we lose sight is first time foremost we are burning the coal, coal is a fossil fuel which is underground, we are bringing it out. And part of it is a available part of the chemical structure is available as heat that is carbon, and then remaining is inorganic material, which may or may not converted to convert into a heat process. So, what remains is a dust particle which is known as fly ash, and they will also be emissions of carbon monoxide, sulphur dioxide, nitrogen oxides, organic compounds and several other organometallic compounds like that coming from atmospheric emissions. So, the localized pollution is also caused by atmospheric emissions.

Now, the third point I want to go back to the slide for you to see is decomposition of organic matter in air and water or land. Now, this is a very important thing because whenever we used any food or something like that for our day-to-day life, part of it gets wasted, and then part of it gets excreted, and then all the excreted material etcetera, they

decompose causing emissions of organic and inorganic substances which may or may not end up in air water or land in one of these three it may end up.

Now, the another type of pollution that is very common is irretrievable loss of metal ions in the environment. Now, this is also a very serious type of environmental pollution that is happening in our midst, basically it is the conversion of the metals corroded in the corroded forms and in the environment these corroded metals pose a threat to the environment. Because as a human being we are all supposed to be born from zero metal ion interaction in the nature; initially whenever life involved on the plant basically it was in a sea environment and which was having very low concentration of all elements except water except hydrogen and oxygen etcetera. So, nowadays we are all evolutionary products from that basic evolution process of from seawater, subsequently amphibians, (Refer Time: 09:43), and the mammals, and all these animal have come. So, from these point of view, we are concerned as scientist about the pollution aspects from these four basic variations.

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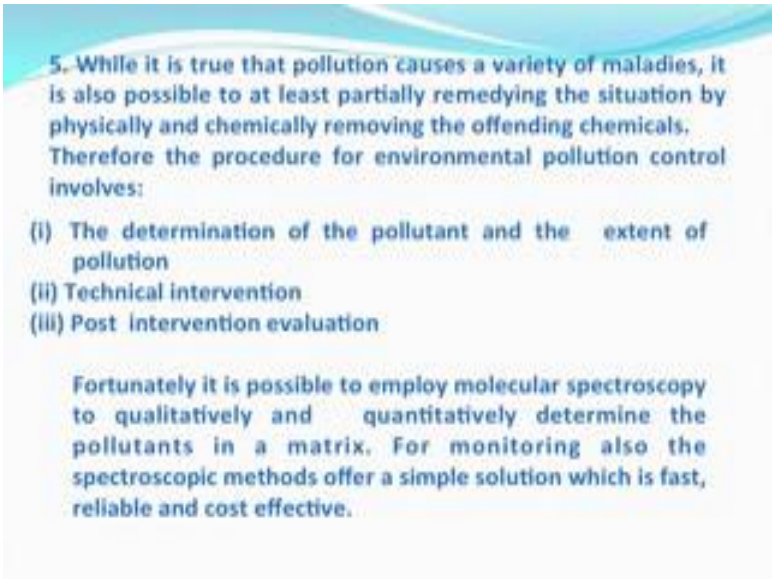

Now, while it is true that pollution causes a variety of maladies, it is also possible for us to at least partially remedying the situation by physically and chemically removing the offending chemicals. Therefore, the procedure for environmental pollution control usually involves determination of the pollutant, how much of the pollutant is there in the environment. So, we have to quantify the amount how much of it is there, and then to

what extent the pollutant is there in the environment, how long it will stay, what are the consequences of these pollutants in the air, land, water etcetera, etcetera.

And then once I know the quantity of the pollutant I need information, how I can take care of the pollutant chemical, polluting chemical. So, the I need a technical intervention to deal with the quality of the pollutant, some pollutants may just react with water over a period of air etcetera, and then they may decompose, some of them may not decompose as I have already explained to you that they may increase, they may increase the BOD and COD. Some of them they may not be amenable for chemical reactions. So, this technical intervention is a very important aspect of pollution prevention.

