Experiment 12: Flame Photometric Estimation of Sodium and Potassium

Significance of experiment : A photoelectric flame photometer is a device used in inorganic chemical analysis that uses the intensity of light emitted from a flame.[1] It has lots of applications.[2] It is used in Potash and fertilizer industry for highly accurate determination of potassium and sodium concentrations, Soil and environmental analysis for laboratory measurements for determination of alkali and alkaline earth elements, drinking water treatment: measurement of calcium and sodium concentrations in drinking water, glass industry for measurement of sodium concentration in glass and in clinical applications such as electrolyte determinations in blood and urin in areas without laboratory automation.

Aim : To estimate sodium and potassium using flame photometer.

Theory – Emission of characteristic radiation by an element and the correlation of the emission intensity with concentration of the element form the basis of flame photometry.

When a solution containing sample element or ion is aspirated into the flame, following changes takes place,

a) Firstly, solvent gets evaporated leaving behind salt in the flame.
b) Then, salt gets evaporated into salt vapours, which further undergo dissociation into its constituent atoms.
c) Some of the gaseous atoms formed may absorb heat energy from flame and get electronically excited to their higher energy level. Being unstable in the excited state, atoms fall back to their ground state, in form of light radiation.
d) Intensity of emitted light is proportional to number of atoms in the excited state, which in turn is proportional to the concentration of solution fed into the flame.
e) Different metals emit their characteristic radiations at different wavelengths, they do not interfere with each other, even when they are present together.

Series of changes taking place at the flame are summarized as follows:

		Evaporation		Vaporization		Dissociation		
M^+X^-	→	M^+X^-	→	MX	→	MX	→	M (gas) + X (gas)
Solution				Mist		Solid		Gas

Intensity of emitted radiation, measured as detector response is related to the concentration by an expression similar to Beer's relation,

$E = k \alpha c$

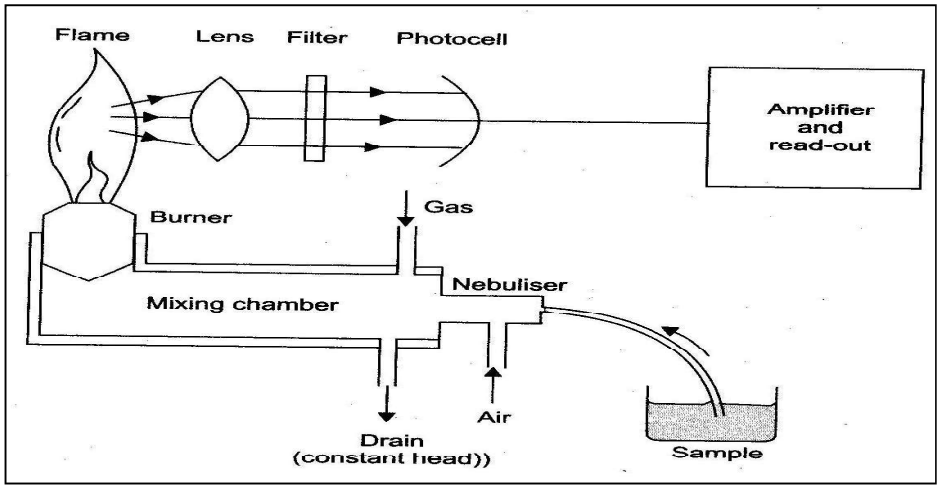
E = detector response

k = constant

α = efficiency of atomic excitation

c = concentration

Instrument: Flame photometer consists of an atomizer, mixing chamber, burner, filter, detector and a display device. Pressurized air is passed into atomizer and due to suction sample solution is drawn into the atomizer. Inside atomizer it mixes with air stream as a fine mist and passes into the mixing chamber. In mixing chamber it mixes with gas and then passes into burner where mixture is burnt. The emitted radiation from flame passes through lens and then through a filter which allows only radiation characteristic of element under study to pass through detector. The output from detector is read out on a display device.



