Course on Analytical Chemistry
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Module No 01
Lecture 01: Chemicals and Materials Analysis

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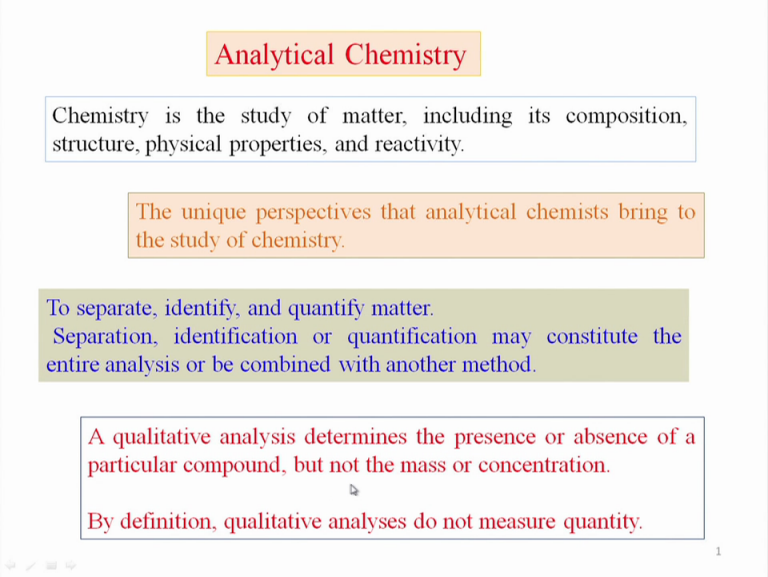

Hello and welcome to this class of an article chemistry where we basically want to see how analytical chemistry as a subject can be helpful to the entire community of people who are dealing with science basically, can help in understanding the utilisation of that particular subject. As we all know that when we talk about chemistry as we see from the very beginning of our life, schooldays that if we consider that what we know about the chemistry of water and the chemistry of our air, so basically we are talking about the composition of that water.

Forget about the other extraneous part present in this particular system. When we talk that chemistry of water is nothing but corresponding molecules which we consider as the H2O. So if we think that there is instead of that simple H2O molecule, if we have some kind of matter, so how analytical chemistry can be useful to apply the identification of that matter in which way it is the way where we can identify its composition.

That means, what are the elemental composition? If it is a compound, what is the composition of that particular compound? Or if it is a complex entity, what is that complex entity? Then, the

critical chemistry knowledge will help us to identifying the crisp morning structure also because they will be handling different states of these as the matter. The matter can be solid-state, the matter can be in the liquid state and the matter can also be in the cashier state.

So related to this particular structure, the physical properties are also very much important. And will also see during this particular course that how an article chemistry will be useful to understand the reactivity of any particular matter. So if we find that matter like water is there and some reactive species is present in the particular water, so how the reactive species can interact with some other species or reagents that we will also try to analyse with the help of this subject.

So how we consider that a person dealing with this particular sort of chemistry can be termed as a typical analytical chemist? As we all know that a person can be designated or termed as a chemist when he or she is dealing with chemistry, not the detail of all other chemistry we know from our schooldays. So basically when a analytical chemist is applying its chemical knowledge or chemical understanding to the unique perspective to study the chemistry of this matter, the chemistry of this material, chemistry of this particular solid product or chemistry of some reaction, we consider that the analytical chemistry will be very much helpful in understanding all these unique properties related to chemistry.

So when we find that a matter is present, so let us consider at the very beginning that the matter is our solid state matter and how we chemical understand this particular system in terms of its separation? Suppose the matter is not a pure compound or a pure material or a pure complex species, but it is a mixture. So we all know that the mixture can have several species. So those species we have to separate so that will also come under the purview of this particular subject.

And individually, whether we will be able to identify those particular components that will also tells us some important idea and once we identify a particular species such that what we all know that iron is present in our blood sample. So which is typically we are going faraway to a biochemical sample. And also, this particular iron is present in some amount of say your iron ore. So how we can understand or we can quantify or initially we can identify the iron present in iron ore sample or iron present in your blood sample.

So taking these samples and their initial identification is the 1st part of understanding the analytical chemistry. So initial thing is that your identification. So we qualitatively identify in a particular matter or in a particular solution or in a particular blood sample with your iron, the species what you are talking about, whether your iron is present in that particular species. So after the separation, what we do? We basically initially identify the species.

