

Lecture No. 2

SCENARIO OF MODERN TECHNIQUES OF ANALYSIS

by

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With the global growth in the industrialization and consciousness about quality, the importance of chemical analysis has exponentially increased. In fact, chemical analysis in mineral and metal industries and related institutions has always occupied a vital position. If you look back to the history, you are aware that the successful elucidation of the process of combustion by Lavoisier was mainly due to his employment of a balance in his investigation. He was among the first to recognize the immense power of quantitative measurement in research. The atomic concept of matter dates to our vedic era, when 'Kanad' gave the idea, that matter is composed of small particle i.e 'Kana'. It was certainly not with John Dalton. The major contribution of John Dalton was to introduce a quantitative aspect to this notion - an aspect which could be verified by actual experiment. Actually it is chemical analysis which provided the necessary support to convert the atomic theory from philosophical abstraction to physical significance.

Early chemistry was principally analytical in nature. Later in other branches, the researchers used to rely heavily upon analytical methods and techniques to provide them with experimental informations and thus chemical analysis assumed the supporting role of indispensable tool in advancing the state of knowledge in the fields of inorganic, organic and physical chemistry. In chemistry the situation is more or less same as to that of the past except in certain areas. A thorough background in analytical chemistry is thus a vital

necessity for all those who aspire to be chemist or manager in these 'areas' regardless of their field of specialization.

The role of chemical analysis in modern industries is difficult to overestimate. Virtually every item of commerce has been subjected to analytical testing at one or more stages in its manufacture. This is true not only for metals and minerals but even for the clothes we wear, the food we eat, the drugs we require, the automobile we drive. All these and many more require the aid of chemical analysis to assure the production of goods having uniform quality and characteristics. Here one should remember that study of quantitative analysis requires development of systematic and orderly work habits as well as intellectually honest observations. These traits are worthy of cultivation regardless of one's ultimate field of endeavour.

Finally in every quantitative analysis, there is a final measurement whose magnitude can be related to the amount of species being estimated. We can classify the methods of quantitative analysis according to the nature of final measurement. Thus in gravimetric analysis the final measurement is weight, in volumetric analysis it is volume and in instrumental analysis various physical parameters are measured.

As it is not possible to describe all the conventional and instrumental techniques, some of the important instrumental analysis are described below.

ATOMIC ABSORPTION SPECTROPHOTOMETRY

This is one of the modern instrumental techniques which has probably seen the fastest growth rate due its simplicity, versatility, reproducibility specific and less interfering nature. The method is excellent for analysing at trace level

but it is also highly reliable for estimating major constituents.

In this technique a solution containing a metallic species is aspirated into flame (flameless technique is also used) resulting the formation of an atomic vapour. Some of the metal atoms are raised to a higher energy level to emit the characteristic radiation of that metal. This phenomenon is utilised in emission flame photometry. An overwhelmingly larger percentage of the metal atoms will remain in the non-emitting ground state. These ground state atoms of a particular element are receptive of light radiation of their own specific resonance wavelength. Thus, light of this particular wavelength is passed through this atomic cloud, part of the radiation will be absorbed. This absorption is proportional to the density of the atoms in the flame. This phenomenon is utilized for the quantitative estimation of unknown constituents using standards for calibration.

X-RAY SPECTROSCOPY

When a material is exposed to a heavy stream of X-rays, then secondary X-rays of specific wavelengths are produced. The intensity of these X-rays are proportional to the concentration of characteristic elements. Unknowns are made knowns by measuring fluorescence radiations of standards and analyte

LATEST TRENDS IN CHEMICAL ANALYSIS

Laser Micro Analysis

In this technique sample is evaporated by laser. Plasma produced by laser is focused thro' entrance slit of a spectrometer and intensity is measured. It can be used for local micro analysis.

Photoacoustic Spectroscopy

In this technique photoacoustic signal is generated and detected. Expansion in solid, liquid and gas is employed. Few instruments in some developed countries are available.

Ultrafast Spectroscopy

Though it is receiving attention in analytical community but still it is far from being a common place. It is expected that analysis will be done in less than a milli-second using laser technology. Ultraelectronics will replace the mechanical parts.

CONCLUSION

Analytical technique depends upon various factors. Some of them are:

- (a) Nature of business
- (b) Objective
- (c) Goal
- (d) Investing capacity
- (e) Level of accuracy desired
- (f) No. of samples to be analysed
- (g) Desired speed of analysis

The above factors are in fact critical in the organizational design of analytical services. Analytical laboratory in an industry pays attention on economy; in university it helps in creative research and training whereas in Government departments it gives priority for the mission of the agency. Organization of any chemical analytical laboratory should be such that it can meet any future challenge of analysis. If these requirements are overlooked in design the scenerio will change and each new business venture will require readjustment in the analytical structure.