Atomic Emission Spectroscopy

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Atomic emission spectroscopy

- Atomic emission spectroscopy (AES) is an analytical technique used for the quantification of metal atoms by measuring the intensity of light emitted by the atoms in excited states.
- When an excited atom returns to the ground level, it emits radiation in a discrete wavelength.
- **Atomic emission spectroscopy** (**AES**) is a method of chemical analysis of samples by the electronic transition of atoms by using flame and argon plasma sources.
- The source of excitation influences the intensity of emission in such measurement.
- The source provides sufficient energy to vaporize the sample.
- It also causes the electronic excitation of gaseous elementary particles.
- Therefore, we get band and line spectra.

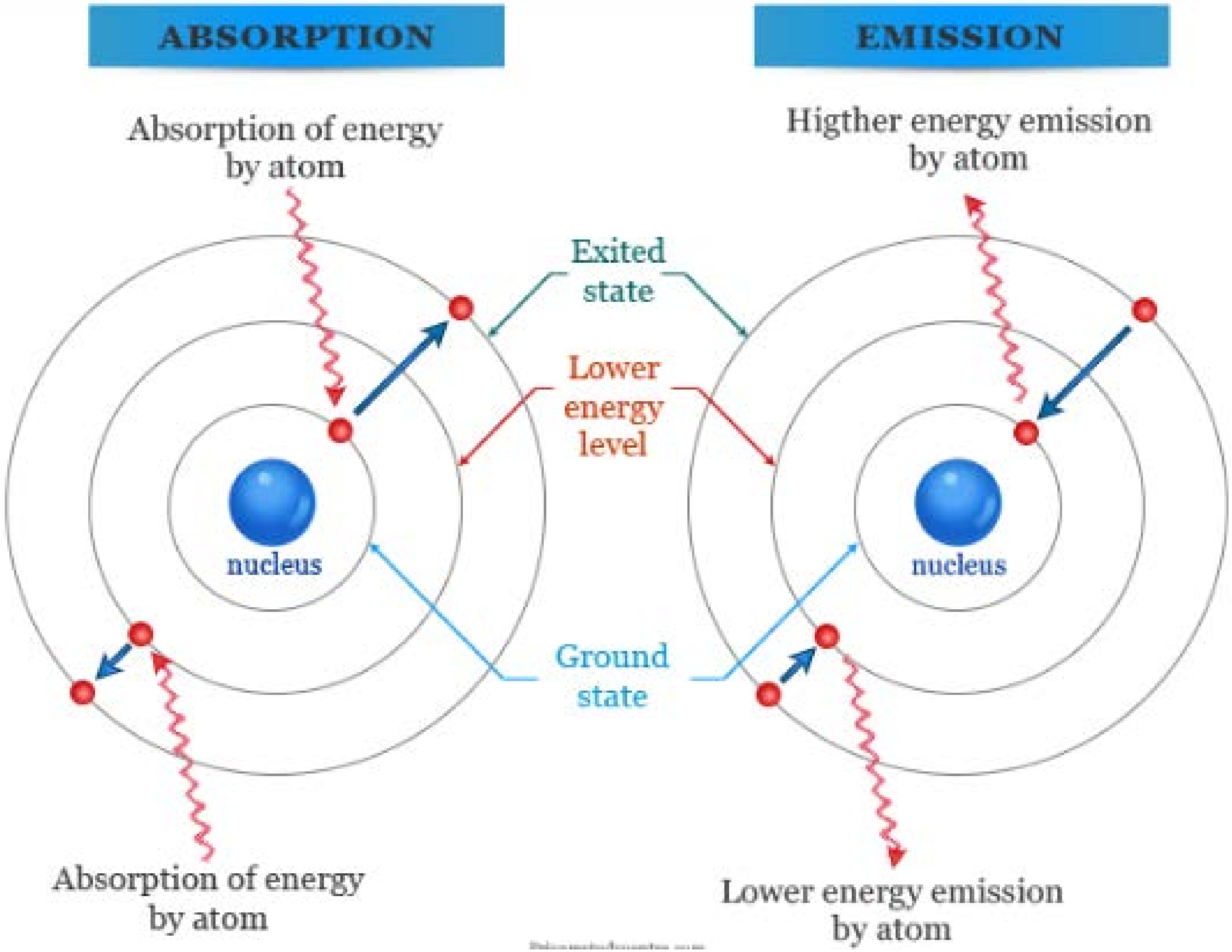
Flame photometer/ Flame emission spectroscopy

- The principle of flame photometer is based on the measurement of the emitted light intensity when a metal is introduced into the flame.
- The wavelength of the colour gives information about the element and the colour of the flame gives information about the amount of the element present in the sample.

