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Technical Bulletin

From Sap to Syrup; Maple Measurements can be Sticky.

Introduction:

The measurement of sugar content in maple sap or maple syrup is not just a matter of convenience, it is important for controlling taste, product quality, and for legal reasons.

Regionally, there are different standards for maple syrup sugar content. The range is usually between 66 to 68 percent by weight. If a product drops below 66%, there is a risk of fermentation, above 68%, some of the dissolved sugar will come out of solution as the syrup cools.

The principle unit of measure the maple syrup producer is most interested in is degrees Brix. Brix is a measure of the percentage of sugar, by weight, dissolved in a sugar/water solution. In the case of maple sap/syrup, 98% or more of the dissolved solids are made up of sucrose so the Brix scale is very applicable to maple syrup measurement.

Understanding Measurement

Metrology is the study of measurement and a branch of science into which all measuring devices, whether they are yard sticks, hydrometers, or refractometers may be classified. Measurement instruments, refractometers being no exception, are often classified by metrological terms according to their range, resolution, precision, and accuracy. It is important to understand the differences between these concepts when using any testing instrument.

What does all this mean for testing maple syrup? Well, measuring maple syrup can present a sticky situation.

Maple syrup requires an instrument, or series of instruments, which span a rather large range. Sap, at the low end of the range, is typically one to five Brix. Concentrated sap, whether derived through reverse osmosis or boiling, can range anywhere from five to 66 Brix. While syrup can be anywhere from 66 to 70 Brix.

To make matters more complicated, most measurement systems have some temperature dependency. Maple sap may be tested at 0 °C (32 °F), while boiling syrup is tested at the other extreme end of the spectrum. This wide temperature range makes it difficult for any one measurement instrument to provide the resolution and precision needed across the full range.

There are a number of different instruments that can be used to measure maple syrup. They are briefly presented here with a discussion of their inherent strengths and weaknesses.

Hydrometers

Density is the ratio of the weight of a substance compared to the volume or space that it occupies. It is closely related to specific gravity, a dimensionless quantity, comparing the density of a substance to an equal volume of water at a particular temperature.

Hydrometers have long been used to measure specific gravity, and there are hydrometers which read directly in Brix instead of specific gravity. To use a hydrometer, you must first have one that covers the range you are interested in. It will usually take several hydrometers to accurately cover the range required by maple syrup production.

Once it is determined that a hydrometer is suitable for a particular range of measurement, a sample is poured into a glass cylinder. The hydrometer is floated in the cylinder along with a thermometer. The thermometer is absolutely necessary because hydrometer readings are very dependent on temperature. Once the temperature stabilizes, a reading may be taken at the point the meniscus (the curved surface of a liquid in a narrow-diameter glass tube) crosses the hydrometer scale, while noting the temperature reading from the thermometer. A chart must be used to then manually compensate for the temperature of the fluid; this manual conversion adds another layer of potential error to the measurement.

The drawbacks to a hydrometer are: that they are breakable; there is no way to calibrate them; their range is limited; they must be manually temperature corrected; the process involves a large fluid sample; there is a lot of cleaning between samples; and the process is slow and time consuming.

Hydrotherm

The Hydrotherm is a hydrometer with a thermometer built in. It simplifies measurement because it is not necessary to have a separate thermometer. Hydrotherms suffer from some of the same problems as hydrometers, plus the US department of Agriculture does not recommend them because they are not calibrated to a particular standard.

Refractometers

A refractometer is more accurate than a hydrometer, requires a smaller sample size, eliminates sources of error, is easily cleaned and reduces the time that it takes to measure maple sap and syrup.

There are two main types of refractometers for field use. The first type is a traditional handheld refractometer that requires you to place a sample at one end and then look at a tiny analog scale through an eyepiece at the other end. It usually takes two traditional refractometers to cover the full range required for maple sap and syrup.

The second type of refractometer is a digital handheld refractometer that allows the user to place a small sample in a well, press a button and get a digital readout.

