VINEYARD & WINERY MANAGEMENT

HOME
Magazine
Subscriptions
Archive Issues

Marne Coggan is a vineyard technology consultant and a Sonoma County vineyard owner.

Feedback can be sent to Mr Coggan and the V&WM Editorial Department by emailing coggan@vwm-online.com

Article Sections

Ozone in Wineries

PART 1
Getting Beyond Myths and Mistakes

By Marne Coggan

THE WINE industry seems to have a schizophrenic attitude about ozone. Many wineries use ozone and are thoroughly delighted with its efficacy as a sanitizer and its safety. Other wineries have had negative experiences with ozone in the cellar. Still others have had no experience, but have heard of workers refusing to use ozone or of ominous consequences from run-away generators. Too often, ozone's virtues seem to have been oversold and its drawbacks overblown. Myths, misinformation, conf licting claims, and even irrational fear abound.

This two part series on ozone in wineries will take a balanced look at this very useful but problematic, misunderstood and misused sanitizer. It will clarif y the facts about ozone, and will provide a thorough explanation of ozone's many uses in the winery. In this first article, we'll review some ozone basics, examine a few common winery problems, and explore ozone key safety and usage considerations in the winery. The second article in the March-April issue will focus on winery applications for ozone, including an in-depth look at barrel treatment.

Part 2 also will examine surface sanitation, and the sanitation of bottling lines and other clean-in-place (CIP) applications. It will discuss building-wide ozone systems where ozonated water is available on-tap throughout the winery facility, and will explore the use of gaseous ozone to sanitize storage rooms and caves and to treat well-water and wastewater. You'll hear about some recent university research on ozone treatments in wineries, and you'll learn about some fascinating but not yet fully developed uses for ozone, including long-term winery barrel storage and vineyard insect and mildew control. All in all, we'll (ahem) fully clear the air on ozone. So let's begin.

All About Ozone

Ozone (O_3) is a naturally occurring gas, an unstable molecule made of three oxygen atoms. In nature, ozone is made when lightning or ultraviolet rays split apart oxygen gas (O_2) molecules high in

Measuring Ozone

What to Watch Out For

Photograph 1
Felipe Martinez, barrel-room foreman at Kendall-Jackson's Oakville facility, standing next to an ozone generator. Note the large ambient ozone display and alarm light on this unit.

the atmosphere. At the surface of the earth, ozone is usually unnoticeable at its normal concentration of 0.01-0.05 parts per million (ppm). You only become aware of ozone in the air at higher concentrations, such as after a thunderstorm—that fresh, clean, somewhat zingy smell. You'll also smell ozone near copy machines, electric motors and arc welders, all of which produce ozone as a by-product. And sadly, ozone makes its presence known in smog-filled city air, where car exhaust and other gases produce irritating concentrations of it at ground level. (Yes, smog produces ozone, not the other way around.) "Spare the Air" days are called for when the ozone level is expected to exceed 0.08ppm.

Ozone is the most reactive substance known, save only free f luoride ions. This high reactivity means that ozone doesn't last long—it immediately transfers that pesky third oxygen atom to any organic compound it touches and returns to stable oxygen. In the process, that organic compound is oxidized—chemically changed, as in burned. This means that ozone instantly annihilates enzymes, microbial membranes and unpleasant taste- and odor-causing compounds.Ozone destroys on contact all known bacteria, virus, molds, spores, yeast, mildew, microscopic fungi and biofilms (toughened colonies of microorganisms on surfaces).

Ozone kills microbes much faster than weaker oxidizers like chlorine—up to 5,000 times faster. But unlike chlorine, ozone oxidation leaves no harmful or foul byproducts and residue only oxygen. Further, microorganisms can't build up a tolerance to ozone as they can to less reactive chemicals like chlorine.

Ozone in Wineries

Because it's highly reactive and unstable, ozone doesn't persist—any ozone not instantly consumed by contact oxidation of organics quickly reverts to oxygen. This makes ozone perfect as a final, no-rinse sanitizer. With no persistence, ozone requires no special disposal system. Ozonated water going down your cellar's drains won't kill the bugs in your biomass, pollute your pond or destroy beneficial bacteria in your septic system or wastewater treatment plant.

