

SALVAGING YOUR SAP - CHECKING VACUUM LINES FOR LEAKS

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Many sugarmakers who collect sap with tubing use vacuum to increase their yield. A vacuum pump attached to a well-designed tubing system will significantly boost sap flow compared to gravity sap collection, by increasing the difference in pressure between the tree, the source of the sap, and the tubing, where we want the sap to flow. This is particularly evident during periods of slow or weeping flow, when sap pressure in the tree is barely above atmospheric pressure. A vacuum pump, however, will not deliver much, if any, vacuum to the trees if the tubing system is not tight and leak-free. This article gives basic instructions on how to check for those leaks, and how to fix them.

Although there are probably many ways to “cruise the woods” and check for leaks in a tubing system, there are three basic techniques: watching how the sap moves, listening for leaks, and using vacuum gauges. The vacuum gauge is probably the most straightforward. A gauge on your pump tells you what the vacuum level is at the bottom of your system. Maybe you are using an old rotary vane pump recovered from a dairy operation, and you can achieve 13” of mercury vacuum; or maybe you have a new liquid ring pump and you have it turned down to 22” (this article isn’t going to cover the subject of what vacuum level is best for the trees). In any case, with a properly sized pump, 1 or 1 1/4 cubic feet per minute (cfm) for every 100 taps (or about 1 or 1 1/4 hp per 1000 taps) you would hope that the trees at the end of the lines are getting vacuum that is within an inch or two of what you see at the pump.

A vacuum gauge at the pump or extractor might alert you to a problem in the woods, if you stop getting the level you expected. Or, if you have an oversized vacuum pump, the readings at the bottom of the system might be fine, but further up the lines the suction might drop off unexpectedly. In any case, you need to get out among the trees to make sure things are as they should be. With a wet line/dry line conductor system, you should have vacuum gauges on your “booster” tanks or manifolds where mainlines branch off the system. These are usually installed with a valve behind them, so that you can shut off a line, and see if this improves the vacuum level on the gauge. You would then know that the problem is down the line that was just closed. Many people using a wet line only system do not install vacuum gauges along the mainline; one reason is that sap freezing in the gauge can ruin it. As a remedy for this, Glen Goodrich suggests attaching a gauge to a 3’ length of tubing that runs up a tree, and connecting this to the mainline with a multi-fitting (“saddle”); this will keep it dry. Even without gauges in the woods, if you have valves on each mainline you can close them one at a time and walk back to the gauge at the receiver or pump (or use a radio to call your partner) to see if you have isolated a problem.

Another use for a gauge is to carry one on your tubing repair trips, and pull a spout at the end of a line to check the vacuum level there. To prepare the gauge, screw on a piece of pipe with some tubing on the end. You can make a tight seal to a health spout using a piece of 5/16” tubing; for 7/16” spouts use 1/2” milk hose. After attaching the gauge, wait about 30 seconds for the vacuum to come back up. If the reading is different from the pump by more than a couple of inches, then you are losing vacuum somewhere on this line. Peter Purinton used to carry a vacuum gauge into the woods but now just

pulls a spout and puts it on his tongue. If it stings, the vacuum is ok at that point. It might take a few years to calibrate your tongue to different vacuum levels.

Follow the mainline into the woods, checking for leaks. Although most leaks will be in the lateral lines, several things can happen to the mainline that can cause significant vacuum loss. Feel the line for chews. Wood peckers and other animals might be pecking or biting out of curiosity. Electrical tape makes a good seal over small holes. Keep in mind that tape repairs will hold vacuum, but may not hold up if you pressure wash the tubing (a hose clamp over these repairs makes them sturdier). If mainline fittings are put on to black mainline using too much heat, or not enough, they may leak or even come apart. If the mainline comes apart it could have a short gap that isn't so noticeable, where sap shoots across, pulled by the vacuum. These gaps will drip sap, and they will result in a huge loss of vacuum above the gap. Older mainline occasionally develops cracks and whole sections may suddenly need to be replaced. Carry some flagging to mark really big problems while you go back for more tools.

To spot most leaks, which will be on the 5/16" lateral lines, you need to watch the sap, and listen. Seeing sap movement is only possible with transparent or semi-transparent tubing, so if you still have, old, dirty, hard-to-see-through PVC tubing in your woods, this is another reason to replace it. Watching the rate of the movement of sap is essential to judging whether or not air is leaking into the system. Sap should move slowly; at times it may not appear to be moving at all. Remember that it comes out of the tree a drop at a time, in combination with gas which also comes from the tree, and so is usually seen in the tubing as small slugs or "boxcars" as Brian Stowe calls them, separated by air space. These bits of sap slowly inch their way down toward the mainline. In a leaking system, air, not from inside the tree but from the stuff that is all around us, is being pulled into the tubing by the vacuum pump, and causes the sap to appear to race through the tubing. Leaking air may cause the sap to appear to flutter, ripple, or move back and forth; this indicates a leak somewhere above the point where you are looking.

