UCB008 - APPLIED CHEMISTRY

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Atomic Emission Spectroscopy

Principle

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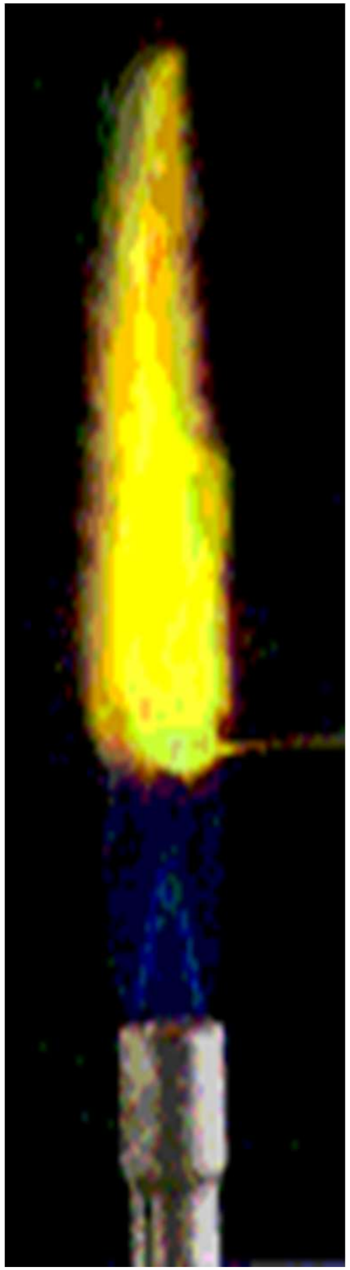
Learning Outcomes

At the end of this session participants should be able to:

- Differentiate the principles associated with atomic emission and absorption spectroscopy



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Atomic Emission and Atomic Absorption Spectroscopy

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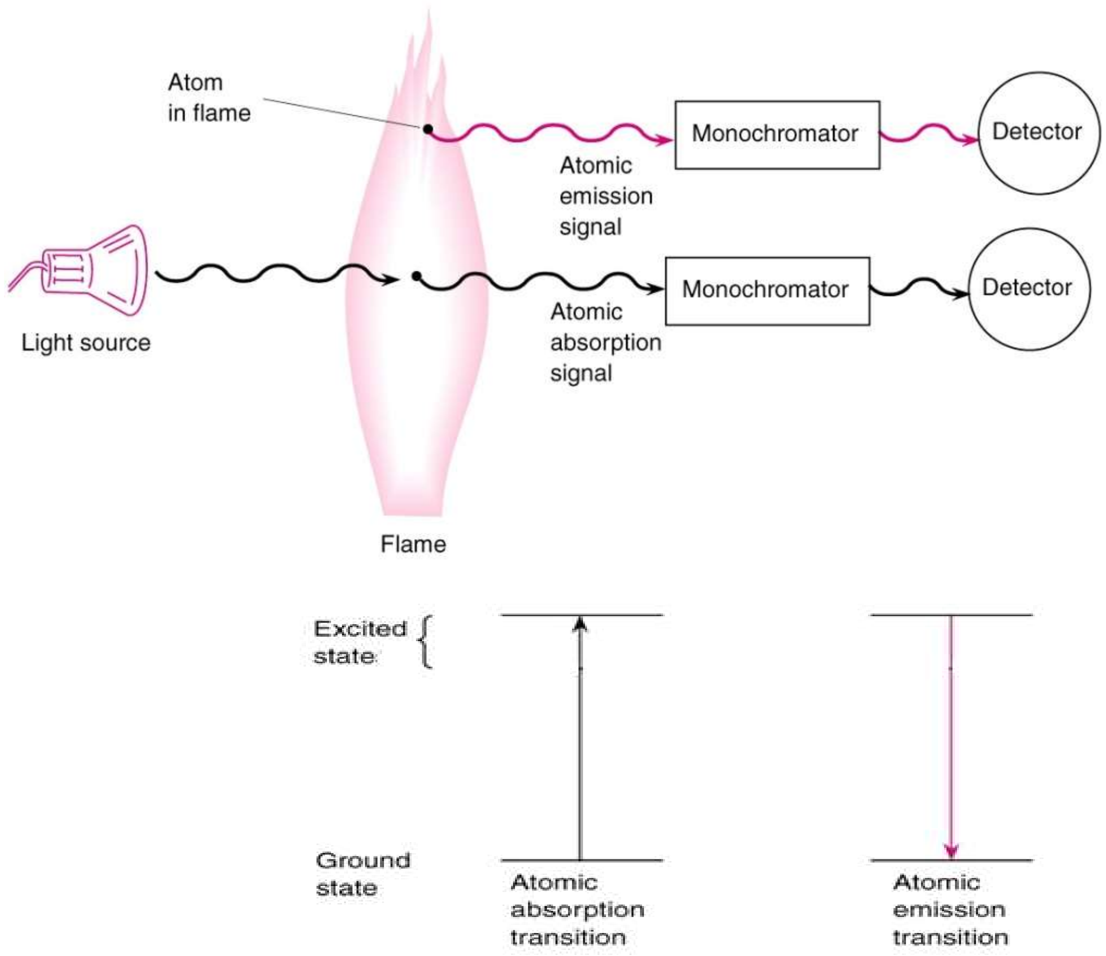
- In atomic emission and absorption spectroscopic technique sample solution is aspirated into a flame that is hot enough to break the ions or molecules into their atomic states.

- The concentration of the analyte in the flame can be measured by either through ***absorption*** or ***emission*** of the radiation.

