Grow All Summer:
Water-Cooling Explained

by Stephen Keen

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Introduction

Water-cooling has been on the scene for some time, but until recently it has been limited to lighting and has only been used by a small group of adventurous pioneers. Now that several new water-cooled products are emerging, water-cooling is seeing more of the spotlight and the average grower is starting to see the benefits. There are excellent reasons for any grower out there to consider making the switch.

Definition of WCS

A water-cooled system is a complete cooling package that can have several components. It generally consists of water lines connected from a chilled reservoir or fresh water source to various heat exchangers, water-cooled lighting vessels, ballast cooling enclosures and/or CO_2 generators. These devices all cool the heat at the source, which is the key to the success of the system. Water-cooled products are able to grab the heat produced by gardening equipment and move it away from the garden quickly before it is dissipated into the garden and diluted by the air.

Water-Cooling vs. Air Cooling

Water-cooling is much more effective and efficient than air-cooling; the thermal conductivity and specific heat capacity of water are both significantly higher than that of air. There is a formula that explains this, but the gist of it is that water is capable of holding four times the heat of air, and can absorb it nearly 20 times faster. As a real world example, someone who is swimming in 40°F water will become hypothermic in a matter of minutes, whereas someone walking around outside when it's 40°F will stay perfectly safe for hours and hours.

Residential chiller

This principle is not just applicable regarding the air cooling of your reflectors; it's significant to your air conditioning system as well. Once heat is released into your room, the ability to efficiently remove it is lost. Only 30 per cent of the energy used in air conditioning is converted into usable cooling power. Up to 70 per cent of the power an air conditioning system consumes is wasted on powering the a/c itself. Further, air can only be cooled with electricity whereas there are several ways to cool water with little or no energy consumption:

Large reservoirs on a recirculation system using passive cooling is the most energy efficient way to cool the water, but can require reservoirs with hundreds of gallons of water depending on the amount of garden cooling needed.

Heat exchangers and fans using outside air can be used to cool the hot water before it re-enters the reservoir. This is very efficient and can reduce the size of the reservoir needed.

Chillers cooling the reservoir are extremely effective. They do consume power but will still be significantly more energy efficient than air conditioners.

Drain to waste systems that utilize cold water directly from taps or wells is only energy efficient if the water from a public utility is being reused for other purposes, or if the water from a well is being recirculated back into the well. With some WCS systems, you can reuse your RO waste water or used nutrient water, getting double the use out of it before discarding.

When using air cooling you are at the mercy of the outdoor elements. The air being introduced to cool the garden varies in temperature and humidity on a day-to-day basis. It's often unpredictable and conditions are ideal for only a few months out of the year. With a WCS, as long as you can control your water temperature, you can control your growing environment. It's 100 per cent predictable and if installed properly, is safe and dependable as well.

Window mount/outdoor chiller

Bringing in outside air to cool your lights creates a list of other problems too. You have the issue of pests, loss of CO_2 and dirty reflector lenses; there's also the issue of exhausting out undesirable odors and the creation of fan noise. With a WCS the only things entering and exiting your garden are two small water lines. That's it. The water lines can be run from virtually anywhere while air ducting is somewhat limited. With a WCS there is no need to cut large holes for ducting through walls and ceilings to provide cooling. Where a set-up with several lights would need several holes cut to supply enough airflow for an air cooled system, with a WCS you only need two small holes for water lines. In fact the entire garden can be cooled using just these water lines regardless of the size and amount of equipment.

Hot Climate Gardening

Most of us have problems with heat in our gardens and as a result, most of us are not able to grow though the summer months. Although it is disappointing to shut down your garden for two to three months, it is standard operating procedure in the indoor gardening industry and we plan for it every year. Indoor gardening is the only division of the gardening industry that actually sees summer as a slow time. It's a nice time to take a vacation, but during these months your garden actually costs you money. There are only two ways to get around this: a costly, energy consuming air conditioning system or a quiet, energy efficient water-cooled system. A complete WCS isn't just water-cooled lighting anymore; it can now include

Water cooled heat exchanger

CO_2 generators, ballast cooling enclosures, ambient temperature reduction and lighting. There is no longer a need for air conditioners and there is no longer a need to bring in outside air to help cool your lights. Imagine complete control over your garden year-round no matter what the temperature is outside, all operated by a pump, reservoir and one water chiller. This kind of system is easy to install, works very well and saves considerable energy over traditional air cooling.

Cold Climate Gardening

A WCS can absolutely work for those in cold climates as well, and in fact can reduce power consumption because the energy savings extend beyond your garden and into your home. With a WCS, every BTU of heat from the ballast, bulbs and CO_2 generator can be captured and reused to heat your garden during the off cycle or even to heat your home. This is accomplished by storing the hot water created during the on cycle and using heat exchangers and fans to put the heat wherever you want it. This can easily and quickly add up to considerable energy savings.

Water-cooled heat exchanger installed

A/C diffuser tube

Water-Cooled Air Conditioning and Dehumidification

With water-cooled a/c, the average gardener can add as much cooling as he needs to any area in his garden. Simple water-cooled air conditioning consists of a water to air heat exchanger and fan located inside the grow room, a water pump and reservoir and some way to chill the water. The chilled water is pumped through the heat exchanger, and the fan blows the room air over the heat exchanger, cooling the room. If a chiller or heat exchanger is used to cool the water they must be located outside the grow room or they will not work properly. The heat is extracted from the air by the heat exchanger inside the grow room and must be released back out of the water somewhere outside the garden.