Inductively coupled plasma atomic emission spectroscopy (ICP-AES

- Atomic emission spectroscopy, also known as ICP spectroscopy stands for inductively coupled plasma.
- It is named altogether as inductively coupled plasma atomic emission spectroscopy (ICP-AES) or inductive coupled plasma optical emission spectrometry (ICP-OES).
- It involves the excitation and de-excitation processes for electrons by absorption of radiation.
- When an electron emits electromagnetic radiation while coming back from an excited to de-excited state, the EMR is measured and analyzed.
- It is called OES due to the optical property of radiation during the de-excitation process.
- Measurement in atomic emission spectroscopy is feasible because the spectral line has a definite wavelength.

ATOMIC EMISSION AND ABSORPTION

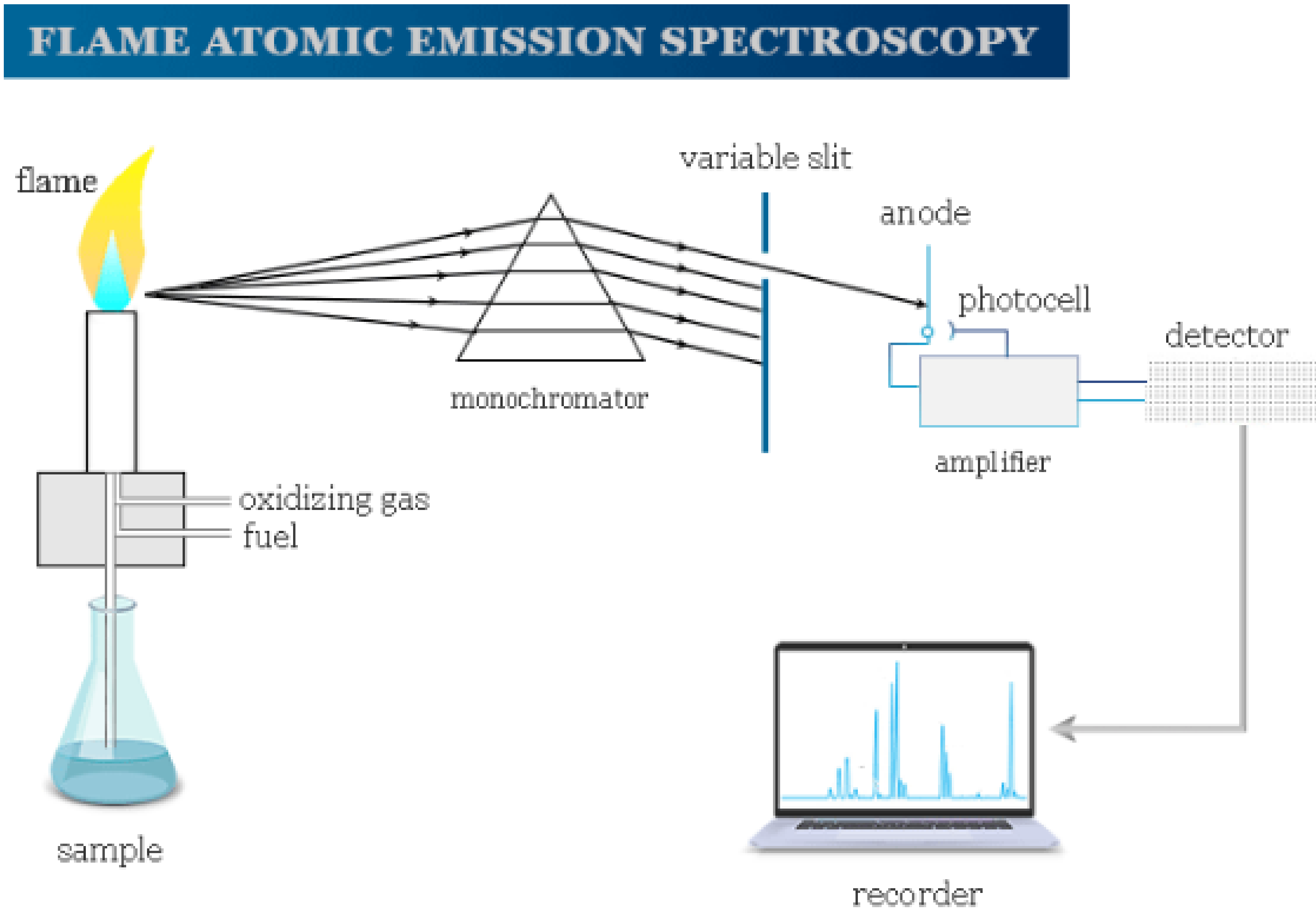


Atomic emission spectra

- Generally, the flame in the atomic emission spectrometer transforms the solid or liquid samples into the vapour state.
- It also decomposes the samples into simpler molecules or atoms.
- Flame in atomic emission spectroscopy finally excites the electrons to higher energy levels.
- These electrons return to the ground state by emission of radiation.
- On dispersing, water or solvent is evaporated and dry salt is left in the flame.
- On further heating at a higher temperature, the dry salt is vaporized and molecules are dissociated to neutral atoms which are responsible for emission phenomena.
- The vapour of neutral metal atoms is excited by the thermal energy of the flame.
- A particular element emits characteristic spectra with a definite wavelength.
- Usually, line spectra are obtained from atoms or ions while molecules give band spectra.