Application:

1) 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.
2) 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 fertilizer.

Procedure for determination of sodium: Transfer 2, 4, 6, 8 and 10cm^3 of standard sodium solution into different 25-cm^3 volumetric flasks from a burette. Make up all the solutions using distilled water. Stopper the flasks and shake well to get uniform concentration. To the given unknown solution also add distilled water and shake well. Switch on the instrument, turn the gas supply on and light the gas at the burner. Adjust the air supply from the compressor to 10 lbs/sq inch using pressure regulator knob. Place the sodium filter (589nm) in position. Now dip the capillary tube in a cell containing distilled water. The stream of air atomized as a fine mist draws up the liquid. Regulate the gas supply so that the color of the flame completely turns to blue. Adjust the flame photometer to zero by means of zero control knob. Now feed the 100 ppm sodium solution and adjust the reading to hundred. Repeat the process to confirm the accuracy of the calibration.

Feed the various sodium solutions prepared through the flame by spraying with atomizer one by one including the unknown solution. Note down the flame photometer reading. Plot a graph of flame photometer readings against concentrations or volume of the solution to form the calibration curve. Using the curve obtained find out the volume of the unknown solution containing sodium ions .and calculate the amount of sodium ions in it.

Procedure for determination of potassium

Preparation of standard solutions for calibration curve:Dissolve exactly 1.090gm of potassium chloride in water and make up to 1 liter. This contains1mg per ml (1000 ppm).

Transfer 2, 4, 6, 8 and 10cm^3 of standard potassium solution into different 25-cm^3 volumetric flasks from a burette. Make up all the solutions using distilled water. Stopper the flasks and shake well to get uniform concentration. To the given unknown solution also add distilled water and shake well. Switch on the instrument, turn the gas supply on and light the gas at the burner. Adjust the air supply from the compressor to 10 lbs/sq inch usingpressure regulator knob. Place the potassium filter in position. Now dip the capillary tube in a cell containing distilled water. The stream of air atomized as a fine mist draws up the liquid. Regulate the gas supply so that the colour of the flame completely turns to blue. Adjust the flame photometer to zero by means of zero control knob. Now feed the 100 ppm potassium solution and adjust the reading to hundred. Repeat the process to confirm the accuracy of the calibration.

Feed the various potassium solutions prepared through the flame by spraying with atomizer one by one including the unknown solution. Note down the flame photometer reading. Plot a graph of flame photometer readings against concentrations or volume of the solution to form the calibration curve. Using the curve obtained find out the volume of the unknown solution containing potassium ionsand calculate the amount of potassium ions in it.

Advantage:

1) The method of analysis is very simple and economical.
2) It is quick, convenient, selective and sensitive analysis.
3) It is both and qualitative and quantitative in nature.
4) Even very low concentrations (parts per million/ppm to parts per billion/ppb range) of metals in the sample can be determined.

Result:

I) Concentration of sodium in the given unknown solution.....

II) The Amount of sodium in the unknown solution.....

III) Concentration of potassium in the given unknown solution.....

IV) The amount of potassium in the given sample……..ppm

Links to the external sources of information about the topic:

1. http://en.wikipedia.org/wiki/Photoelectric_flame_photometer
2. http://www.merriam-webster.com/dictionary/flame%20photometer

Experiment 12: Observation and calculations

For determination of sodium:

Concentration of solution:

Flame photometer reading for sodium

Sl.No.	Volume of sodium solution taken (mL)	Weight of sodium (g)	Concentration (ppm)	Flame photometer reading
1	2			
2	4			
3	6			
4	8			
5	10			
6	Unknown			

For determination of potassium:

Concentration of solution:

Flame photometer reading for potassium

Sl.No.	Volume of potassium solution taken (mL)	Weight of Potassium (g)	Concentration (ppm)	Flame photometer reading
1	2			
2	4			
3	6			
4	8			
5	10			
6	Unknown