- The absorption mode is known as **atomic absorption spectroscopy** (**AAS**) whereas emission mode as **flame emission Spectroscopy** (**FES**) or Atomic emission spectroscopy.

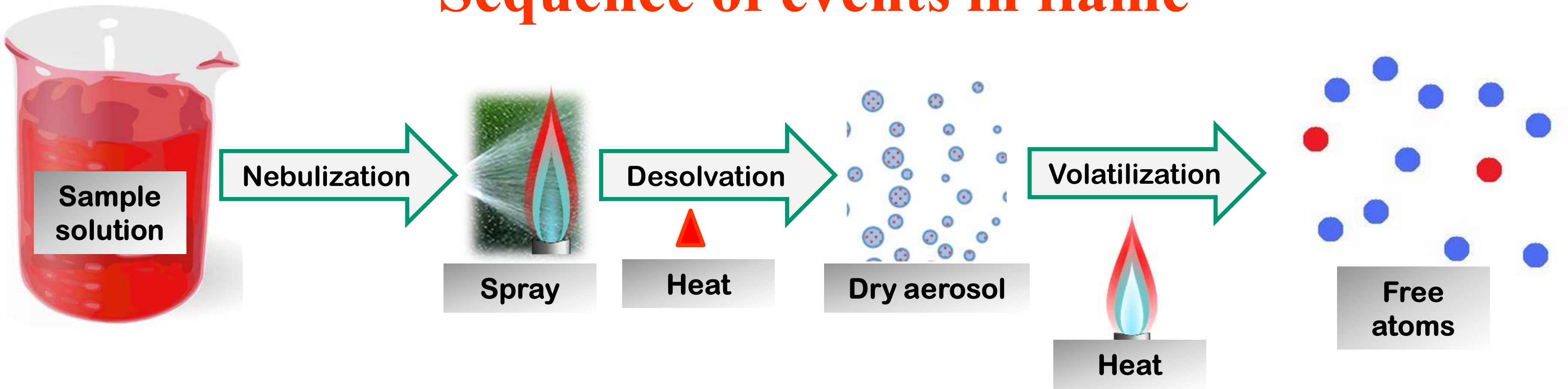


Upper Diagram shows FES while the lower one shows AAS. In FES the flame provides energy for atomization and excitation, but in AAS it provides only atomization .

Flame emission spectroscopy

- Flame emission spectroscopy (flame photometry) is a special area of emission spectroscopy in which a flame is used to excite the atoms.
- For a few elements, such as the alkali metals Na and K, flame is hot enough not only to produce ground state atoms, but to raise some of the atoms to an excited electronic state.
- So Flame emission spectroscopy is used for the detection of alkali metals and some of the alkaline earth metals.

Sequence of events in flame



- Atomic absorption and atomic emission techniques involve introduction of sample solution into a flame.
- The solution of the metal salt in question is sprayed into the flame.
- Solvent evaporates leaving the finely powdered salt.
- Vaporization of the salt.
- Conversion of ions into free gaseous atoms.
- Valence electron (●) is raised to a higher energy state.

Flame emission spectroscopy

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Nebulization – **Conversion of sample solution in fine droplets – aerosol formation which is aspirated to flame**

Desolvation – **Removal of solvent leaving dry sample**

Sublimation- **Transition of salt from solid to gaseous state**

Atomization – **Conversion of ions in to atoms**

Excitation – **Valence electrons of atoms get excited to higher energy state**

Relaxation – **Excited electrons relaxes from higher energy state to ground state**

Measurement – **Wavelength and intensity of emitted radiations is measured**

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Flame emission spectroscopy

Principle

- Absorption of heat energy by ground state atom present in the flame results in the excitation of valence electron of atoms.
- This valence electron comes back to ground state with the emission of photon.
- Wave length and intensity of emitted photon helps in qualitative and quantitative analysis of the sample.

The energy emitted when this electron drops down into a vacant lower level is given off as radiant energy of a wavelength determined by the Planck-Einstein relationship:

$$E_2 - E_1 = \Delta E = h\nu = hc/\lambda$$

$$\lambda = hc/ E_2 - E_1$$

λ of the emitted radiation is characteristic of atoms of a particular element from which it is emitted. It tells us about the elements which are present in the flame

For example,

Na -------> Na* (energy from flame)
Na* -------> Na + hν (at 589 nm)

Intensity of radiant energy *emitted* when the atoms return to the ground state is proportional to the concentration and is the basis of *flame emission spectroscopy*.

The fraction of free atom that are thermally excited is governed by boltzmann distribution law-

$$N^*/N^0 = A\, e^{-\Delta E / kT}$$

- **According to Scheibe-Lomakin equation**

$$I = k \times C$$

Where :

I = Intensity of emitted light
C = Concentration of the element
***k* = Constant of proportionality**

- **The signal intensity from a flame is dependent on the flame temperature, the rate of flow of liquid (sample solution) into the flame, the pressure and rate of flow of fuel gases, and on many other variables which affect the character of the flame or atomization of the sample.**

- **So flame temperature should be controlled. Flame temperature depends on fuel, oxidant and fuel to oxidant ratio.**

Fuel	Oxidant	Flame temperature (^0C)
Propane	Air	1900 ^oC
Propane	Oxygen	2800 ^oC
Hydrogen	Air	2100 ^oC
Hydrogen	Oxygen	2800 ^oC
Acetylene	Air	2200 ^0C
Acetylene	Oxygen	3000 ^0C

In the next session…..

- Instrumentation of atomic emission spectroscopy