Refractometers, like the hydrometer, are also temperature dependent, so the only instruments that are useful for maple syrup production are refractometers that are automatically temperature compensated.

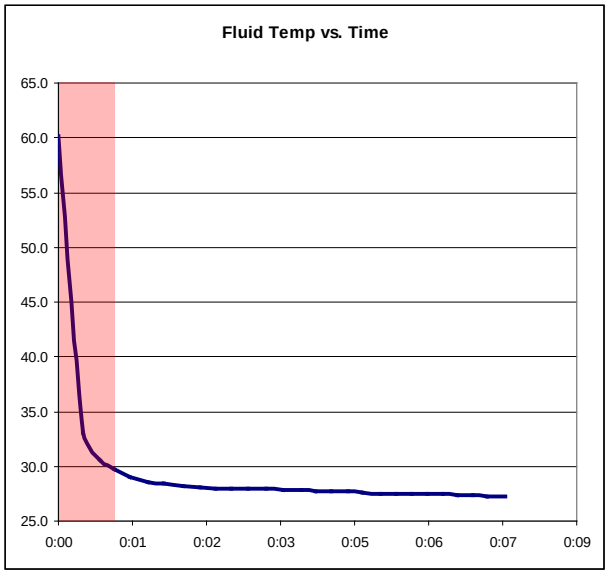
It is essential that the refractometer that you are using is automatically temperature compensated for the temperature range at which you are testing. Many traditional handhelds are only temperature compensated to about 40 °C (104 °F).

When taking measurements, it is always important that the sample, the instrument, and the ambient temperature are in equilibrium before taking a measurement.

The eMaple Digital Refractometer from MISCO has a range from 0 to 85 Brix and was designed specifically for the maple syrup industry. The eMaple refractometer features two scales for measuring both hot and cold fluids.

Measuring Hot Fluids

As hot maple syrup is applied to the sample well of the refractometer, the instrument optics are shocked by the instant temperature change. You can see from Figure #1 that in the first 45 seconds after applying a hot sample to the refractometer, there is a rapid drop in the temperature of the fluid.



The rate of change (time vs. temperature) is very steep, and there is not time for the fluid, instrument, and ambient temperature to come to an equilibrium. Although the instrument has automatic temperature compensation, the rate of change is so steep that it is impossible to get a stable reading for nearly the first 60 seconds.

The MISCO eMaple approaches hot fluid measurement in two ways. First, the eMaple has special electronic circuitry to prevent the display of readings before the temperature has stabilized. Second, because of the difficulty in reporting stable readings of hot syrup, there are two scales on the eMaple.

The first scale is a high-precision scale with a precision and resolution of 0.1 Brix for measuring sap and syrup with a stable temperature below 30 °C (86 °F).

The second scale is a high temperature scale for testing syrup above 30 °C (86 °F). Although the resolution of the scale is in whole numbers (no decimal), the user will get a stable repeatable reading within +/- 0.5 Brix with every press of the GO button.

Once the scale is selected, the user simply places one or two drops of maple syrup, or maple sap, on the refractometer measuring surface, waits 30 to 60 seconds and then presses the GO button. The temperature compensated reading is nearly instantly displayed on the large 24-character text display.

The eMaple Refractometer features a stainless steel sample well, an evaporation cover, and a 1,024 element measuring array. The eMaple Refractometer can be easily calibrated to a drop of water at the touch of a button. There are even special NIST traceable calibration fluids available if required by your quality control policy.

Summary

The measurement of maple syrup is necessary for quality control and for meeting certain regional standards.

Refractometers overcome many of the limitations of hydrometers and Hydrotherms and allow for faster, more accurate and more reliable measurements.

The MISCO eMaple refractometer is designed specifically for the demanding needs of maple syrup production. It has the necessary range, resolution, and precision required for measuring everything from sap to syrup.

Please visit the MISCO website at www.misco.com for detailed information concerning specific refractometer models or call toll free 800-358-1100 for help with application issues.

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