Ozone has other useful qualities. Ozone is just as reactive when dissolved in water, where it is pH neutral and non-corrosive. Ozone reacts with dissolved iron and manganese, precipitating those ions for easy removal. And compared to hot water or steam, its chief rival sanitizers in wineries, ozone is dramatically less expensive to produce and safer to use. Switching to ozone sanitation can cut a winery's hot water usage in half.

There's more. Ozone won't harm stainless steel, most plastics or fitting and sealant materials like viton, silicone, Teflon, kinar, and epdm. Handled correctly, ozone can be safer than SO_2 or steam. There are no storage, handling or reporting requirements for ozone. And as we'll see in Part 2, ozone can maintain and improve the microbial health of oak barrels. All in all, ozone offers a number of benefits to wineries as a fast, effective, environmentally friendly sanitizer, with no residue and no residual.

Misconceptions and Concerns

But ozone isn't without its drawbacks. And despite what some overzealous advocates have said, ozone absolutely is not the panacea, cure-all, or single solution to every problem in the winery. As we examine some potentially negative aspects of using ozone in wineries, we'll explode some myths and highlight some basic but crucial facts about ozone use.

Graphic 1
Test results on the antimicrobial power of ozonated water produced by two winerysized generators from DEL Agricultural. The study was conducted by the National Sanitation Foundation (NSF). Chart courtesy of DEL Ozone.

Organism	Reduction
Trichophyton mentagrophytes (ATCC 9533)	6 log (99.9999%)
Salmonella choleraesuis (ATCC 10708)	6 log (99.9999%)
Staphylococcus aureus (ATCC 6538)	6 log (99.9999%)
Pseudomonas aeruginosa (ATCC 15442)	6 log (99.9999%)
Campylobacter jejuni (ATCC 33250)	4 log (99.99%)
Listeria monocytogenes (ATCC 7644)	4 log (99.99%)
Aspergillus flavus (ATCC 9296)	4 log (99.99%)
Brettanomyces bruxellensis (ATCC 10560)	4 log (99.99%)
*Escherichia coli** (ATCC 11229)	5 log (99.999%)

any wineries have used ozone inappropriately, and have been disappointed in the results. For example, ozonated water is not a cleaner. It's a sanitizer. Ozone doesn't attack tartrates, minerals, scale, or corrosion. It's no more effective than cold water rinses for cleaning the lees, dirt, solids and crud from the surfaces of tanks, floors, barrels or anything else. Hot water is much more effective at cleaning, with added scrubbing and possibly caustics included for tough cleaning jobs. Ozonated water may be great for killing any bugs remaining on the surface after cleaning, but until the crud is gone using ozone is a waste of time and money. Sums up Joe Mendez of Piper Environmental Group, "Regardless of what anybody tries to sell, ozone is not a silver bullet. Ozone is not always the right answer, especially for cleaning. Ozone is a lousy cleaner. If you want to clean, go to Costco, buy yourself a powerwasher, and clean. Use the ozone after you've cleaned."

Similarly, ozone is not a sterilizer, just a sanitizer. Sanitizing means controlling microbial populations by dramatically reducing their numbers. Ozone will do that. But sterility is a much more difficult state to attain- complete destruction of absolutely almicrobes. In the lab, microbial kilrates are expressed in log numbers, where each log is a reduction in about 10%. A 1-log reduction kills 10% of the bugs, leaving 90% alive. A 4-log reduction kills 99.99% of the microbes, leaving 0.01% alive. (One test of ozonated water treatments indeed shows that Brettanomyces organisms are killed at the 4-log level. See chart

above.)

But leaving alive only one ten-thousandth of the organisms on the surface of a barrel does not mean that the barreis completely sterile. Microbes are small and exist in large numbers. If there were a million Brett cells before the ozone treatment, a 4-log reduction means that about 100 are still alive and kicking. That isn't sterility, but it may be good enough microbial control for a working winery. We'll come back to this sterility-versus-control issue in Part 2 when we talk about treatment times for problem barrels and bottling lines.

Problems in the Cellar

Beyond inappropriate usage, ozone can create some significant problems for wineries. Significant damage can occur to cellar equipment which isn't ozone-ready. For example, ozone wilattack and destroy any natural rubber compounds. Gaskets, fittings, pump seals and hoses made of rubber-based elastomers will be quickly destroyed on contact with ozone. Ditto for unlined fiberglass tanks. (Ozone attacks fiberglass resins.) Before you use ozone, you need to make doubly-sure that all of your cellar equipment-every internal piece and part of it which might come in contact with ozone- will stand up to it.

