Refractive Index

PRINCIPLE

The index of refraction of a substance is the ratio of the velocity of light in a vacuum to its velocity in the substance. This, in turn, is dependent on composition, concentration (e.g. dry substance) and temperature of the substance. When solids composition and temperature are known, index of refraction is a measure of dry substance (Note 1).

SCOPE

The method is applicable to corn syrup (including those containing high fructose), maltodextrin solutions, dextrose and sucrose solutions, invert sugar and blends.

SPECIAL APPARATUS

1. Refractometer: An instrument is necessary with a range of indices from 1.32 or lower to 1.53 or higher, accurate to 0.0001 unit. It should be so constructed that samples can be introduced with ease and speed, and the instrument should be easily cleaned.

   Follow the manufacturer's instructions for use of the particular instrument. Standardize using purified water and the test block supplied with the instrument; calibration with the test block or immersion (calibration) oil must be performed at the temperature specified by the supplier.

2. Water Bath: Operate at a temperature of 20° C or 45° C. It should be sufficient in size to allow circulation of water, by means of a pump, through the refractometer so that the refractometer temperature, especially the prism faces, is controlled within ± 0.2° C of that prescribed for the bath (Note 2). Certain instruments with automatic temperature control may not need water baths.

3. Light Source: Frosted incandescent bulb.

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PROCEDURE

Dilute syrups are best applied with a dropper, while concentrated syrups are handled most conveniently with a fire-polished glass rod. After water bath and refractometer have reached the prescribed temperature, apply sample to the prism face, and close the prism in minimum time possible, so as to avoid sample concentration change (Note 3). Examine the optical field through refractometer observation lens; if the light and dark fields are not separated by a sharp line, remove the sample, clean and dry the prism faces, and apply a fresh sample. Read the index, estimating to the nearest 0.0001 unit, as soon as temperature equilibrium is indicated by constant readings (not more than 3 minutes) (Note 4). Prior to applying any sample, rinse the prism faces with purified water at the bath temperature (20°C or 45°C), to facilitate temperature equilibration.

CALCULATIONS

If desired, obtain the percent dry substance of the sample by referencing the CRA RI-DS calculation program located at http://corn.org/rids.htm.

NOTES AND PRECAUTIONS

2. If the refractometer temperature is lower than room temperature, there is a tendency for the prism to fog, especially at high relative humidities. Also, thick viscous syrups present difficulties which are best overcome at higher temperatures where their viscosities are sharply decreased. Hose connections between the water bath and refractometer must be the shortest length possible to avoid temperature differences. Hose insulation is recommended. A 1° C temperature discrepancy corresponds to a dry substance discrepancy of about 0.1%.

3. For accurate measurements, particularly with warm samples, speed in application of the sample and closing the prism is imperative. No more than 2-3 seconds should be consumed in this operation. Also, water used to rinse the prism faces should be at the measuring temperature specified.

4. When analyzing freshly prepared solutions of crystalline sugars, mutarefraction equilibrium must be attained before accurate refractive index values can be obtained. Equilibration can be hastened by heating and is obtained when the optical rotation stabilizes. In addition, solutions of pure sugars, and syrups exhibiting a crystallization tendency, must be completely free of all crystalline materials because they prohibit accurate refractive index measurement.