ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF BIOMEDICAL ENGINEERING

BM3491 Biomedical Instrumentation

UNIT- V BIOCHEMICAL MEASUREMENTS

5.6 Flame Photometer

- The flame photometer, shown in Figure 5.6.1 measures the color intensity of a flame that is supported by oxygen and a specific substance.
- The flame photometer is one of the most useful instruments in clinical analyses.
- The method of flame photometric determinations is simple.
- A flame photometer is an analytical instrument used to measure the concentration of certain metal ions, such as sodium (Na), potassium (K), calcium (Ca), and lithium (Li), in a sample.
- It works on the principle of flame emission spectroscopy, where the intensity of the light emitted by the flame is measured to determine the concentration of the metal ions.

Principle of Flame photometer:

1. A solution of the sample to be analyzed is prepared. A special sprayer operated by compressed air or oxygen is used to introduce this solution in the form of a fine spray (aerosol) into the flame of a burner operating on some fuel gas, like acetylene or hydrogen.
2. The radiation of the element produced in the flame is separated from the emission of other elements by means of light filters or a monochromator.
3. The intensity of the isolated radiation is measured from the current it produces when it falls on a photodetector.
4. The measurement of current is done with the help of a readout meter, whose readings are proportional to the concentration of the element. After carefully calibrating the meter with solutions of known composition and concentration, it

is possible to correlate the intensity of a given spectral line of the unknown sample, with the amount of the same element present in a standard solution.

Construction of Flame Photometer:

A flame photometer has three essential parts (Fig 5.6.1). These are:

(a) Emission System: consists of the following:

(i) Fuel gases: and their regulation: comprising the fuel reservoir, compressors, pressure regulators and pressure gauges.

(ii) Atomizer: consisting, in turn, of the sprayer and the atomization chamber, where the aerosol is produced and fed into the flame.

(iii) Burner: receives the mixture of the combustion gases.

(iv) Flame: the true source of emission.

(b) ***Optical System***: It consists of the optical system for wavelength selection (filters or monochromators), lenses, diaphragms, slits etc.

(c) ***Recording System***: It includes detectors like photocells, photo-tubes, photomultipliers, photodiodes etc. and the electronic means of amplification, measuring and recording.

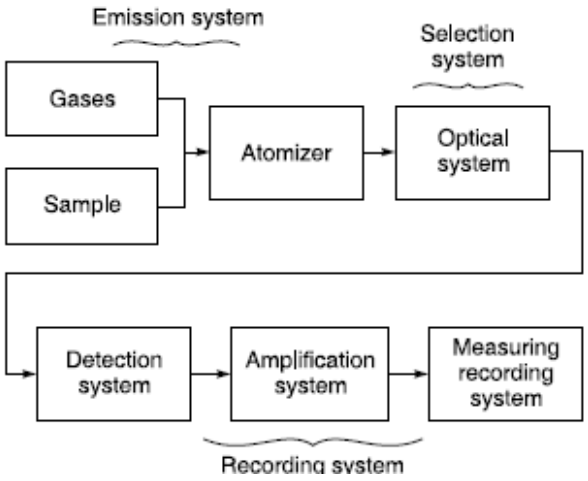

Fig. 5.6.1 *Essential parts of a flame photometer*

Dedicated instruments for the simultaneous analysis of sodium, potassium and lithium are available for clinical applications. In these instruments, sample handling is automatic, as the system has a turntable, which will hold up to 20 samples in cups and an automatic positive piston displacement dilutor, that dilutes the sample prior to entering the spray chamber.