That means, we all know that the sample, whether it is a corresponding or sample or a corresponding compound of iron, we identify the presence of iron by qualitative tests. So, was schooldays, we all know that how we can identify iron in any unknown sample or sodium in any unknown sample because all we know that is a typical food material for us is your sodium chloride. So how to identify the presence of sodium as sodium +, sodium catan in our common table salt what we take every day or every time.

So identification of that particular sodium in sodium chloride sample will give us some idea, the methodology how will you identify. In our schooldays, we know that this can be identified by the simple simple test your flame test. So sodium can give rise to a good flame test. So any white powder sample which is your sodium chloride can be identified nicely for the presence of sodium as NA + in that particular sample.

So your sodium chloride can be your unknown sample but we can identify the presence of sodium over there and we can differentiate that particular sample from other white powder like samples like potassium chloride, calcium chloride et cetera. Now if we go for the amount of that particular species whether any unknown white powder we are handling, and in that unknown white powder, if we find that in unknown white powder, if we try to find out or figure out the amount of sodium chloride present in that unknown sample, what we have to do?

We have to do the corresponding quantification. That means, the amount of sodium chloride present in that particular sample. So the entire process of analysis, may constitute the typical analysis process and once this analytical process is there, we can do by our hand. We know that typical type method from our schooldays. We have learnt that qualitative analysis by identification and followed by the corresponding quantitative analysis which is the volumetric method we call, we call it (())(8:03) as a dietary metric method.

Or if we go beyond, why we should go beyond? That we will also consider slowly that why we require another method of analysis. So if that particular method what we are applying at present is not suitable enough due to the paucity of the amount of sample present, we should go for another technique or another method for that particular analysis. So in a particular process, a qualitative analysis determines the presence or absence of a particular component.

So it not only tells us the amount of iron present in any unknown sample, it also tells us that something is absent which is also very much important that whether a particular species which is toxic to us, that means when we drink a glass of water, whether the glass water contains something which is obnoxious, which is harmful to our body which is toxic to our body, is present or not. So not only the presence but also sometimes, this particular technique or this particular analysis, will also tell us whether this particular species is absent.

So a portable water what we drink for our daily needs, can have some ions like sodium ion, potassium ion, chloride ions, all these things but it should devoid of some other salts. So it should not contain some contaminated mercury, it should not contain high amount of iron. So this particular thing, that means the absence of that particular metal iron or a particular compound can also be useful to know if we go for understanding this particular chemistry.

So this particular way, the qualitative analysis is directly related to the identification and this identification is not related to the corresponding mass. That means the amount what is present in that particular sample and the corresponding concentration. So by definition, if we consider because we will come once again what is known as the corresponding qualitative analysis. We know from our schooldays which do not measure the quantity. It only identifies the unknown species which is present in that particular sample.

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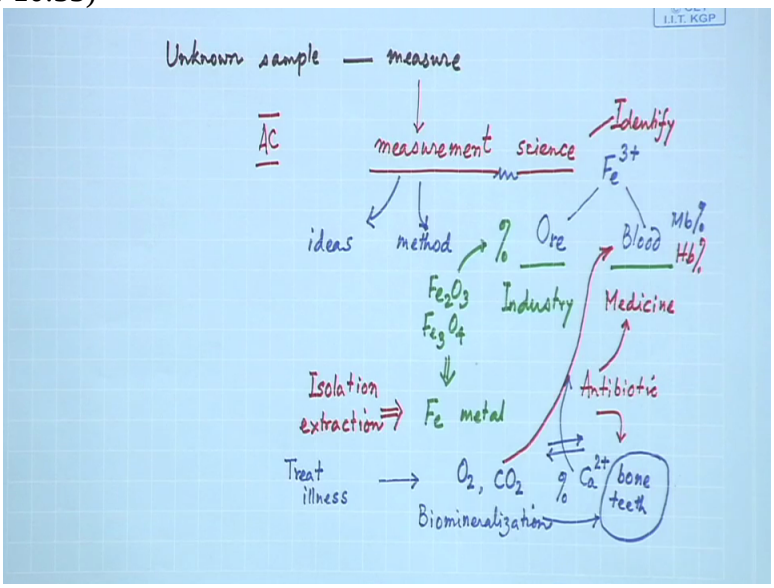

So if we consider that if we have certain amount of this particular unknown sample and this unknown sample we want to measure, so how we can measure that we also want to know. So this is basically therefore gives us some idea that analytical chemistry now onward I will abbreviate this as AC, so this is particularly known as a measurement science and which is very useful for all branch of science. So is the measurement science where we see that initially we can identify that your sample has this particular unknown species which is your say ferric iron.

