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ATOMIC ABSORPTION SPECTROSCOPY

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Introduction

Atomic absorption spectroscopy is the most widely used tools in analytical chemistry.

It has high sensitivity for the determination of metals and metalloids. By definition, Atomic absorption spectroscopy is a type of quantitative analytical technique where in absorption of a specific wave length of light by the atoms in the neutral state is detected and recorded.

The more the number of the atoms in the given sample, the higher is the intensity of adsorption and vice-versa.

This cab also be called as metal analysis spectroscopy as it mainly used for metal analysis.

Atomic absorption spectroscopy principle

The method relies on the principle of absorption method of spectroscopy.

The liquid sample is allowed to convert into free atoms. These absorb light of a specific wave length and remaining light is detected and recorded. The intensity of absorption is directly proportional to the concentration of the sample.

Atomic absorption spectroscopy Instrumentation

Atomic absorption spectroscopy, unlike other spectroscopy methods, has two additional requirements like a specially designed lamp to produce light of a desires wavelength and a burner to prepare the sample for absorption of light.

Additionally, the method also involves, spraying of the sample in the solution state over an atomizer. This leads to evaporation of the solvent and leaves a fine dry residue behind which has neutral atoms in the ground state.

The instrument is available as single and double beam instruments.

The instrumentation includes:

1. The atomizer to dry the sample and produce atoms.
2. Sample container.
3. Fuel and oxidant to burn the sample by heat.
4. Hollow cathode lamp to produce light of the desired wave length.
5. Detector to detect the absorption intensity.
6. Amplifier and data recorder.

The burner(Atomizer)

Here the sample from capillary rises to the tip of burner where it is burned with the flame produced by the fuel and oxidant combination. The sample after evaporation leaves a fine residue of neutral atoms.

Sample container

This is a beaker-like a container of the sample which is placed below the burner preferably. A capillary tube drains the sample to the tip of the burner.

Fuel and oxidant

This is a very important part of the entire process to be remembered. If the heat produced is not sufficient then the sample doesn't form neutral atoms. If the heat of burner is more, the sample molecules may ionize instead of forming atoms. So, both are

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undesirable for experimentation. Hence a proper combination of fuels and oxidants are to be used to produce recommended temperatures. Commonly used flues include propane, hydrogen and acetylene and oxidants are mostly air.

Fuel combination chart:

Fuel combinations	Flame temperature	Metals analyzed
Acetylene + Air	2550 degrees	For most samples
Acetylene + Nitrous oxide	2900 degrees	Aluminum(Al), Molybdenum(Mo), Silicon (Si), Titanium(Ti)
Hydrogen + Air	2200 degrees	Lead(Pb), Tin(Sn)

Light source

The light source should produce a narrow spectrum with little background noise. Besides the light should be stable and have sufficient intensity. Two types of light sources can be used based on the requirement.

1. **Hollow cathode lamp:** This is most widely used as light source. Inside the lamp, the cathode is coated with a metal of analyte to be analyzed. For instance, if magnesium is to be analyzed in the sample, the cathode coated with magnesium is used.

i. Similarly, for all the other elements like Na, Ca, K, Zn, etc. to be analyzed respective metal coated cathode is used in the lamp. The lamp is filled with inert gas like argon or neon which is ionized by an electric arc. The ions get attracted toward cathodes and strike it leading to excitation of metal ions. This leads to the emission of radiation with a characteristic wave length of analyte metal.

2. **Electrode- less discharge lamps:** These lamps are less common in regular use but are essential of determination of Arsenic and Selenium. A bulb containing an element of interest is present in the lamp. This element is excited using microwave energy or radio frequency energy.

Detector: The detector consists of a photomultiplier tube or simple photocell. The current or potential recorded for the sample absorption is recorded in computer software and then analyzed.

Atomic absorption spectroscopy Applications

1. Atomic absorption spectroscopy is used for quantitative analysis of metal elements in samples like soil, plant material.
2. It is especially useful to analyze ionic metal elements in blood, saliva, urine samples like sodium, potassium, manganese, calcium and other body fluids.
3. To determine heavy metals like Fe, Mn, Cu, Zn, Hg, Pb, Ni, Sn, etc. in urine, blood, etc. This analysis is essential in case of heavy metal poisoning as regular monitoring of poison levels in the blood are to be determined until patient recovery.
4. To determine metal elements in food industry.
5. To estimate lead in petroleum products.
6. To determine metal concentration on ground water and bore well samplings before using for drinking and irrigation.