And number third is post intervention evaluation. Suppose, I deal with a pollutant by a chemical reaction or something like that and then that the pollutant is removed. I want to know how much of the pollutant has been removed, and how much of the pollutant may come back again, part of it may be in equilibrium with the other environmental processes and all these things will have to really worry about when we are dealing with the pollution by aspects. So, the marriage between the pollution and the technology is totally sort of you know intertwined, it cannot be changed just like a day the flick of hand or something like that.

Fortunately, we are in a position to employee molecular spectroscopy to qualitatively and quantitatively determine the pollutants in a given matrix. Now, you may ask me what is a matrix, a matrix is a physical description of a system in which a pollutant is there along with other common commitment substance that is we call it as matrix. Suppose, you want to determine sulphur dioxide in air. So, air is a matrix. Now, that air may contain nitrogen, oxygen, sulphur dioxide, nitrogen oxide, sulphur compounds, organic compounds, inorganic compounds and all those paraphernalia. Suppose, it is water, water may contain apart from your pollutant, it will have the dissolved salt, sodium, potassium, chloride etcetera, it will have hardness, it will have many other chemicals oil, grease, soaps and detergents and several other chemicals such a system which contains the pollutant is known as the matrix. Now, for monitoring also the spectroscopic methods of are a simple solution which is fast reliable and cost effective. So, you may ask why spectrophotometry for the determination, why not some other technique.

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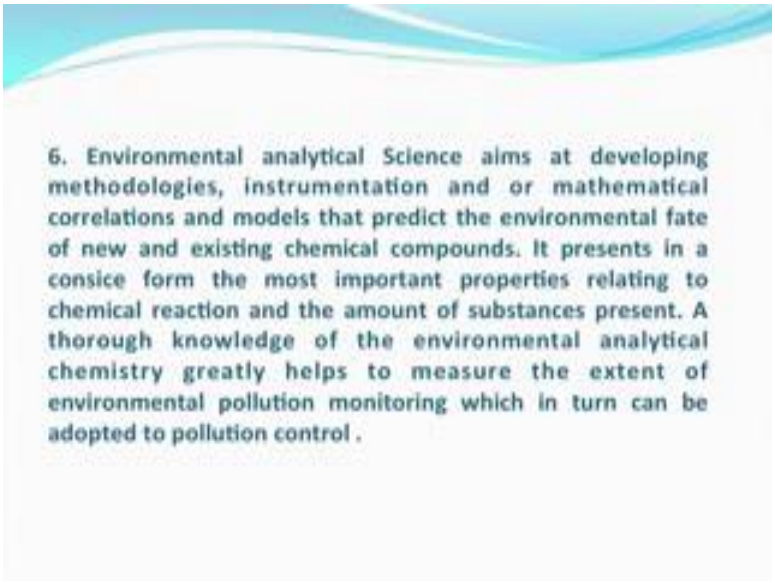

The basic reason is the substances undergo chemical reactions, which can be monitor, and through spectroscopy, it is very simple. Look at the slide if a you are facing now what I have written here is environmental analytical science aims at developing methodologies, instrumentation and or mathematical correlations and models that predict the environmental fate of new and existing chemical compounds. Read instead of chemical compounds you may be it as pollutant, it presents in a concise form the most important properties relating to the chemical reaction and the amount of substances present. Say thorough knowledge of the environmental analytical chemistry greatly helps us to measure the extent of environmental pollution monitoring which in turn can be adopted for pollution control. So, this is what I wanted to explain to you.

