When is it Syrup?

Tools and techniques for measuring syrup density

One of the most important skills for sugarmakers to master is knowing when what's boiling in the evaporator has become syrup. Quality control is key, and packaging syrup too dense or not dense enough will ruin the best of any sugarmaker's efforts. No one wants to put a lot of work into tapping, gathering, boiling, filtering, and packaging, only to find that their syrup is spoiling on the shelf.

The unit of measure most often used for syrup density is Brix – one Brix is equal to about 1% sugar content. The correct density for maple syrup is between 66° and 68° Brix, with some local jurisdictions that have strict maple laws requiring a narrower range.

Using proper equipment to measure sugar content is important not only because of regulations, though. If your finished product is below 66° Brix it will likely become moldy and ferment, and if it is above 68° Brix it will form sugar crystals in the bottom of the container. Both situations lead to negative experiences for your customers and likely lost future sales. Controlling this is avoidable with care and the proper use of one or more methods available to measure syrup density.

The boiling process makes sap more dense as the water steams away and the sugars stay behind and get more concentrated. As the liquid gets denser it gets heavier, darker, and sweeter. Some sugarmakers make an effort to finish their syrup on the denser or 'heavier' side, thinking that their customers prefer the thicker 'mouth feel' and sweeter or stronger flavored product. The heavier the syrup the harder it is to filter, however, and it is also not economically wise, as it means putting more sugar into each jug without the benefit of being able to charge a higher price. It is important to keep the density of finished syrup

Syrup that is packaged at improper density can result in mold or crystals forming. Customers who discover either of these in their syrup will develop a negative impression of your products, and of pure maple syrup in general.

at no lower than 66° Brix and no higher than 68° Brix. Maintaining consistent density also helps assure that your customers are buying a familiar product and will return year after year for your pure maple products.

There are many tools and methods available from your local maple equipment supplier for determining when syrup has reached the correct density. As with any tools, each must be used properly to achieve accurate and consistent results. Most sugarmakers use a combination of two or more of these tools and practices to double-check and ensure that they are making the best syrup possible.

Thermometer

Syrup is denser than water, and so boils at a higher temperature than water. Syrup measuring 66° Brix will boil at 7.1° Fahrenheit higher than the boiling point of water.

While the common reference for the boiling point of water is 212° Fahrenheit, the reality is that this threshold changes depending on altitude and on climatological conditions. Since air is thinner and thus there is lower ambient pressure at higher elevations, the boiling point of water is lower. Water boils at 212° at sea level, but that number is closer to 210° at 1,000 feet, for example. Because much of the sugaring region is hilly, the boiling point varies significantly throughout.

At the same time, the natural atmospheric pressure changes brought about by changes in the weather will affect the boiling point of liquids. On a clear, sunny day the boiling point may be a few degrees higher than on a day when a low pressure front moves through. Since sugaring season is often marked by variable weather, the boiling point of water and syrup can change from day to day, or even within the course of a day.

To use temperature to accu-

rately test when syrup is at the proper density, you must have an accurate reading for the current boiling point of water. To do so, boil a small pot of water – NOT sap – in the same room as your evaporator. Bring it to a rolling boil for three minutes, and use a thermometer to measure its temperature. Many thermometers made for syrup production provide an adjustable scale specifically to accommodate for changes in boiling points.

There are a range of stem thermometers available. Most can be adjusted using a screw or nut where the stem meets the dial, allowing the user to calibrate it against another thermometer. Some thermometers have a scale that allow you to set the reading at zero when measuring boiling water, so that a reading of 7.1° will be the indicator of finished syrup, while others have a scale that simply indicates the real temperature. Unless you are sure that all of your thermometers are calibrated accurately, be sure to use the same thermometer that you used to measure boiling water to check your syrup. There are also digital thermometers which can be calibrated in a variety of ways, based on the instructions that come with the unit.

A thermometer that goes into a fittting in the evaporator pan can be quite handy. One that can be adjusted to accomodate changing boiling temperatures even more so.

Thermometer stems should be stainless steel, clean, and not rusted or coated with sugar sand, as such buildups will make the readings less accurate. Use soft materials to clean the thermometers between uses, as scraping them with anything hard or abrasive can scratch them and lead to inaccurate readings.

Some evaporators' syrup pans have threaded fittings near the draw-offs where thermometers can be installed, so sugarmakers can easily read the temperature of the boiling liquid. These can usually be removed easily (not when boiling or when there is syrup in the pan) and calibrated in boiling water before re-installing.

Hydrometer

A hydrometer is a tool designed exclusively to test density of a liquid. There are a number of types

Lower the hydrometer into the cup gently, so it doesn't break. Have at least one spare, in case it does.

of hydrometers made specifically for testing syrup, and purchasing good ones is an excellent investment for a sugarmaker.

The most common type of hydrometer is a glass tube with a weighted bulb at the bottom and a paper scale running up the inside of the tube. By setting the hydrometer in a column of syrup, usually a hydrometer cup, an accurate density measurement can be taken based on where the scale of the hydrometer floats at the top of the liquid.

To use this type of hydrometer properly, warm the stainless steel hydrometer cup first by filling it with hot syrup that you then pour back into the pan, because a cold cup will cool off the syrup sample too quickly and yield an inaccurate reading. Fill the cup all the way with hot syrup to eliminate any foam on the surface of the sample before placing the hydrometer in the cup.

Your hydrometer should be clean, and it should be dry or have just a thin film of water on it. Lower it gently into the cup – dropping it will let it hit the bottom and likely crack or break. Allow it to settle for a moment, and when it stops bobbing note the Brix reading on the scale at the top of the syrup. You will need to compensate for the meniscus, the slight curvature of the surface of the syrup up toward the hydrometer – the accurate reading should be taken at the flat part of the surface, not the top of the meniscus where it touches the glass.