Using this type of air conditioning can help dehumidify your grow room because the chilled water tends to make the exchanger sweat. This water can be collected and removed from the room or used in the garden since it is essentially pure water extracted from the air. To control a water-cooled a/c there are thermostats available to control the fans. The water temperature is kept at a preset level (the cooler the better), the thermostat connected to the fans is set at your desired room temperature and the fan speed increases or decreases accordingly.

Another great point about water-cooled a/c is that it is very flexible in the design. You can put the heat exchangers anywhere and as many as needed could be added to one cooling line. This way you can evenly disperse the cooled air exactly where you want and need it.

Water-Cooled CO_2 Generators

These are fairly new to the market and generally come in two sizes: the standard unit, which is designed for mid-to-large size gardens, and a small version for environments like huts and closets. These generators use a water to air heat exchanger mounted directly over the flame. When cool water is circulated through the exchanger it absorbs most of the heat created by the flame, carrying that heat out of the garden. The water-cooled generator is capable of removing over 80 per cent of the heat produced by the flame. A standard 12,000 BTU setting will result in only 1500 BTU of heat actually being released into the garden. A traditional generator releases 100 per cent of this heat into the garden, requiring one full HP of air conditioning power to counteract it.

Mini water cooles CO_2 generator

Water-Cooled Lighting

There are several companies that currently sell water-cooled lighting fixtures, but there are basically two types. Both types have pros and cons depending on a gardener's growing environment and specific needs.

Water-cooled glass vessels

Water-Cooled vessels can be mounted inside existing reflectors. These basically consist of a double wall glass design with a gap in between. Inside the center tube is a dry cavity where the bulb is mounted. Purified water is pumped from a reservoir and it flows through the gap, cooling the heat generated by the bulb. Unlike the water-cooled vessels of the past, the bulb is not in contact with the water. The main advantage of the vessel solution is that you can place the lighting much closer to the plant canopy, and since these vessels are cool to the touch when running, they allow you to place more lighting in a given area, increasing your yields on a per square foot basis. Also, because the lighting can be placed much closer to the plant canopy, you can use lower wattage lighting and get the same results as higher wattage lights.

The main disadvantages to these fixtures are that since the light passes through the water it must be purified and the inside of the fixture must stay perfectly clean or lumen loss will occur. Also, since they are mostly made of glass, they are fragile to handle, but once installed are safe as long as they are used with a flow detector that will shut down the lighting in case of pump failure or any loss of water flow.

Water cooled CO_2 generator

Heat exchangers can be used to water-cool the warm air from your air-cooled lighting system. These are designed to attach to the air ducting flange of any six inch or eight inch reflector. This system works similar to an air-cooled set-up in that air is still passed over the bulb, but it then passes through the heat exchanger where it's cooled before re-entering the room, eliminating the need to exhaust air from the garden. The main advantages of this system is that not only can it be used to efficiently cool the heat from the bulb, but it can also be used to provide water-cooled air conditioning as well. There is no need to use purified water since light is not passing through the water. The water temperature can also be brought down lower than that of the water-cooled vessels because condensation does not negatively affect the function of the unit. This system requires air cooling for it to function, so you will need to utilize fans.

Water-Cooled Ballast Enclosure

New to the industry is the ability to water-cool your digital ballasts. The product is an air-cooled aluminum tube designed to hook up inline with your air cooled reflector ducting. A water-cooled duct mounted heat exchanger is used to cool the air passing over the ballast just like the heat exchanger system for the lights.

All ballasts create a significant amount of heat and should not be ignored. As a general rule, one watt of power equals 3.41 BTU, so a traditional coil 1000 watt ballast is generating around 3,500 BTU per hour by itself. We all know that coil ballasts get very hot to the touch, especially after several hours. What is deceiving is the heat generated by digital ballasts. Digital ballasts seem considerably cooler to the touch than coil ballasts, but this is because their extruded aluminum housings are excellent at dissipating heat. They do create roughly 25 per cent less heat than coil ballasts (and use roughly 25 per cent less energy), but this still amounts to over 2500 BTU per hour. Efficiently water-cooling the heat source will help you maintain complete control of your room temperatures. As an added bonus, protecting your ballasts from excessive heating will extend their life.

Ballast cooling enclosure

Summary

On average, a complete water-cooled system will require an initial investment that is approximately 50 per cent higher than a traditional air cooled system. However, savings in energy consumption over time will cover these costs very quickly for the average gardener. Additionally, most growers will see an increase in yields as a result of optimizing the environment and adding summer harvests. It's a worthwhile investment for any size garden and by no means should be limited to the hobby gardener.

Our industry is evolving as it should, and we have reached the capacity of air-cooling. The ducting can't get any larger and the fans can't move any more air, and most of us are still struggling with heat problems. Obviously a learning curve comes along with switching to a water-cooled system but don't let it intimidate you; once you get into it, you'll realize that it's really not that complicated. Once you get it running you'll find it to be a worthwhile investment.

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