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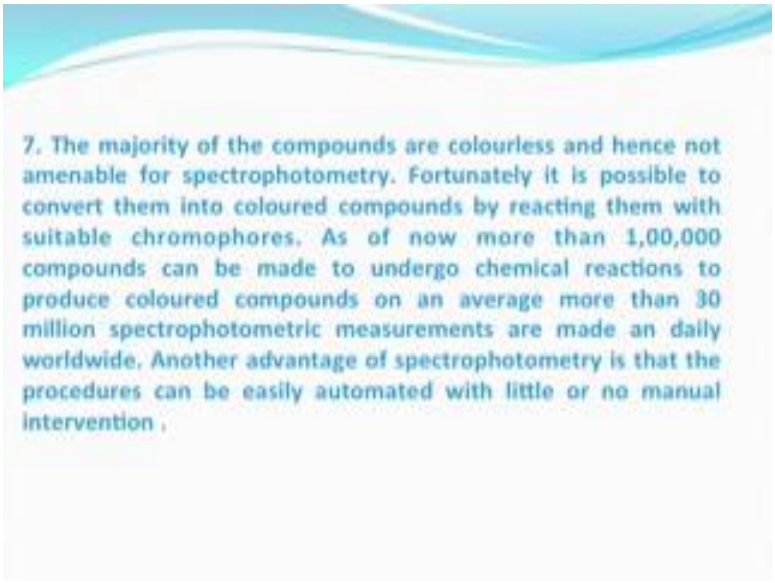

So, a majority for example, the slide you're reading right now, it says a majority of the pollutants are colourless and hence not amenable for molecular spectrophotometry. Fortunately, it is it is possible for us to convert them into coloured compounds. As of now more than 1,00,000 compounds can be converted to undergo can we make to undergo chemical reactions to produce either a coloured substance or remove a colour from an existing substance like that which make them amenable for spectrophotometer. And believe me this is a very, very large number. So, I may even try to shock you in believing if I tell you that more than 30 million spectrophotometric measurements are made every day worldwide. Why so many, because the advantage of spectrophotometry is that the procedure can be easily automated with little or no manual intervention, this is very important because the spectroscopy gives you a chance to automate the whole environmental monitoring process which is very, very essential for their for our day-to-day survival.

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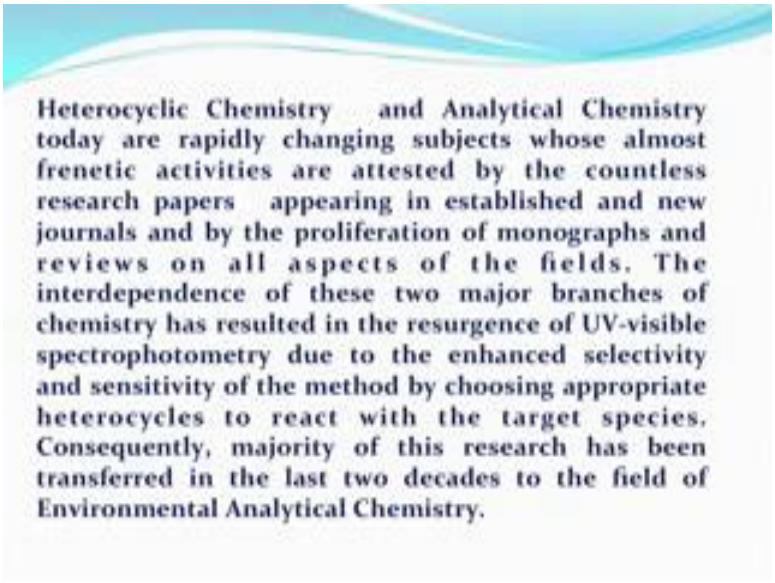

Now, there is also another aspect to pollutants that is I said that they can be made to undergo several chemical reactions with to produce coloured compounds. Here on the slide facing you are really you should be able to read that heterocyclic chemistry and analytical chemistry today are rapidly changing subjects whose almost frenetic activities are attested by the countless research papers appearing in established new journals. And also by the proliferation of monograph, reviews, and several other on several aspects other aspects of the analytical fields the interdependence of these two major bunches of chemistry has resulted in the resurgence of UV-visible spectrophotometry which we are going to study now in detail to in this program. And this is because due to the enhanced selectivity and sensitivity of the method by choosing appropriate heterocyclic chemical known as a reagent, spectrophotometric reagent it is also known as a chromophoric reagent and all these things react with the target species. Consequently, the majority of this research has been transferred in the last two decades to the field of environmental analytical chemistry including automation, so that is very important for us.

