can be obtained: chemical shifts, spin-spin coupling constants, resonance intensities (the number of nuclei) and relaxation times. These parameters are useful for the structural determination, the identification and the quantitative analysis of molecules. Spin decoupling, nuclear Overhauser effect, and two-dimensional NMR techniques are also available for the structural analysis.

Spectrometer

There are two types of spectrometers.

(1) Continuous wave NMR spectrometers.

(2) Fourier Transform NMR spectrometers.

Measurement

Prior to measurements, the sensitivity and resolution of the instrument must be adjusted to the best conditions using the standard sample (ethylbenzene, *o*-dichlorobenzene or acetaldehyde) dissolved in an appropriate NMR solvent or carbontetrachloride.

(1) The sample dissolved in a relevant solvent is transferred into an NMR tube. The reference compound can be added directly to the sample solution (internal reference), or a sealed capillary tube containing the reference compound can be inserted into the NMR tube (external reference). The sample solutions should completely be homogeneous. Particularly solid contaminants should be removed in order to obtain good spectra. Various deuterated NMR solvents and carbontetrachloride are used for the ^{1}H-NMR and the following considerations should be paid for selecting an appropriate solvent: (i) The solvent signals do not overlap with the sample signals. (ii) The sample must be soluble in the solvent selected. (iii) The solvent does not react with the sample. Furthermore it should be noted that chemical shifts can depend upon solvents employed, sample concentrations and deuterium ion concentrations and that viscous solutions usually give rather broad, poorly resolved spectra.

(2) Tetramethylsilane is usually used as the reference compound for samples dissolved in organic solvents. For samples dissolved in deuterium oxide, sodium 3-(trimethylsilyl)propane sulfonate or sodium 3-(trimethylsilyl) propionate is used.

(3) When it is required to compare the spectrum with that of the authentic sample for identification, the measurement conditions, such as the oscillator frequency, the solvent and the concentration, should be the same with those for the authentic spectra.

40. Optical Rotation Determination

The Optical Rotation Determination is a method for the measurement of the angular rotation of the sample using a polarimeter.

Generally, the vibrations of light take place on planes perpendicular to the direction of the beam. In the case of ordinary light, the directions of the planes are unrestricted. In the case of plane polarized light, commonly designated as polarized light, however, the vibrations take place on only one plane that includes the direction of the beam (plane of polarization). Some drugs in the solid state or in solution have the property of rotating the plane of the polarized light either to the right or to the left. This property is referred to as optical activity or optical rotation, and is inherently related to the chemical constitution of the substance.

The extent of the rotation, expressed in degrees of rotation of the angle of the plane of polarized light caused by the optically active substance or its solution, is measured with a polarimeter. This value is proportional to the length of the polarimeter tube, and is related to the concentration of the solution, the temperature and the wavelength. The character of the rotation is indicated by placing a plus sign (+) for that which rotates the plane of the polarized light to the right, when facing the direction of the beam, referred to as dextrorotatory, or a minus sign (−) for that which rotates the plane to the left, referred to as levorotatory, before the number indicating the degrees of rotation, as like as +20°, meaning 20° to the right, or −20°, meaning 20° to the left.

The angular rotation α_x^t is that which is measured with specific monochromatic light of x (described in terms of the wavelength or the name) at a temperature of t°C. Usually the measurement is performed at 20°C, with a polarimeter tube of 100 mm in length, and with the D line of sodium as the light source.

The specific rotation is represented by the following equation:

$$[\alpha]_x^t = \frac{100\,\alpha}{lc}$$

t: The temperature of measurement.

x: The wavelength or the name of the specific monochromatic light of the spectrum used (in the case of the D line, described as D).

α: The angle, in degrees, of rotation of the plane of the polarized light.

l: The thickness of the layer of sample solution, i.e., the length of the polarimeter tube (mm).

c: For the purpose of the Pharmacopoeia of Japan, the number of grams of a drug present in 1 mL of the solution. When an intact liquid drug is used for determination, not in solution, c represents the density. However, unless otherwise specified, the specific gravity is used instead of the density.

The description, for example, "$[\alpha]_D^{20}$: −33.0 – −36.0° (after drying, 1 g, water, 20 mL, 100 mm)," in a monograph, indicates that the $[\alpha]_D^{20}$ is between −33.0° and −36.0° in the determination in which the substance is dried under the conditions described in the test for Loss on Drying, and about 1 g of the substance is accurately weighed, and dissolved by adding water to make exactly 20 mL, then the solution is measured with a polarimeter tube 100 mm in length.

41. Osmolarity Determination

Osmolarity determination is a method for measuring the osmotic concentration of the sample solution from the extent of the freezing-point depression.

When a solution and a pure solvent are separated by a semipermeable membrane, through which the solvent can pass freely, but the solute cannot, a part of the solvent passes into the solution compartment through the membrane.