We will be thinking for whether your ferric is present in that particular sample. It can be our iron ore sample or it can be our blood sample. So this particular thing, that means this measurement science which is there will involve several important ideas and some methods because we have to devise the corresponding methodology that how we utilise that particular methodology to get a corresponding understanding about these measurements.

So if ore is available for this analysis and if the blood is available, so it will be related to industry. So the industry people will also be very much interested to know about this subject whether we can analyse the percent composition of that iron ore which is our haematite or magnetite we all know, FE2O3 or FE3O4, how much? That means, what is the percentage of that active ingredients where we will be interested to know or identify or isolate iron as the corresponding metal because our ultimate goal is to find out our isolation process or the extraction process.

So isolation or extraction of iron from these over will tell us that how much it is important to the industry. Similarly when we talk about this blood, we talk about the subject which is medicinal chemistry or the clinical bar chemistry where we can talk about the corresponding understanding about the medicine related to the analysis of blood sample. That means, the percentage of haemoglobin.

So this particular technique is also useful to understand something for the active ingredient in terms of the corresponding pharmaceutical chemistry as well such that you have a medicine or a pharmaceutical species and we want to analyse these suppose we have some antibiotic and it has some active ingredient. How to analyse this particular active ingredient which is present in this particular antibiotic will also tell us that how we go for this measurement and this measurement science will also tell us whether this particular analysis will give us some idea about the blood sample.

Because if we consider that this blood sample is not a pure thing, that means it not has only that haemoglobin or sometimes we know that it has the corresponding myoglobin percentage and these 2 things are related for their oxygenation reaction, so the dissolved O2 and the dissolved CO2 we can find for this particular bell sample. So to treat some illness, so this will be related to the illness, so doctors will go for treating this illness.

So to treat this illness, we always should know what is the corresponding dissolved amount of O2 and CO2 in our blood sample. Similarly in terms of these metal ions because we are talking about these metal ions, because we know that a very active ingredient of all these samples in our bone and all, so in our bone samples, calcium 2 + is there but if you are asked to determine whether your blood sample has some sufficient amount of calcium, because the calcium will always be present in the blood, because there will be a reversible transfer of these ions because some amount of time will be deposited in our bone, in our 30s and son will be reaching out from the corresponding solid materials.

So these are all materials related to our this bone and teeth and this is directly related to something which is known as the corresponding mineralisation process. So biomineralisation will tell us how much calcium we can have in our bone and teeth and if we want to determine the percentage of calcium, which is less if it had a corresponding disease condition, then we should

take the help of this particular subject, that means the analytical chemistry will be helpful to us to find out these concentrations.

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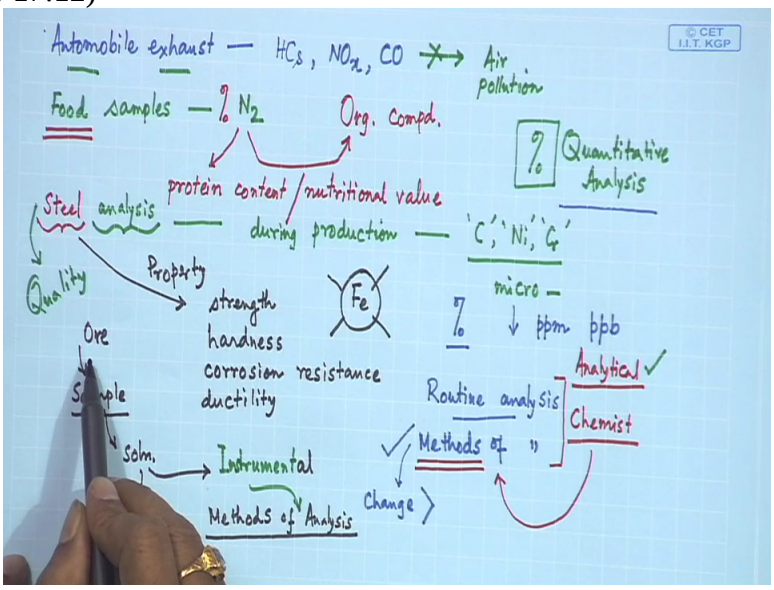