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Therefore, now what this course actually means to you, what you will achieve. The idea is this course as therefore, being designed to give you an insight into this aspect of pollution control by incorporating several scientific disciplines, you should not forget. Spectroscopy alone is not that discipline I am going to teach you here or it is not that just pollution control field that I am not going to teach you only pollution control. It is the marriage between these two, but it also involves several other aspects of pollution control or several other disciplines, which you will be learning.

For example, number two - second point on the slide facing you there is molecular spectroscopy. I am going to teach you basics of molecular spectroscopy. So, actually for those who are familiar with spectroscopy, it may not be of much the learning process, but for those who do not know, it forms the fundamental understanding of the spectroscopy which will also help you to learn more about molecular spectroscopy, atomic spectroscopy, fluorescence spectroscopy and several other spectroscopy techniques that are there for day-to-day monitoring of the pollutants. So, you are going to learn something about molecular spectroscopy.

First you are going to learn a little bit about atomic and molecular structure. Secondly, you are going to learn something about molecular spectroscopy basics. And third is how spectroscopic instrumentation, what are the components of a spectrophotometer, how do I apply the molecular spectroscopy to a process in which I am understand I make a

substance undergoes spectroscopic changes and the instrumentation required for that purpose. So, for spectroscopy which instrument I used for optimum results. Then there is also another aspect this is more related to analytical science that is practice of spectrophotometry. And then how do I actually go about determining the pollutant in a given matrix. And once I determine how much of it is there I have to know how reliable is my method of analysis correct. Therefore, I also need to know how much faith I can have in my measurements given the various circumstances in which in determinants, the uncertainty occurs.

So, practice of spectrophotometry in general refers to the understanding of the uncertainty of the measurements or understanding the reliability of the measurements and then which includes statistics and then confidence levels, frequency distribution, and all those things. And all these things are applicable to spectroscopic techniques then there are other related molecular spectroscopy techniques which I am going to teach a little bit that includes fluorescence, phosphorescence, turbidimetry and nephelometry. So, I am also going to teach you something about molecular spectroscopy for pollution monitoring this aspect molic last one molecular spectroscopy for pollution monitoring is a little bit involved because it is for online and continuous monitoring of the pollutants in a given environment or in a given matrix.

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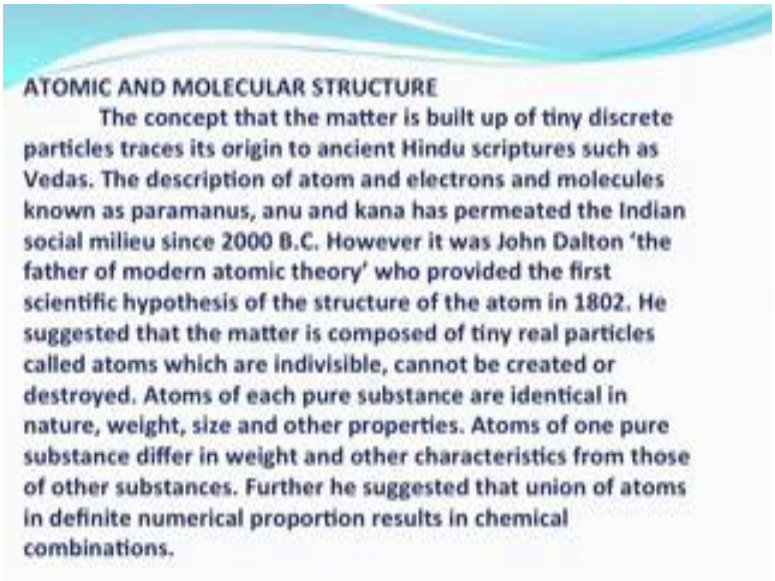

So, this is what we are going to learn in the in our program. In the next session, I will teach you fundamentals about the atomic and molecular structure. So, thank you very much. So, I hope you have been able to courier light pollution aspects and spectroscopy with respect to the practice of day-to-day monitoring and understanding, what are the basic things involved in understanding such a complex subject is what I expect you to know at the end of the course. In our next session, what will do is will study the fundamentals of atomic and molecular structure.

Thank you very much.