If you place the hydrometer in the cup quickly enough after drawing the syrup off the evaporator, the syrup should still be at or above 211°, as measured by a thermometer. A reading of 211° is hot enough to rely on what most hydrometers label as the 'hot test' line, a red line that, if entirely

visible just at the surface of the syrup, means the density is 66° Brix. (Note that hydrometers are calibrated by the manufacturers and some states have them calibrated for higher density, so read the instructions and the scale carefully.) If that line is significantly higher than the surface the syrup is too dense and should be adjusted by adding hot sap or concentrate to the syrup pan. If the red line isn't visible at all the syrup is too thin and needs to be boiled down further.

If you are testing syrup that is not hot from the evaporator, you will need to check the temperature of the syrup and compensate for the reading using a table that usually comes with the hydrometer or can be found online or in the *North American Maple Syrup Producers Manual*. The cooler the syrup the higher the hydrometer will float in the test cup.

Never place a hydrometer in the evaporator pan itself. Not only will you likely burn your hand, but the syrup level is not deep enough to float the hydrometer. If the hydrometer breaks you'll have shards of glass in your syrup, resulting in you having to dispose of the entire batch and clean the pans.

As with thermometers, hydrometers should be cleaned carefully to avoid a buildup of niter or syrup on them. The paper scales inside them can shift and become inaccurate, so having at least two hydrometers and checking them against each other often to ensure they are both giving the same reading is strongly recommended. Hydrometers are very fragile and prone to breaking, and if you break one mid-season you will want to have a spare. Note that there are differently calibrated hydrometers that are used to measure the density of sap. These are not interchangeable with those used for syrup.

A hydrometer, hydrometer cup, and stem thermometer are inexpensive and important tools for determining syrup density.

Hydrotherm

A less common tool for checking density is a hydrotherm. It is shaped like a hydrometer, but has a built-in thermometer that allows the user to adjust the reading to compensate for the temperature of the sample as it fluctuates. It is used in much the same way as a hydrometer, in that it is gently lowered into a column of hot syrup, but it is read differently in that the thermometer portion has a scale on it that corrects for temperature variations. When using a hydrotherm the user needs to wait about a minute immersing it in the cup of syrup, as it takes time for the thermometer to adjust to the actual temperature.

Refractometer

Optical and digital refractometers measure density based on light refraction through a liquid, which varies based on density.

Optical refractometers are used by placing a drop of syrup on the clean glass window at one end of the tool, and looking through the eyepiece at the other. When viewed, the syrup casts a shadow on a scale that indicates the density. Using this type of refractometer with hot syrup is not recommended. These tools need to be calibrated from time to time, to ensure accurate readings.

To operate a digital refractometer, a drop of syrup is placed on the small clean glass plate of the tool and a digital readout reports the density. Most of them compensate for temperature variations. These also need to be calibrated, either with distilled water or a calibration solution.

As with most sensitive scientific measurement tools, cleaning refractometers carefully is very important, using soft cloths to

Optical and digital refractometers are excellent tools for testing the density of syrup.

avoid scratching the glass elements. Any scratches, or buildups of syrup if not cleaned often, will likely result in inaccurate readings.

Automatic draw-off

Another excellent tool to ensure proper density syrup is an automatic draw-off. This is an electronic solenoid valve mounted on the syrup pan draw-off. It is controlled by a temperature probe placed in the syrup pan near the draw-off. The sugarmaker inputs the temperature at which syrup is to be drawn off at the proper density. The valve automatically opens when it reaches that set temperature, closing again when the syrup leaving the pan cools to a temperature below that setting.

Tool-less measurements

Before the advent of contemporary measurement tools, many sugarmakers relied on 'aproning' to tell when the syrup boiling in their pan was ready to draw off. This was done by dipping a metal scoop into the section of the pan closest to the draw-off, raising it above the pan, and watching how the syrup dripped off the edge of the scoop. If it held together, running off in 'sheets' rather than individual drops, it was considered dense enough to draw off. Aproning syrup should not be considered an accurate method of determining proper density.

The reality, however, is that syrup boiling in the pan is so hot that if it is viscous enough

An auto draw-off takes the guesswork out of knowing when syrup is at the right density, and allows for a continuous flow of just-right syrup out of the pan.

to 'sheet' in this way it is likely already too dense. Drawing off or scooping out a bit of syrup and letting it cool for a minute or so can be a more effective way to test for aproning, but even this method should only be used as a way to tell when you should start using more accurate tools to test for density.

Another tool-less way to determine that syrup is close to being ready to draw off and should be checked with an accurate instrument, is by observing the bubbles in the boiling syrup closest to the draw-off. This takes some time and experience, but a seasoned sugarmaker will notice the bubbles in nearly-done syrup get much smaller and break more rapidly than the bubbles in liquid that is still not dense enough to be called syrup.

Finally, while some sugarmakers claim that they can tell if syrup is at the proper density based on taste or 'mouth feel,' this is not an accurate nor advisable method. Not only are you likely to burn your tongue, the slight difference between 65° and 66° Brix is simply not detectable in your mouth.

Before precision tools became available to sugarmakers, aproning was the common method for determining whether syrup was done. It's still a good way to get a sense of whether a batch of syurp is getting close, but always check using modern tools.

For more information on finishing syrup contact your local maple association, or ask your maple equipment supplier about what methods are best for your sugaring operation.

Photos: pg. 1: Michal Lumsden; pg. 2: Kathy Hopkins; pg. 6 (r): Keith Bardwell.

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