

Ask Proctor: Tiny Bubbles

Timothy D. Perkins, Research Professor
University of Vermont, Proctor Maple Research Center,
Underhill, Vermont

Maple producers using tubing often observe bubbles emerging from the tree within the spout or first few inches of tubing when the sap is running. If the spout is not seated properly, leaks may occur. These are most noticeable as rapidly moving streams of small or large bubbles. At other times, these are not leaks, however repeated or overly aggressive attempts at seating spouts to make the bubbles stop can create leaks that further attempts at spout seating will only make worse.

If they aren't leaks, what are those really tiny bubbles coming out of the tree? Where do these come from? Why do they seem to grow in size as they come out of the tree? How do we stop them?

Of course, as scientists there are several components to this answer filled with lots of details (and math, https://mapleresearch.org/search/?_sf_s=exudation), but to simplify things, most of the extremely small bubbles we see coming slowly out of the taphole into the tubing originate as dissolved gases in sap. Within the stem, expansion of air trapped within the fibers combined with gravity pushing down on the column of sap above the taphole creates stem pressure. These pressures can reach up to about 35-40 psig – about the same pressure as the air in your car

tires. This pressure causes air within the stem to dissolve into the sap. This process is extremely important as it is the way in which maple stems fix and refill cavitated, non-functional vessels to maintain deep areas of functional sapwood. When sap that was at a relatively high pressure (35-40 psig) within the tree exits into a lower pressure tubing system (0 psig for gravity collection or up to -28" Hg under vacuum collection), the air that was dissolved in the sap comes out of solution to form bubbles. A miniscule bubble forming under pressure within the stem expands by a factor of about 3.4 times in volume when it exits the tree and reaches air pressure. If you have 25" Hg vacuum on the dropline, the bubble will expand over 4 times in volume as it exits the tree. Often these bubbles merge as they exit, forming trains of gas and liquid in the tubing system.

A good analogy is a soda. In an unopened can sitting in your fridge, the pressure is about 17 psig at a temperature of 34-37 deg F, but there are no bubbles. If you put the unopened can on the counter, the pressure inside the can will rise to about 36 psig as the temperature as the temperature reaches 70 deg F, but there are still no bubbles. If you open that can, whether straight from the fridge or after it sat on the counter, bubbles will form in response

to the lower pressure.

How do we stop the bubbles from forming? The short answer is, you don't. There is no way to prevent air coming out of the tree. The gases are naturally there dissolved in the liquid. The tree tissues produce some of these gases through their normal living processes (respiration). As air temperature goes up during the day, gas production also increases. As the pressure on the sap coming out of the taphole drops to air pressure or to the vacuum pressure in the tubing system, the bubbles will expand. These two factors (temperature rise and pressure drop) together result to bubble formation and expansion during maple sap flow. While this gas production from tapholes can contribute to reduced vacuum during hot spells, it really is only a problem if you diagnose the bubbles as leaks and attempt to fix them by overdriving the spouts.

