

Flame photometry essay sample



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1. 0 INTRODUCTION

Flame photometry, also referred to as ‘ flame atomic emission spectrometry’ is a quick, economical and simple way of detecting traces of metal ions, primarily Sodium, Potassium, Lithium, Calcium, and Barium, in a concentrated solution. The process is an extension of the principles used in a flame test, with the main differences having more precision in the results, and the use of more advanced technology. This report focuses on the theory, applications, limitations and analysis of Flame Photometry.

2. 0 EXPLANATION OF THEORY

2. 1 A flame photometer is an instrument used for measuring the spectral intensity of lines produced by metals present in ionic compounds. “ Measuring the flame emission of solutions containing the metal salts is done to perform a quantitative analysis of these substances” (Internet 1).

2. 2 The electrons of an atom exist in different energy levels. When energy is added to an atom in the form of light/heat/electrical energy, the atom becomes excited and electrons begin to ‘ jump’ to higher energies (Figure 1). There are two states that an atom can exist – an excited state and a ground (natural) state. The ground state of an atom is when the electrons are in their lowest energy level. The use of a flame photometer “ relies on the principle that a metal salt drawn into a non-luminous flame will ionise, absorb energy from the flame and then emit light of a characteristic wavelength as the excited atoms decay to the unexcited ground state” (Internet 10).

Fig. 1

2. 3 Flame photometers work by vaporizing metallic salts in a very hot flame: when a solution of a salt, such as sodium is sprayed into the flame, the elements in the compound are partially converted into their atomic state. “ Due to the heat energy of the flame a very small proportion of these atoms is excited and the electrons move to a higher energy level. The proportion of the atoms that are excited depends upon the concentration of the particular element and on the temperature of the flame. In the excited state the electrons are unstable and they rapidly revert back to their former lower energy level” (Internet 2). As they change from the excited state or higher energy level back to the lower energy level, they emit light in the form of a fixed wavelength, to produce a spectrum.

2. 4 This data is then recorded by the flame photometer, which gives a precise reading and suggests how much of the metallic substance being tested is present in the sample. The photometer uses the end of a fibre optic cable to read the light intensity of a spectral line. The photometer then converts this information into comprehensible output and displays it on a computer monitor (Figure 2).

Fig. 2

2. 5 The Beer-Lambert Law

Under carefully controlled conditions, the amount of light emitted is directly proportional to the number of atoms that are excited, which in turn is proportional to the concentration of the substance in the sample. Therefore

the intensity of light emitted can be used to find an unknown concentration of a substance.

2. 6 Applying the Beer-Lambert Theory

If samples of a known concentration are tested (a standard), the amount light emitted can be recorded in a graph, allowing a calibration curve to be produced. The curve can then be used to determine the concentration of an unknown. (Figure 3). As the Beer-Lambert Law states light emission and concentration of a sample are directly proportional, the concentration of the substance can be discovered.

Fig. 3

3. 0 APPLICATIONS AND ANALYSIS

Flame photometers are used in many applications. Some examples include analysis of salt presence in biological material, and identifying the composition of alkali and alkaline salts present. It is also used clinically in the analysis of environmental studies.

3. 1 Flame photometry is a fast and precise technique, which can be used to determine the concentration of potassium in soil samples. To measure the potassium concentration, the soil is first ground, before being passed through a 2 mm mesh sieve. Approximately 20g of air-dried soil is then transferred into a bottle and about 50 ml of ammonium nitrate solution is combined. Before being shaken, this mixture is then passed through a flame ionisation detector. The mixture can then be shaken using a machine for about 30 minutes at a rate of 275 strokes per minute. Next, the shaken

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mixture is filtered through paper to preserve the solution extract. The amount of potassium in the extract is then determined using flame photometry. If there is too much or too little potassium present in the soil, chemicals can be added to modify the soil, to create optimal conditions for plant life.

4. 0 LIMITATIONS

The low temperature of the natural gas and air flame, compared to other methods used to excite substances, such as arcs, sparks, and rare gas plasmas, limit the use of flame photometry to easily ionised metals. Highly reactive metals such as sodium, potassium, lithium and calcium are generally used in this method. These elements require little external energy to excite the electrons and cause them to jump, and convert to an excited state.

For precise and accurate results to be achieved, the process must be conducted in controlled environments. As with other scientific methods and processes, contamination, (i. e. cleaning the equipment with detergents or a soap solution, as soap residue will remain inside if not rinsed properly) will result in either erratic or unbalanced results and readings.

The low temperatures required in Flame Photometry also render this method susceptible to certain disadvantages, most of them related to interference and the lack of stability of the flame and aspiration conditions. “ Fuel and oxidant flow rates and purity, aspiration rates, solution viscosity, concomitants in the samples, etc affect these” (Internet 1). Therefore, it is

important to measure the emission of the standard and unknown solutions under conditions that are as identical as possible.

5. 0 CONCLUSION

It can be seen that flame photometry is a quick, economical and simple way of detecting traces of metal ions in a concentrated solution. The use of the Beer-Lambert Law through the measurement of standards is a crucial component of this method. With many applications, including analysis of salt presence in biological material, and identifying the composition of alkali and alkaline salts present, as well as clinical and biological uses, the technology used in flame photometry is vital in today's society.

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Figure 1. modified from <http://student.ccbcmd.edu/~gkaiser/biotutorials/photosyn/images/photon.gif>

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Figure 2. modified from <http://www2.sjsu.edu/faculty/chem55/55aaovw.html>

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Figure 3. Own Design