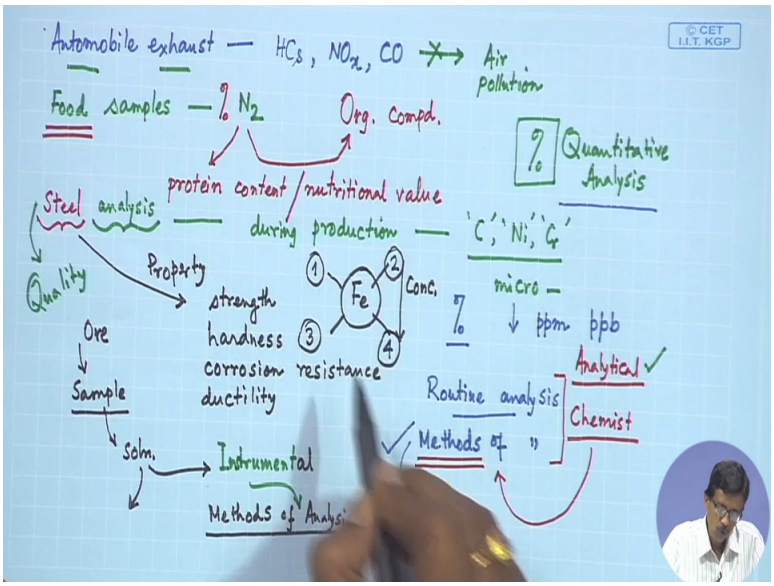

And moving from there, if we just go their application to some say automobile exhaust, so what are the species we can analyse in the automobile exhaust? So there, became analysed the typical hydrocarbons, the nitrogen oxides and carbon monoxide because all we know that these are basically harmful to our health, to the plants, to the other living organisms. So we should not have a very high concentration of these gases in air.

So we basically contribute to air pollution. So this particular chemistry or the chemical knowledge or the chemical understanding have the direct relevance to understand the corresponding pollution of the error. So the air quality can be monitored if we are able to monitor air sample from this particular city to some other city where large amount of automobiles are being used and the exhaust amount of these gases is also very high and is basically polluting the corresponding air.

Then we can go for the typical application for the food samples. So we can analyse the different food samples in terms of their nitrogen content. So this is a very important analysis what we can understand in terms of the percentage of nitrogen. As the particular course progresses, we will find out that this is a very active ingredient where we can find out some other compounds also. Suppose we are handling some organic compound, whether it is a solid or a liquid or say some gaseous compound and all we know that the organic compound can have nitrogen also.

So basically these food samples which are also organic in nature, most of these gases, so we can identify or we can analyse or we can estimate the nitrogen content of these particular samples and once we find out this nitrogen content, why we are so interested to know this nitrogen content? Because this nitrogen content of these food samples will be directly related to the corresponding protein content. So this protein content of the food material because always we should know that there is a typical balance, we should maintain that particular balance.

For our food material, we should have the right amount of carbohydrate, we should have the right amount of protein and also the fat content. So if we are basically interested to know about the corresponding protein content of the food samples, we definitely go for the nitrogen analysis and once we determine this protein content, it will tell us about the corresponding food material, how good it is for its nutritional value.

So what we can do, we can find out the corresponding nutritional value by using this analytical chemistry of the different food samples. So which is a very important area of understanding and also we can have some say the way we are talking about the iron ore, if we go further, so industry people are also related to know the quality of the steel. They are producing or the quality of steel somebody is buying from some industry, so they try to know, I to go for a typical analysis.

So what we see that this is basically a subject where we can go from analysis of the blood sample to the steel sample. So this particular analysis selected we get some data related to that particular analysis and data will be helpful to understand the quality of the steel. So we can analyse the quality. So quality of the steel can be analysed while we produce this thing. So during production also, so during production in industry, a huge iron industry, so different iron industries we know, they are producing.

And when they are producing this steel sample, they always try to monitor the quality of this particular steel by knowing some ingredients. So during the production, what they can monitor? We know that in steel, certain amount of carbon is present and if we monitor the percentage of carbon, so always we should know that the percentage of some amount of species which directly tells us some analysis, which we term as quantitative analysis under analytical chemistry.

So quantitative analysis of carbon because this amount is very less sometimes. Then we can find out the corresponding nickel. We all know the nickel is present for steel preparation and chromium is there. So any high end material or any high end metal sample if we want to make and these are present in a very small level.

