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Sap Steady UV Unit for Maple Sap

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Overview

The Sap-Steady unit from FPE Inc. (Macedon NY) has been designed to kill bacteria yeast, and some other microorganisms in maple sap. Bacteria and yeast consume sugars in the sap and convert sucrose into the reducing sugars glucose and fructose. This reduces the amount of sugar in the sap. Also, reducing sugars are more chemically reactive than is sucrose and will combine with amino acids when the sap is heated during evaporation producing flavor and color compounds. Some of these flavors and colors are essential to creating maple syrup. However, too much produces darker syrups.

Components

The Sap-Steady consists of two components connected by a power cable. A stainless steel cylinder containing an inner quartz cylinder. Six germicidal low-pressure ultra-violet (UV) lamps are placed within the quartz cylinder and maple sap flows in the space between the quartz and stainless cylinders where it is exposed to UV radiation. A box on top of the cylinders provides access to the quartz cylinder in order to install and service the UV lamps. A fan in the lid of this box helps to cool the lamps.

A second box contains ballasts for the UV lamps and a green ON-OFF switch. The unit operates on 110 volts and draws about 6 amps.

Note: some early models of the Sap Steady were sold as a stand-alone unit on wheels and with a built in sap pump.

Installation

The unit can be installed at many locations in the sap collection system. Much microbial activity occurs in the lateral lines so providing UV treatment in the mainline as soon as possible will have the most effect. The UV treatment should occur before sap enters a storage tank where it may sit for more than a few hours.

Installation position may also be in a location where it is possible to re-circulate sap from a storage tank through the unit in order to continue treatment if the sap needs to be held in storage for longer than 18 hours. Refrigeration of the sap in addition to UV treatment during long holding times greatly reduces the growth of microorganisms that can consume the sugar contained in the sap.

Sap can move through the treatment cylinder from the bottom or from the top. The cylinder needs to be drained when not in use to prevent freezing of sap and consequent breaking the enclosed quartz cylinder.

Steel wall brackets must be securely mounted to wall

framing that will carry the weight of the treatment cylinder. Brackets are used to hold the stainless cylinder to the brackets.

When mounting, **allow space for installation and replacement of the UV lamps** above the treatment cylinder. Alternatively, the cylinder can be removed from its mounting brackets to service the lamps, but be careful not to drop the unit.

The inlet and outlet connections have quick disconnects so that the treatment cylinder can be disconnected easily from the sap system for cleaning. The inlet hose should be at least 1 inch inside diameter and the outlet at least ¾ inch inside diameter.

There should be a filter in the sap line ahead of the UV treatment cylinder to prevent debris from accumulating in or blocking fluid flow through the cylinder.

Installing the Lamps

Once the unit is securely mounted, the UV lamps should be carefully installed by opening the lid of the box on top of the cylinder. It is very important that the quartz tubes of the lamps be kept clean. Do not touch the quarts part of the lamp unless you are wearing clean cotton or latex gloves. The oils on your fingers will etch the quartz when it becomes hot and the lamps will crack and fail. Handle the tubes by the end caps very carefully. Insert each tube through the notched hole and lower into the cylinder. When the tube is fully inserted and resting on the bottom, then attach the electrical socket. When all tubes are installed and connected to the power source, close the lid on the top box.

If you do touch the quartz tubes with your bare hands or need to clean them for other reasons, rinse them with isopropanol (isopropyl alcohol) on a paper or cotton towel and dry them off with paper towels.

Safety Precaution!

Never look at the UV lamps when they are lit without having UV-protective eyewear. UV exposure can permanently damage eyesight. Normal eyeglasses or safety glasses (either glass or plastic lenses) will be sufficient if the exposure is brief. Plastic lenses, especially polycarbonate, are better than glass lenses. You also should avoid prolonged exposure of skin to UV radiation. Again, glass, plastic or UV-protective clothing between you and the lamp will provide reasonable protection. The lamp itself is made of quartz, not glass, to allow UV energy to pass into the sap.

Flow Rates

Maple sap may be pumped through the treatment cylinder using the releaser pump or a dedicated pump, or it may flow by gravity from a tank above the unit. **The maximum flow rate of the unit is 30 gallons per minute.** Above this limit, bacteria and yeast in the sap will not be exposed to UV long enough to provide effective killing of live cells. Flow rates less than the maximum will produce more complete killing of microbes in the sap. This becomes more important during warmer weather and later in the season when the number of microbial cells in the sap entering the unit is very high.

Starting the Unit

To **power the lamps** pull out the green button on the front of the ballast compartment. The button will light up indicating that the system is now powered.

The lamps can be left on during periods of sap flow, but should be turned off if no sap sap

flow is expected. The UV lamps have limited life that is determined both by the operating hours and by the number of times they are turned on. Turning the lamps on/off frequently will reduce their lifespan.

The lamps also generate heat that can cause drying of sap on the quartz cylinder when the unit is not full of fluid. A thin layer of sugar crystals on the cylinder will reduce the amount of UV radiation delivered to the sap. There may be a reason to leave the unit full of sap when the lamps are on.

