

What is Reverse Osmosis, and how is it used for maple syrup production?

The short answer is that reverse osmosis is a method of removing water from the sap. Remember that all maple syrup is created by taking pure maple sap and removing the majority of the water from it to leave the sugar and other trace components. The traditional way to do this was to heat the liquid to its boiling point. The water would be boiled off as steam, leaving the other components of the sap behind in ever increasing concentration. In the middle of the 20th century maple producers discovered that you could use the physics of a reverse osmosis machine (a device created for purifying salt water for drinking) to remove the water from the sap prior to boiling.

To understand reverse osmosis, we must first understand osmosis. Osmosis is the natural movement of water across a semi-permeable membrane from an area of high concentration to an area of low concentration. A semi-permeable membrane is simply a surface that allows some things to pass through it but not other. A good example is a leaf. The surface of a leaf will allow water to pass through it, but will not allow sugar, chlorophyll, or other components of the leaf to pass. When water falls on the leaf the system “notices” that there is a higher concentration of “sugar water” inside the leaf than there is outside, so water is “sucked” inside the leaf to try and lower the concentration of sugar (this is because physics is always seeking equilibrium). The ideal solution to the high concentration of sugar inside the leaf would be to move sugar out of the leaf (so that it was equal inside and outside) but that can’t happen because the barrier is only *semi*-permeable (it will only allow water, but not sugar, to pass). A second example of osmosis is when you get shampoo in your eyes. The membrane on your eye allows water to pass but not soap, so the high concentration of the soap molecules outside your eye pulls water out. This is why your eyes hurt when you get soap in them.

Both those examples describe a process to reduce the concentration of something, but in maple syrup making we want to increase the concentration of sugar. This is why we refer to the process as reverse osmosis. By applying high pressure (often well over 200 psi, which is about 7 times the pressure in a car tire) we can overcome the natural forces of osmosis and cause the water to move backwards across the semi-permeable membrane. The result is an increasing amount of pure water on one side of the membrane and an increasingly concentrated sugar solution on the other. In the original application (purifying water) the pure water (known as permeate because it has permeated, or passed through, the membrane) was saved for use and the concentrate (because it has a higher concentration of impurities) was thrown away. In maple production we do the opposite: We throw away the pure water (or save it for cleaning or other uses) and save the concentrate.

Using reverse osmosis we can take the sap from around 2% sugar when it leaves the tree (although each tree is different and this varies during the season) to between 8% and 10%. This saves us a tremendous amount of fuel and time during the boiling process. With sap at 2%, we must remove 42 gallons of water to produce one gallon of syrup. With sap at 8% we must remove only about 10 gallons of water to produce one gallon of syrup. This allows us to be more efficient and to produce higher quality syrup.