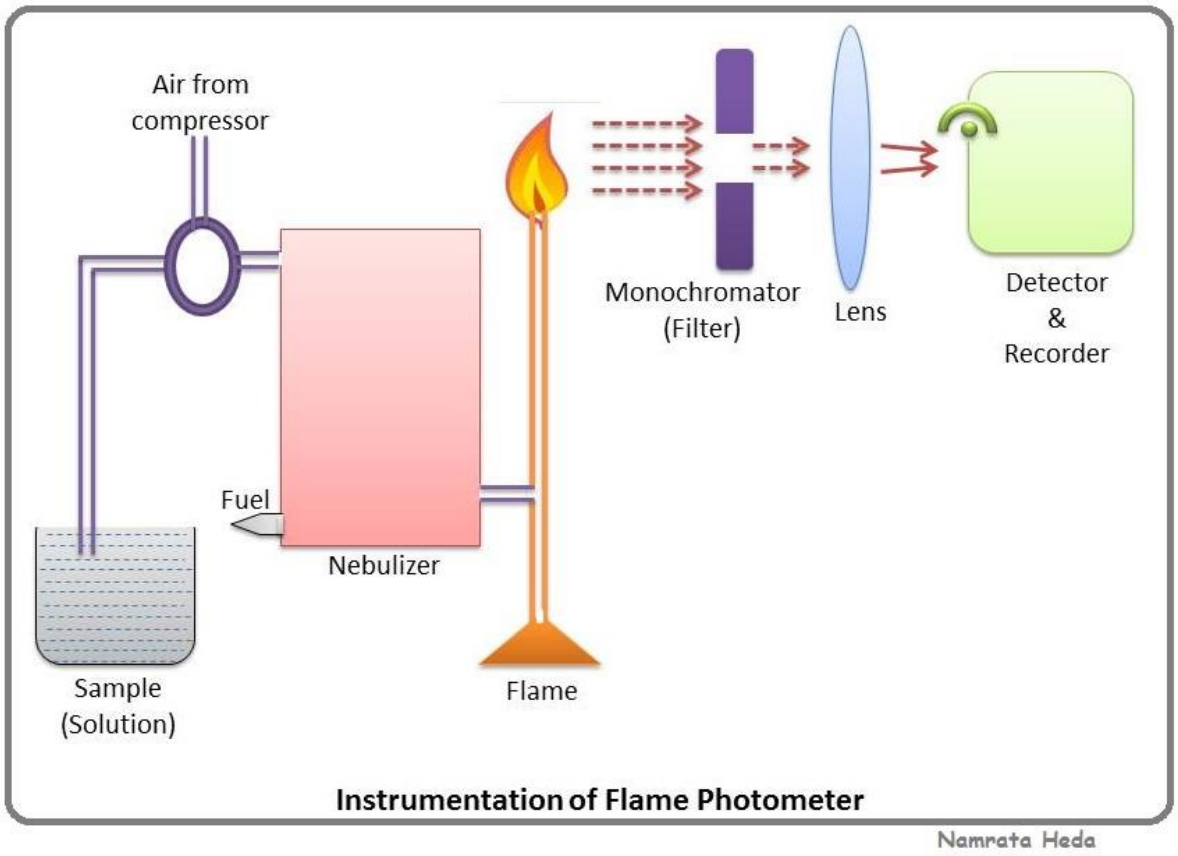

Fig. 5.6.2 Flame Photometer

Working of Flame Photometer:

- **Sample Preparation:**

  The sample is prepared by diluting it with a suitable solvent, often distilled water, to bring the concentration of metal ions within the measurable range of the flame photometer.

- **Sample Aspiration:**

  The prepared sample is aspirated into the nebulizer, where it is converted into a fine mist and introduced into the flame.

- **Excitation:**

  In the flame, the metal ions are excited to higher energy levels. As they return to their ground state, they emit light at characteristic wavelengths specific to each metal ion.

- **Wavelength Isolation:**

  The emitted light is passed through the monochromator, which isolates the characteristic wavelength of the metal ion being measured.

- **Detection and Measurement:**

  The isolated light is detected by the photodetector, which generates an electrical signal proportional to the intensity of the light.

- **Data Processing:**

  The electrical signal is processed and converted into a concentration reading, which is displayed on the readout device.

Calibration :

Calibration is a critical part of flame photometry. The instrument is calibrated using standard solutions of known concentrations of the metal ion of interest. A calibration curve is plotted by measuring the intensity of light emitted at different concentrations. This curve is then used to determine the concentration of metal ions in unknown samples.

Applications :

Flame photometers are widely used in various fields, including:

- ✓ **Clinical Laboratories:**
  - For measuring electrolytes such as sodium, potassium, and calcium in biological fluids.
- ✓ **Agriculture:**
  - For soil and plant analysis to determine nutrient levels.
- ✓ **Environmental Monitoring:**
  - For analyzing water samples for metal contamination.
- ✓ **Food Industry:**
  - For quality control by measuring mineral content in food products.

Advantages of flame photometer

i. The method of analysis is ***very simple*** and economical.
ii. It is quick, convenient, selective and ***sensitive analysis***.
iii. It is both ***qualitative*** and ***quantitative*** in nature.
iv. Even very ***low concentrations*** (parts per million/ppm to parts per billion/ppb range) of metals in the sample can be determined.
v. This method compensates for any ***unexpected interfering material*** present in the sample solution.
vi. This method can be used to ***estimate elements*** which are rarely analysed.

Disadvantages of flame photometer:

In spite of many advantages, this analysis technique has quite a few disadvantages:

i. The ***accurate concentration*** of the metal ion in the solution ***cannot*** be measured.
ii. It cannot directly detect and determine the ***presence of inert gases***.
iii. Though this technique measures the total metal content present in the sample, it does ***not provide*** the information about the ***molecular structure*** of the metal present in the sample.
iv. ***Only liquid samples*** may be used. Also sample preparation becomes lengthy in some cases

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