Most wineries use ozone dissolved in water. And while ozone gas itself can be used in wineries (we'll discuss this in Part 2), a real problem is created in the cellar when ozone gas unintentionally gets into air as a gas by escaping-"off-gassing"-from the water in which it is dissolved. Off-gassing is unavoidable; it's caused by the laws of physics which affect every kind of gas. The laws are simple: If you put any gas in contact with a liquid, the gas will dissolve into the liquid until a natural equilibrium concentration is reached. If you increase the pressure of the gas in contact with the liquid, more gas will dissolve into it. If you decrease the pressure of the gas, some of the dissolved gas will come out of solution. The more surface area of the liquid is in contact with the gas, the faster the dissolved gas will go in or come out of solution.

You know these laws from drinking soda pop. Soda bottles or cans are pressurized with CO_2. While closed, there is CO_2 dissolved invisibly in the liquid pop. When the containers are opened, the much lower concentration of CO_2 in normal air pressure makes the dissolved CO_2 bubble out. If you pour the soda into a wide-topped drinking glass, the bubbles come out faster than in the narrow-necked bottle, and faster still if you spill the pop onto the f loor where it's in near complete contact with the air.

The same thing happens with ozonated water. In the ozone generating machine, lots of ozone gas is put in contact with water, so some of it dissolves. (Some of it doesn't. We'll come back to this below.) Meanwhile, the ambient cellar air has very little ozone in it. As soon as the ozonated water touches the air, some of the ozone comes out of solution and enters the air as a gas. The larger the surface of ozonated water in contact with air, the more ozone is off-gassed. A small amount of ozone will be offgassed from a thick stream

of ozonated water from an open hose, more if the ozonated water is sprayed with a nozzle, and more stil l when the ozonated water spreads out over the f loor.

Just like ozone in water, ozone gas in air reacts immediately with organics -it instantly toasts any airborne organics and becomes oxygen. But there are far fewer organics in cellar air than on cellar surfaces, and ozone gas in the air serves no useful purpose. Gaseous ozone spreads out quickly and tends to pool in low areas since it is heavier than air.

What airborne ozone does do is make people damned uncomfortable. As the ambient concentration goes up, ozone first becomes unpleasant, then a serious irritant, then quickly insufferable. The natural reaction of anyone to ambient ozone is to quickly get the hell away from it. While high ozone concentrations cause vomiting and extended exposure can cause pulmonary edema, such severe effects are rare; ozone gas is very noticeable and remaining in its presence requires a ruthless exercise of will. (Happily, victims of ozone overexposure have recovered completely, and no long-term health effects have been observed.)

The severe discomfort ozone gas creates is a significant issue for wineries- cellar workers really hate being around it. Employees can be made to wear ozone-absorbing masks or breathing apparatus when ozone is being used. But personal protection gear is a thirdrate approach to worker comfort and safety, for when ozone is used properly, the concentration of ozone gas in cellar air should never approach the discomfort level. Three factors will ensure this: thorough training of winery staff in standard operating procedures for ozone usage and safety; using only properly designed, correctly sized and carefully maintained ozone generating equipment; and appropriate testing and monitoring of ozone concentrations. We'll look at each of these now.

Training & Regulations

Training in ozone safety and standard operating procedures (SOPs) is essential. It should be thorough, repeated, and given in English and Spanish. Every worker in your winery should be completely trained when your ozone equipment is first installed. Every new worker hired thereafter should get the same training. All workers should periodically have refresher training so proper ozone usage and safety is completely understood. Your ozone equipment supplier should provide the ozone monitoring and generator operation training. Your supplier also should offer assistance to your safety staff in researching industry safety standards and developing winery- specific SOPs. If your supplier can't or won't provide this training and SOP assistance, find another who can and will.

