Trace and ultra trace analysis of metals Using atomic absorption spectrometry

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Lecture - 38
Conclusions

Dear participants, it has been my pleasure to discuss with you about the atomic absorption spectrometry and it is a beautiful technique for one to determine elements in parts per million and parts per billion levels.

And we do not know as of now any other technique which can determine almost all the elements of the periodic table except halogens and noble gases directly or indirectly, and atomic absorption is the best technique. And, all normally there are number of instruments available in the market, very easy to operate and it is an element specific technique. So, if you have the element in the sample you will get the signal, if it is not there you will not get the signal.

So, in this course what I have tried to teach you is I am assuming that you are all students and also you could be professionals also working in central government, state government, private organizations, industries, etcetera; I have tried to give you a theoretical background of atomic absorption and instrumentation and applications interferences and the nomenclature followed by specific areas where the atomic absorption is useful.

Now in the first section I have tried to introduce you to the subject of pollution and the atomic absorption. That is the introduction part. So, what is pollution, how it generates, what are the different aspects of pollution, etcetera we have discussed. And then we have discussed the application of spectroscopy to pollution monitoring- environmental pollution monitoring. And then I have also brought about the significance of trace elements and ultra trace elements determination in the analysis of day to day significance.

So, that was the introduction part. And in the second part again it has nothing to do with atomic absorption. So, you may see that is the actual introduction part with respect to atomic structure. So, if we want to use spectroscopy we have to know about the atomic

structure, because it is the science of excitation of the electrons and protons and other things in the spectroscopic regime. So, we have to know about the atomic structure. What I what is an atom, what are the components of an atom, what is the nucleus, what are the electrons, what are the neutrons, and how they are organized. All of these, you would have studied in your basic school schooling as well as in your college levels, but just to refresh your memory I have gone through the whole set of atomic structure try to bring you up to date almost at the BSC level- graduate level and to try to understand the atomic structure.

We have also discussed about the electrons, protons, neutrons and then nuclear structure. And what is the origin of the element formation, how the electrons are filled in a given element, how the periodic table is formed by adding one electron one neutron etcetera. And then we have discussed how the electrons occupy different energy levels of the atomic structure. And the final thing is how the whole periodic table is organized; that also we have discussed.

In the next part what we have discussed is the nature of electromagnetic radiation, because in spectroscopy we are dealing with two types of matter: one is the elements atomic structure another is radiation. So above, we want to know all about the electromagnetic radiation and how it interacts with the matter, because the spectroscopic science is the culmination of the interaction of atomic matter- electromagnetic radiation and the electrons and protons and things like that.

So, we have discussed what is reflection, what is refraction, what is the nature of the radiation, how the radiation effects or is affected by if I pass it through a prism, what is a grating- we have discussed and dispersion diffraction and all those electromagnetic radiation etcetera we have discussed: and its interaction with particulate matter or atomic structure with the electrons in specific.

Afterwards we have gone on to discuss about the theoretical basis of atomic absorption spectrometry. So, we have said that the excitation of the electrons to next higher energy level coming back to the ground state leads to atomic absorption if it is not accompanied by the emission of radiation of different wavelength. That means the absorbed energy is lost by thermal means.

Now we have said that for absorption to occur we need to have a resonance structure. So, resonance structure that is very important with respect to all atomic absorption determination of the elements and resonance line is the one which you choose for atomic absorption measurements. Now, all the smallest or the lowest atomic absorption energy which is in resonance is the wavelength that is useful for atomic absorption.

So, later on we have discussed about the instrumentation of atomic absorption. And then we have discussed about the hollow cathode lamps, light sources, EDLs, xenon lamps, etcetera. And then we have moved on to the discussion of how to produce an aerosol in the flame to get the metals in the ground state. We have also discussed the theoretical basis of how to produce metals in the ground state. And then the we have discussed about the monochromator and detector etcetera; followed by which completed the instrumentation part. And then we have discussed about the interactions, what are the different types of atomic absorption: that is flame atomic absorption, hydride generation, and then mercury cold vapour, and finally in detail about the graphite furnace atomic absorption spectroscopy.