So if they are present in microgram level, so the micro constituents, so the micro constituents we can analyse such that we can balance the amount of carbon present in that particular steel, the amount of nickel present in that particular steel and the amount of chromium present in that particular steel because they basically contribute the corresponding hardness of the steel because the steel property, the property of this particular steel or the stainless steel which cannot have rust so easily.

So this particular property of the steel is directly related to some balance amount of the carbon present in it, the balanced amount of nickel present in it, and the chromium. Because these micro elements present in the steel can contribute to the desired strength. So we can think about the strength of the steel. Then we can think of its hardness because some of these species are there present as their hardness.

Whether these species are corrosion resistant, so the corrosion resistance we can also monitor and also the ductility. So you see that a typical analytical data which otherwise is not so useful to

us, so what we uhh do is that a particular analytical chemists can do is that she simply report after analysis that percentage of carbon in that particular steel, percentage of nickel present in that particular steel and percentage of chromium present in that particular steel.

So quantitative analysis and daily analysis what we do, that means the routine analysis which is also an important guideline for understanding that how we produce this particular steel and what is the type of this particular steel and the nature of he steel and characterisation of that particular steel is also very important. So when we go for a routine analysis where the methodology is very much known or established, so we have the methods of this particular analysis.

So, methods of this particular analysis if it is known to us and we find that for a routine analysis because they today, we are doing this. Every day, we are producing steel in the industry and some chemist will be available over there. The corresponding identification or the amount of this particular micro nutrients, so we go for a corresponding chemical analysis but the person who is doing this particular thing is a typical or a routine chemist.

So he cannot be termed as an analytical chemist. So an analytical chemist to be an analytical chemist, you must have some different duty. So who will be the typical analytical chemist? Because this analytical chemists can have some other duty. Because once the analytical process, that means the routine analysis is established, every day the chemist, the corresponding chemical analyst, the chemical analyst can do or analyse these particular steel samples everyday for its percentage of the different micronutrients, even sometimes the percentage of iron which is present in the steel because we are getting from the ore sample of this iron for making this particular steel.

But these particular methods which is very important, if we consider that we can change this method, suppose your percentage of this nickel or chromium present in this particular is very less, so we are going down from this microlevel, so we know that two terminology we sometimes used that the parts per million or parts per billion percentage, so if we go down, that means the concentration of this species is very less.

So whatever methodology this person, this chemist was utilising is no longer useful to identify the amount of these species with certainty. So you have to change the corresponding method. So

if we change the method, you have to introduce a new methodology, you have to introduce a new process of this analysis. So how to go for this particular methodology? So there comes into the picture, the analytical chemistry.

He or she is the analytical chemist who can introduce a new methodology. Suppose we are doing a simple dietary metric method or the gyro metric method of analysis but if this person can introduce something with the help of some instrument which give rise to some instrumental methods of analysis, so that instrumental methods of analysis can have something or some steps and those steps we get from the sample.

The raw sample what we can have suppose is a ore sample. So ore we take, so sample is there and suppose if we want to analyse that in solution, so we can have this solution and if we want to determine a very low concentration, very small concentration without going for some analysis like we all know from our school is that gyro metric analysis or the volumetric analysis we can directly go for analysing this in a particular technique which is the instrument technique.

So this method of analysis will also give rise an analysis, this is a quantitative analysis but this is instrumental methods what we are utilising. So instrumental will be utilising instrument. So instrumental methods of analysis. So this analytical chemistry can have some good role to play to introduce a new method of analysis.

Once we know the constituent like that of our iron what we are talking from the very beginning of this particular class, that how iron can be determined this iron depending on its source, whether your iron is coming from your ore sample or a steel sample or a blood sample, we have to devise a particular methodology for this particular analysis. We can do buy routine titration, by bullet pipette titration or we can use some instrument to handle this amount of iron present in it.

But as it goes down, that means the concentration, so as concentration goes down, and it would be very difficult, as we go down from this concentration, it is very difficult to handle one particular analysis, so we have to change for method 1 to go to method 2 to method 3 or sometimes to method 4. So all these methods, the introduction of these methods are very useful and interesting to understand or utilisation of this analytical chemistry for over day-to-day use.

So it has a huge application, so you in our next class we will be seeing what are the different areas, what we can apply this particular subject to understand all the other areas by knowing this full knowledge of chemistry and our very simple knowledge of our analytical techniques. Thank you very much.