Technical basics polarimetry

Classical physics teaches that light consists of electro-magnetic waves, whose vibrations are transverse to the direction of propagation. Polarized light is light, which's vibration pattern exhibits preference. If natural light passes through a so called polarizing filter, most of it's other vibrating directions will be filtered out, leaving only one specific direction. If this light is oscillating then in only one direction, it is called "linearly polarized".

There is a great number of organic and inorganic substances being optically active in their crystalline, liquid or dissolved state. That means, these substances are able to rotate the direction of oscillation of polarized light around a determined angle. Typical optically active substances contain at least one asymmetric atom in their molecule structure. Such atoms are (Carbon), sulphur, phosphor, silica and few others. This asymmetry leads to the formation of two mirror images, which are called enantiomorphs.

In general, the rotation of natural substances introduced into a sample tube at 20°C will be described and measured by a so called polarimeter.

To determine the exact compensation position, SCHMIDT+HAENSCH uses Faraday modulation as an electronic enhancement. Without mechanical transmission by a V-belt or gear being necessary, we apply a direct coupling of optical encoder and analyzer in all measuring instruments.


Optical rotation is measured in a so called measuring tube at 20°C under normal pressure and, most important, its wavelength. The quartz and the sample react in an identical way to different optical wavelengths. The rotation of a sucrose solution will linearly increase with higher temperatures.

As the quartz and the sample react in an identical way to different optical wavelengths. The rotation of a sucrose solution will linearly increase with higher temperatures. For example, this is achieved today with a halogen lamp and an interference filter with a narrow spectral half width. The quartz wedge principle

Quartz has an optical rotation dispersion (ORD) almost identical to that of a sucrose solution. This fact is exploited as a unique compensation mechanism using a quartz wedge in SCHMIDT+HAENSCH'S SACCHAROMAT®. When a sample is introduced, the quartz wedge slides into the optical path (equivalent to changing the thickness of the quartz) to a point where the optical rotation of the sample is exactly compensated. The position of the wedge is then determined by a linear encoder, giving rise to a very precise measurement. The principle of quartz wedge compensation is unique and is unrivalled today. With its high precision and high reliability it is used throughout the sugar industry.

As the quartz and the sample react in an identical way to small shifts of the wavelength, these shifts are beeing automatically compensated and the effect becomes irrelevant. This ensures highest wavelength stability without the necessity of recalibration over the lifetime of the instrument. The quartz wedge principle also results in higher optical light input allowing very dark solutions to be easily measured.

- Little influence of wavelength shifts
- Long time stability of measured values without calibration being necessary

<table>
<thead>
<tr>
<th>Description</th>
<th>Wavelength [nm]</th>
<th>[α]</th>
<th>[β]</th>
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</thead>
<tbody>
<tr>
<td>Mercury green</td>
<td>546.2 nm</td>
<td>54.6°</td>
<td>43.9°</td>
</tr>
<tr>
<td>Sodium yellow</td>
<td>589.4 nm</td>
<td>38.0°</td>
<td>35.8°</td>
</tr>
<tr>
<td>Ne-Laas</td>
<td>589.0 nm</td>
<td>589°</td>
<td>589°</td>
</tr>
<tr>
<td>NIR</td>
<td>882.6 nm</td>
<td>39.9°</td>
<td>39.9°</td>
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Flow-Through tube with 1 Sensor

Temperature effects

The measured optical rotation values depend on the temperature. The rotation of quartz for example raises with higher temperatures:

Rotation (α) = rotation (20.0°C) x (1.0 + 0.000144 x (T-20.0°C))

A quartz plate, showing a value of 40.000° ang at a temperature of 20°C, will give a value of 40.005° ang at 21°C and the value will even raise to 40.029° at 25°C already.

In contrast, the rotation of a sucrose solution will decrease with rising temperature:

Rotation (α) = rotation (20.0°C) x (1.0 - 0.000471 x (T-20.0°C))

A solution indicating 40.000° ang at a temperature of 20°C, will indicate only 39.981° ang at 21°C and just 39.906° ang at 25°C.

Please consider, there are three temperature effects on diluted samples:

1. The flask, which is applied to fill up the 100 cm³ is calibrated for 20°C.
2. The length of the tube is valid for 20°C.
3. The optical activity of the sample is influenced by the temperature.

The formula given above only counts for the third effect. To compensate all temperature effects, the SACCHAROMAT® quartz wedges are equipped with a temperature sensor that is also optionally available for the tubes. SCHMIDT+HAENSCH guarantees for the precision of its Polimeters only as long as original SCHMIDT+HAENSCH measuring tubes are used. These tubes offer a certified tolerance in length (0.02 mm for a 200 mm tube, 0.01 mm for a 100 mm tube.). To measure unclarified samples, SCHMIDT+HAENSCH recommends the system AutoFilt®. This semi automatic filtration system filtrates an industrial sugar solution to a turbidity-free state within 30 sec. maximum.