And there we have stopped we have not gone into further detail. But as of now the state of the art of atomic absorption is the graphite furnace technology. In the graphite furnace technology we have always said that you can reach detection limits up to parts per billion levels or parts per trillion levels. And then nowadays we are talking about pentagram; that is 10 raise to minus 15 gram detection limits using atomic absorption. So, we have said; what are the different kinds of atomic absorption.

When we choose a particular technique for the atomic absorption determination; whether I use a flame, whether I use graphite furnace or hydride generation or flame emission or graphite furnace- we have discussed all these things. We have also gone into detail quite a lot about the interferences that occur in flame, hydride generation, cold vapour mercury, as well as in graphite furnace.

So, the interactions are of various kinds that is transport problems vapour phase transfer problems, condensation problems, etcetera; how these interaction interferences affect the signal. And then we have discussed all these things. We will also ask questions, in your assignments on all these aspects. But what I wanted you to understand is, whenever we want to determine do the a specific material metallic metal element analysis we have to

know about the basic fundamental aspects of analytical chemistry. You should know what is a sample, what is a reference solution, what is a calibration, and all those things.

In the last lecture today, I have given you a small introduction to the atomic absorption methods, nomenclature, detection limits, etcetera. And during the last class I have also emphasized how the atomic absorption spectrometry can be applied to different areas, such as body fluids, rocks and minerals, environment, plant samples and then coal paper or plastics. And if you take a look at all these sections that areas that I have covered you will really understand the potential of atomic absorption spectrometry for chemical analysis at the parts per million level, parts per billion level and parts per trillion levels also.

I think you remember that I have talked to you about parts per trillion level quantization of the determination of mercury using cold vapour mercury techniques. So, the field of atomic absorption is quite vast. And if you are working in atomic absorption the more and more you work the more and more you will get excited to work with the instrument.

So, it is a beautiful technique, I wish you all that you listen to the lectures quite often carefully again and again so that you get your ideas very clear. Now if you wish to know more about atomic absorption there are a couple of books which I have given in the reference and you can refer to them. But most of these are very few dedicated an atomic absorption books in the market now: one is available with Perkin Elmer scientist written by Dr. Wells and Sperling also, and I was associated with the some of the techniques with the matrix modification etcetera; we have all worked on the determination of metals in using graphite furnace etcetera. And books are available.

I suggest you also go for high purity metals, high purity acids, high purity environment, where you do the analysis because I have emphasized again and again the requirement of high purity analysis because of the contamination and background correction. So, if you want to determine aluminum in a normal atmosphere in a laboratory you will be surprised to know that you will get about 20 to 25 parts per billion of the concentration of aluminum is there in the air. Similarly, we have come across situations where there is silver in the air, beryllium in the air.

So, like that it is very important for us to understand the significance of cleanliness with technical cleanliness that is what; I mean not just the outer cleanliness with a soap solution etcetera not like that. But the air in which you breathe when you are doing the analysis that should be clean. So, it has to in an area where the particulate matter should be about 100 per cubic meter.

So, it is important for you to locate the atomic absorption in such a way that there are no blanks, high blanks etcetera. And you should also think about a decomposition system whenever you want to by an atomic absorption. So, a decomposition digester; for example, microwave digesters are available nowadays in the market, where samples can be very safely and quickly decomposed without hazards. And that is an important contribution you should remember whenever you are working with atomic absorption.

Another area where you should concentrate especially when you are working with atomic absorption is to get high purity materials. Especially the acids and alkalis which you prepare must be specially prepared redistilled and may be you know without any contact with glass and other things quartz etcetera it is very important that non contact distillation of acids. So, such equipments are also available in a market.

So, if you consider all in all about these aspects I am sure you will be a very good analyst, and you will also do well in your academic and curricular academic curriculum studies as well as if you go into profession you will be one of the best. I wish you all the best thank you very much, and you need anything please let me know I am available.

Thank you very much.