APPLICATION NOTE – USING POLARIMETRY FOR PHARMACEUTICAL APPLICATIONS

Application Need: Pharmaceutical companies often need to analyze a substance's structure, but samples are expensive and sometimes non-duplicable. Analysis must be accurate and use as small a sample as possible.

Solution: Use Reichert's polarimeters for analysis. Polarimetry is employed in quality control, process control, and research in the pharmaceutical, chemical, essential oil, flavor, and food industries. It is so well-established that the United States Pharmacopoeia and the Food and Drug Administration include polarimetric specifications for numerous substances.

Polarimetry Fundamentals

Polarimetry is a sensitive, non-destructive technique for measuring the optical activity exhibited by inorganic and organic compounds. A compound is considered to be optically active if linearly polarized light is rotated when passed through it. The amount of optical rotation is determined by the molecular structure and concentration of chiral molecules in the substance. Each optically active substance has its own specific rotation as defined in Biots law:

$$[\alpha]_{\lambda}^{T} = \frac{\alpha_{\lambda}^{T}}{c \cdot l}$$

$[\alpha]$ = specific rotation, l = optical pathlength in dm; λ = wavelength, T = temperature, α = optical rotation, c = concentration in g/ml.

The polarimetric method is a simple and accurate means of determining a substance's structure in macro-, semimicro, and micro-analysis of expensive and non-duplicable samples.

Polarimetry Uses

Polarimetry measurements can be used to determine the concentration and purity of the following substances in liquid pharmaceutical samples:

- Amino acids
- Amino sugars
- Analgesics
- Antibiotics
- Cocaine
- Codeine
- Dextrose
- Serums
- Steroids
- Tranquilizers
- Vitamins

How to perform a measurement

This section gives an example of measuring a mixture of L- and D-glutamic acid.

Calculate the specific rotation, [a], of the sample according to

$$[a] = a / (c * l)$$

where *a* represents the observed rotation, i.e., the reading from the polarimeter, *c* represents the concentration of the sample in grams per milliliter (g/mL), and *l* represents the length of the sample container in centimeters (cm).

For the example, if a sample prepared from 1.5 g of optical material dissolved in water to a final volume of 10 mL and measured in a 5.0 cm cell was determined to have an optical rotation of +3.5 degrees, then the concentration would be 1.5 g / 10 mL = 0.15 g/mL, and [a] = 3.5 / (0.15 * 5.0) = 4.7.

To find the specific rotation of one of the enantiomers in the mixture in its pure form, you can use dictionaries of organic compounds, specialized books, or search the internet.

If the compound under investigation is a mixture of L- and D-glutamic acid, then L-glutamic acid exhibits a specific rotation of +12 degrees.

Calculate the enantiomeric excess (*x*) according to

$$x = (\text{observed specific rotation}) / (\text{specific rotation of pure enantiomer}) * 100\%$$

For this example, glutamic acid: x = (3.5 /12) * 100% = 29%.

This means that the sample contains a 29 percent excess of L-glutamic acid. Or, because the percentages of the D- and L-enantiomers must sum to 100 percent, then the sample contains 64.5 percent L-glutamic acid and 35.5 percent D-gluamic acid.

Reichert Polarimeters

Reichert has been a leader in the development and manufacture of optical instruments for over 150 years. This expertise has resulted in the most accurate polarimeters on the market. Reichert instruments are unique in that they provide a linear response and maintain accuracy over the entire reading range. Most other instruments are accurate only at small angular rotations. Choose Reichert polarimeters for:

- Ultimate accuracy throughout the reading range
- Robust, low-maintenance construction
- Modular design to combine with refractometers and density meters