Flame atomic emission spectroscopy

- The overall instrumentation of flame atomic spectroscopy is similar to other spectrometric methods like atomic absorption spectroscopy.
- A flame photometer contains,
  - A pressure regulator and flow meter;
  - An atomizer;
  - A burner;
  - An optical system;
  - A photosensitive detector;
  - Recording output


FLAME ATOMIC EMISSION SPECTROSCOPY
flame
variable slit
anode
photocell
detector
monochromator
amplifier
oxidizing gas
fuel
sample
recorder

... **Flame atomic emission spectroscopy**

- The pressure regulator and flowmeter are used for the proper adjustment of pressure and flow gases.
- The atomizer is used to introduce a liquid sample into the flame at stable and reproducible rates.
- Glycerine can be utilized as a solvent. The burner should produce a steady flame. A Maker burner is good for working at low temperatures. We used a deep metal grid across the mouth of the burner to prevent the flame from striking back.
- The optical system in flame atomic absorption spectroscopy functions as a collector and monochromator of light. It focused on the photosensitive detector. A monochromator can isolate the characteristic of electromagnetic radiation. A good slit with a narrow opening is necessary.
- Photosensitive detectors are not useful because the response is not amplifiable. We used a filter flame photometer in flame atomic emission spectroscopy instrumentation.
- Amplifiers can amplify the signal to boost the output.

ICP-AES system

- An ICP-AES system can be divided up into two basic parts; the inductively coupled plasma source and the atomic emission spectrometry detector.
- ICP source is extremely hot and produces a maximum temperature of up to 6500 °K.
- This temperature is enough for the ionization of samples.
- ICP source comprises three concentric silica quartz tubes each of which is open at the top.
- The argon stream carries the sample in the form of aerosol and passes through the central tube.
- The excitation is provided by the radiofrequency range radiations (∼ 27 MHz).
- The argon gas is ionized in the intense electromagnetic field and flows in a particular rotationally symmetrical pattern towards the magnetic field of the RF coil.
- A stable, high temperature plasma of about 7000 K is then generated as the result of the inelastic collisions created between the neutral argon atoms and the charged particles.

- A peristaltic pump delivers an aqueous or organic sample into an analytical nebulizer where it is changed into mist and introduced directly inside the plasma flame.
- The sample immediately collides with the electrons and charged ions in the plasma and is itself broken down into charged ions. The various molecules break up into their respective atoms which then lose electrons and recombine repeatedly in the plasma, giving off radiation at the characteristic wavelengths of the elements involved.
- The two emission systems, FAES and ICP-AES, differ in the way atomic species are created and excited.
- Because of the relatively low temperatures (~2000-2500 C) in a flame-based system, not all of the atoms or elements present in the sample are excited, particularly if they exist in a polyatomic compound.

Applications of flame photometer

- Flame photometer can be applied both for quantitative and qualitative analysis of elements.
- The radiations emitted by the flame photometer are characteristic to particular metal.
- Hence with the help of Flame photometer we can detect the presence of any specific element in the given sample.
- The presence of some group II elements is critical for soil health. We can determine the presence of various alkali and alkaline earth metals in soil sample by conducting flame test and then the soil can be supplied with specific fertiliser.

... **Applications of flame photometer**

- The concentrations of Na+ and K+ ions are very important in the human body for conducting various metabolic functions. Their concentrations can be determined by diluting and aspirating blood serum sample into the flame.
- Soft drinks, fruit juices and alcoholic beverages can also be analysed by using flame photometry to determine the concentrations of various metals and elements.
- Used in determination of calcium and magnesium in cement.
- Used in determination of lead in petrol

Applications of ICP-AES system

- In agriculture, the ICP-AES technique can be used for the analysis of agricultural and food products.
- In earth science, it can be used for the analysis of rare earth elements present in rocks.
- Trace metals from alloys, steel, lubricating oils, and gasoline can be analyzed by the ICP-AES technique.
- Similarly, in biology, aluminum from blood, copper from the brain tissue, selenium in the liver, and sodium from breast milk can be analyzed by the ICP-AES technique.
- The traces of metals like calcium (Ca), copper (Cu), iron (Fe), manganese (Mn), magnesium (Mg), phosphorus (P), potassium (K), and zinc (Zn) from beer or wine can be analyzed by inductively coupled plasma atomic emission spectroscopy.