The first place to check the movement of sap is at the beginning of each lateral line. The newer system of attaching the lateral to the mainline support wire with a hook fitting, a "harness" and then into the mainline with a short loop, is very useful for seeing sap movement. At this loop, the sap must run uphill for a short distance, so it should pool up at the bottom of the loop. Here you can see whether sap is moving slowly, as it should, or fluttering because air is leaking into the line. As soon as you see a lateral line where the sap is moving too rapidly, you know to follow that line in search of leaks. But check that the multi-fitting is seated properly onto the mainline, and the rubber seal is tight and not letting in air. From the mainline back toward the trees, slide your hand along the lateral line, feeling for animal chews. When you get to the first drop, hold the tubing a little further up the line behind the T and make a dip in the line so that the sap must run uphill. This is especially important when there isn't much visible sap in the lines. If your loop fills completely, then you know that the line behind you is ok and the problem is at this tree; but if air and sap are racing through the loop you made, then you need to keep going farther up the line to find the leak. Keep repeating this at every T until you find the problem(s).

In addition to using your eyes, you are also using your ears. Some people think that the only leaks worth fixing are the ones you can hear 100' away. Big leaks of the right shape will whistle loudly, but many leaks will be much quieter. When you are on

track of a problem, you should listen closely for more subtle leak noises. Put your ear near the T, or the spout if you can reach it. If you score the ribs on a fitting with clippers, it may make a soft buzzing noise. If you didn't use a tubing tool during installation, especially with rigid poly tubing, then the tubing may not be tight on the fitting. Spouts make leak for several reasons. The spout may just be loose-easy to fix, but not always easy to spot. If you tapped while on snowshoes and the snow settled in the midst of drilling, the hole may be out of round. The hole might be too close to soft punky wood, or to last year's hole, or to a frost crack. Put your ear by the base of a hollow tree and you might hear a soft hiss of air. Good tapping practices can prevent many leaks at the spout. For example, don't let the bit wander when drilling, or the hole will not be round. Don't pound spouts in too far, or too hard, especially in frozen wood, or a split cambium will result, making a good seal impossible. Shallow tapping (not more than 1" below the bark) is one way to minimize placing a taphole in unsound wood. If you see dark wood chips when tapping, you probably have made a hole that won't yield good sap and may leak vacuum. If you are unsure whether there is a leak at a certain tree, make a bow in the dropline and look for filling of the dip. If it's more than just a loose spout, or the dropline is loose on the spout, then you should cap it off and forget that hole for this year.

Checking for leaks is a great excuse for getting out into the woods, and can be very satisfying. More important, fixing leaks will maximize the value of your equipment and result in greater sap production. Some leaks are very hard to find and require much patience. Certain techniques take practice, like putting your ear to the mainline and hearing a certain slushing that indicates too much air in the lines. If you missed some leaks during sugaring, and you wash your tubing with pressure, you will find them by the spray. Fix those problems before next year's season.

Summary:

Check the vacuum gauge(s). To isolate a problem area, close valves on mainlines one at a time and see if the gauge responds.

Walk up the problem mainlines, examining and listening for hissing, drips, animal bites. Check each lateral (5/16" line) for rapid sap movement that indicates a leak. If your setup doesn't include hook fittings and loops where the laterals join the mainline, then make a dip at the beginning of each lateral and see if the sap fills the dip and is moving slowly.

Follow each problem lateral line toward the trees, feeling for animal chews, and making a dip in the line behind each T, to isolate the problem. If the sap won't fill the dip but moves by rapidly, then there is a leak further up the line.

When in doubt, listen closely to any suspect fitting. Cut and reinstall tubing over fittings that leak. Replace broken fittings and spouts.

Give a couple of taps to reseal a loose spout. If this doesn't help, pull the spout and cap it off.

Avoid certain practices that create leaks, like not using a tubing tool when installing fittings on lateral lines, scoring the ribs of fittings with clippers, drilling sloppy tapholes, or pounding spouts hard into frozen wood.

Fix the big leaks first, then go back for the smaller ones. If the vacuum at the last spout is satisfactory, then move on to another area.

Where the leaks will be:

Mainline—animal chews, loose couplings, cracks.

Multi-fitting to mainline connection.

Lateral line fittings.

Animal chew in lateral line or spout.

At the spout—loose spout, hole out of round, hole too close to last year's, too close to punky wood, frost crack, hollow tree. With all but a loose spout, just pull and cap it.

What to bring with you:

Vacuum gauge. Pull spouts at the end of the lines and check the vacuum.

Tubing clippers. Use these to cut tubing off the fittings that leak, to cut and repair tubing that is buried under a fallen limb, to shorten up sags in the tubing.

Tubing tool. You can't put stiff poly tubing on fittings by chewing and wiggling; this will just lead to vacuum leaks.

Spare fittings. Note the ones that break often. Maybe you should try another brand.

Electrical tape. Good for temporary mainline repairs (woodpecker holes, etc.). If you pressure wash it may not hold up. It isn't food grade.

Roll of flagging. Use this to mark problems that will require more tools, or more time.

Food. You can build up quite an appetite in the woods.

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The author has been a researcher at the UVM Proctor Maple Research Center since 1986.



1. A manifold that connects a dry line with a wet line should have a vacuum gauge (Glen Goodrich installation). Shut the valve on the left that leads to the branch mainline. If the vacuum improves, there are leaks along that line that need to be fixed.



2. A hook fitting with a loop where a lateral line joins a mainline (IPL installation). A quick glance will tell you whether the sap is filling the lower part of the loop and moving slowly, as it should, or racing by because air is leaking into the lateral line.



3. Making a dip in the line so that the sap has to run uphill. When there isn't much sap in the lines, this is the best way to see if the leak is beyond this tree, or right here. Cecile Branon is checking one of the 40,000 taps she maintains in the woods of Fairfax and Bakersfield VT.