Washing the Unit

The unit should be rinsed periodically with clean water and always before storage at the end of the season. UV kills bacteria and yeast so that the slime that will be found in other parts of the sap system should not develop inside the UV unit.

If a more thorough washing is needed, a suitable sanitizer is “Chlor-tergent” (Oakite Products Co.) or “Diversal CX” (Diversey-Wyandotte Chemical Co.). Unit should be rinsed thoroughly after washing.

If the unit is stored in an unheated area, it must be rinsed with a food grade non-toxic antifreeze and then drained to prevent the breakage of the quartz cylinder.

Servicing the UV Lamps

UV lamps will not last forever and should be replaced regularly. The general life expectancy is 10,000 hours of continuous use. On/off cycling will reduce this by some amount. In normal maple operations we recommend replacement every 5 years.

You will still see visible light from the lamps, but the amount of UV, that you can’t see, decreases over the life of the lamp. After 10,000 hours the amount of UV has decreased to the point where there is no longer enough to be effective. The aging is due to changes in the mercury within the lamps and to aging of the electronic ballasts that operate the lamp. Although they have a longer life, eventually you will need to replace the ballasts as well.

A record of lamp installation, service, and operating hours should be kept on or near the unit.

The effectiveness of the lamps will improve with annual cleaning. This can be done by wiping the lamps with either dry cotton or paper towels or towels moistened with alcohol. Remember to handle the lamps wearing clean cotton or latex gloves.

Lamp current fault
Failure of a lamp to light could be due either to the lamp or to the ballast.

Check the current on the ballast. This is done by measuring the current on the black wire of each ballast. It should be 1.4 amps +/- 0.2.

On one or more ballasts you may get a low reading. A low reading indicates either lamp or ballast failure. To determine which it is, measure the output voltage on the blue wires of the ballast in question. This voltage should be between 115 to 147 VAC. If the voltage is out

of range, replace the ballast. If it is within range, check the lamp bank with UV-protective eyewear and replace the lamps.

How UV Works

The six low-pressure mercury vapor lamps in the Sap-Steady emit radiation when they heated by an electric current passing through mercury vapor inside the lamps. This is the same process as common fluorescent lamps but without phosphor coatings to change the light spectrum and glass to remove UV radiation. Ultraviolet "light" refers to the part of the electromagnetic spectrum with wavelengths shorter than blue and violet light. We can't actually see the UV wavelengths that kill organisms. The visible glow from the lamps comes from longer wavelength radiation that our eyes can respond to as light.

The UV spectrum is divided into three bands, A, B, and C. It is the shortest wavelengths of UV-C that are germicidal. UV-C energy is absorbed by parts of the DNA molecule eventually destroying the ability of cells to function and replicate. This killing process requires a certain amount of energy. Both the strength of the radiation at the DNA in the cell (determined by lamp output and absorption by the sap and the cell) and the exposure time will provide a killing dose of energy.

Some organisms are better protected from UV than others. Humans have a tanning reaction that provides partial protection from UV in sunlight. Bacteria have the least protection and are relatively easy to kill. Yeast have a cell wall that provides some protection and require a larger dose (energy x time) to kill.

A few other interesting facts: UV-B is useful to humans because it is absorbed by our skin to produce Vitamin D. However, too much is not good. UV also causes skin cancer, accelerates aging of the skin, and cataracts. Ozone in the upper atmosphere reduces the amount of UV in sunlight. Reduction of the ozone layer due to our use of chlorinated hydrocarbons has produced an increase in UV at the Earth's surface and an increase in skin cancer and other UV-related health problems.

Are all UV Units Equally Effective?

All UV sanitizing units are not equally effective. The Sap Steady unit is the only unit specifically designed for maple sap. Its performance in killing micro-organisms in sap has been tested and continues to be tested.

The Sap Steady was developed by Philip Hartmann in cooperation with Professor Randy Worobo at Cornell University. It is a version of the Cider Clear unit that is used commercially to pasteurize apple cider. The Cider Clear unit was extensively tested to meet requirements of the Food and Drug Administration for effectiveness in killing human pathogens. The design principles that make the Cider Clear work were then used in the Sap Steady unit.

Brian Chabot and Randy Worobo tested six different UV units being used by maple producers and found that none of them significantly reduced bacteria and yeast as determined by counting the number of living cells that survived the treatment. All of the UV units that we have seen in use were designed for use in water systems. Several things make it unlikely that any of these water systems will be effective for killing micro-organisms in sap. First, the

density of micro-organisms in sap is very much higher than in water, especially later in the season. This higher density reduces the penetration of UV energy into the sap. Second, the "thickness" of the sap around the UV lamp is usually greater in water units. The Sap Steady has a thinner layer of sap than the water units we have seen. Third, water units usually have one UV lamp; the Sap Steady has six. This means considerably more energy entering the sap in the Sap Steady units. Water units work for water, but not for maple sap.

Something that will affect the performance of any UV sanitizer is maintenance. Lamps need to be replaced on a regular basis. The inner quartz tubes protecting the lamps need to be inspected to insure that the surfaces are clean. This can be done at the time of lamp replacement. If there is a sign of reside or film buildup, these tubes will need to be cleaned.