Mass Spectroscopy
Essays
Physics class section 11

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1 Definition

Mass spectrometry (MS) is an analytical chemistry technique that helps identify the amount and type of chemicals present in a sample by measuring the mass-to-charge ratio and abundance of gas-phase ions. The mass spectrometer is an instrument which can measure the masses and relative concentrations of atoms and molecules. It makes use of the basic magnetic force on a moving charged particle.

2 Basic Principle

A mass spectrometer generates multiple ions from the sample under investigation, it then separates them according to their specific mass-to-charge ratio (m/z), and then records the relative abundance of each ion type.

The first step in the mass spectrometric analysis of compounds is the production of gas phase ions of the compound, basically by electron ionization. This molecular ion undergoes fragmentation. Each primary product ion derived from the molecular ion, in turn, undergoes fragmentation, and so on. The ions are separated in the mass spectrometer according to their mass-to-charge ratio, and are detected in proportion to their abundance. A mass spectrum of the molecule is thus produced. It displays the result in the form of a plot of ion abundance versus mass-to-charge ratio. Ions provide information concerning the nature and the structure of their precursor molecule. In the spectrum of a pure compound, the molecular ion, if present, appears at the highest value of m/z (followed by ions containing heavier isotopes) and gives the molecular mass of the compound.

3 Calculations

3.1 Formular in accelerator

$$r = \frac{mv^2}{qvb} = \frac{mv}{qb}$$

If the velocity v is produced by an accelerating voltage V:

$$k(gain) = U(loss)$$

$$\frac{1}{2}mv^2 = qv$$

$$v = \sqrt{\frac{2qv}{m}}$$

After substitutions:

$$r = \frac{1}{B}\sqrt{\frac{2mv}{q}}$$

3.2 Velocity selector with B,E

Mass spectrometers are sensitive detectors of isotopes based on their masses. They are used in carbon dating and other radioactive dating processes. The combination of a mass spectrometer and a gas chromatograph makes a powerful tool for the detection of trace quantities of contaminants or toxins. A number of satellites and spacecraft have mass spectrometers for the identification of the small numbers of particles intercepted in space. For example, the SOHO satellite uses a mass spectrometer to analyze the solar wind.

$$F(B) = F(E)$$

$$qvb \times sin(90) = qE$$

$$vb \times 1 = E$$

$$V = \frac{E}{B}$$

3.3 Radius of path produce by magnetic field

If a charge moves into a magnetic field with direction perpendicular to the field, it will follow a circular path. The magnetic force, being perpendicular to the velocity, provides the centripetal force.

$$F(net) = ma$$

$$qvb \times sin(90) = m \times \frac{v^2}{r}$$

$$qB = m \times \frac{v}{r}$$

$$\frac{q}{m} = \frac{v}{rB}$$

The image above is a diagram of the mass spectroscopy result, the chart recorder mark down all the data. The data is often managed and organized as a stick diagram. This shows the relative current produced by ions of varying mass/charge ratio.

4 Sources

1. "OpenStax CNX." OpenStax CNX. N.p., n.d. Web. 26 Oct. 2015.

2. "Mass Spectroscopy." Wikipedia. Wikimedia Foundation, n.d. Web. 26 Oct. 2015.

3. "Simple Explanation of the Mass Spectrometer." YouTube. YouTube, n.d. Web. 26 Oct. 2015.