Graphic 2
This OSHA chart shows

Besides fostering the prudent and effective use of ozone, safety and SOP training will help ensure that government regulations for ozone use will be observed. But there are surprisingly few of these. OSHA sets maximum human exposure to ambient (gaseous) ozone at 0.1ppm for an 8-hour period, and 0.3ppm (a very irritable level) for any 15-minute

the health effects of various concentrations of ambient ozone gas.

period. In Southern California, wineries may be required by the Air Quality Management District to obtain a $100 permit when installing ozone generating equipment. The Federal EPA lists ozone as a pesticide, but totally exempts it as "Generally Recognized As Safe" (GRAS) for use on and around food. The Federal FDA accepts ozone as an anti-microbial agent for use in contact with food and food processing equipment, requiring only that good manufacturing processes be followed. The Uniform Fire Code specifies some basic labeling and installation requirements for ozone generators producing more than two pounds per day. There are no State agriculture or pesticide department regulations for ozone, probably because with ozone's short life you can't ship it, store it or spill it.

At some future time, it is possible that the OSHA or some other agency will require wineries to keep records and submit reports of ozone use-concentration produced, hours used, etc. Such regulations are now being considered for the bottled water industry. But even without a legal requirement, there are two reasons why monitoring and maintaining records of ambient ozone levels and cellar usage may be a smart strategy. First, this will continually keep ozone safety and SOPs in the minds of cellar workers. Second, such records could be useful as a liability defense if an employee were to say, 'I was exposed to ozone, I'm sick and I'm going to sue.'

Health Effects of Ozone			
	Concentration (ppm)	Duration of Exposure	Health Effects
ACCEPTABLE ZONE	0.01-0.04	—	Odor threshold.
	>0.1	few minutes	Continuous headache, shortness of breath.
	0.1	—	Minor eye, nose and throat irritation.
	0.1	*8 hour average exposure limit*	
HAZARDOUS ZONE	0.25-0.5	2-5 hours	Reduction in lung function and the ability to do physical work (for persons with a history of heart or lung disease).
	0.3	*15 minute exposure limit*	
	0.4	2 hours	Reduction in lung function during moderate work for all persons.
	>0.6	1-2 hours	Chest pain, dry cough.
	1	1-2 hours	Lung irritation (coughing), severe fatigue.
	>1.5	2 hours	Reduced ability to think clearly. Continuing cough and extreme tiredness maybe lasting for 2 weeks. Severe lung irritation with fluid build-up.
	9	intermittent	Severe pneumonia (arc welders).
CRITICAL ZONE	*10*	*Immediately dangerous to life & health*	
	11	15 minutes	Rapid unconsciousness.

	50	30 minutes	Expected to be fatal.

This OSHA chart shows the health effects of various concentrations of ambient ozone gas.

Machine Design

Ozone must be made on-site at the winery, and used immediately. The equipment which produces ozone can be referred to by several different names. For simplicity, we'll use the term "ozone generators" for the machines which make ozone in wineries.

How do ozone generators work? First they compress ambient air, then separate out and concentrate the oxygen. A few generators make ozone by exposing the oxygen to ultraviolet light, but most run the oxygen through a high-voltage device called a corona, essentially 'lightning-in-a-bottle.' (Copy machines produce ozone because they use a corona to fix toner onto paper.) The generator then "injects" the gaseous ozone into water using negative pressure or a vacuum.

With just those parts, you'd have a generator which would produce ozonated water. But without thoughtful design and some other key components, such minimal generators would be inefficient and unsafe, as some wineries discovered to their dismay. Recalls Tom Beard, whose company produces automated barrel washers and other barrel handling equipment, "The early machines weren't designed to stand up to winery use or to simple but likely mistakes. Some had plastic internal fittings. The simplest rookie mistake by a cellar hand-hooking it up to hot water at 160-170°-pretty much melted the inside of the machine. Other generators injected the ozone in horizontal pipes, where it quickly f loated to the top. When the water came out of the spray wand or barrel washer, the ozone came out as a gas rather than being dissolved in the water."

Graphic 3
A simplified schematic of an ozone generator. Other useful but often optional, extracost components include dissolved ozone concentration meters, ambient (air) ozone detectors, alarms, and safety shutdown systems. Graphic courtesy of DEL Ozone.

Fortunately, continual development and competition have now improved the design of winery ozone generators. Paddles stir the water so the ozone dissolves more efficiently. Compressors and concentrators are sized to a certain production amount, so on-board pumps boost the f low rate of water through the generator to optimize its output. Larger mixing tanks are used to make more ozonated water available. Special features can create higher concentrations of ozone-drying and cooling the concentrated oxygen, chilling the incoming water, and using recirculating pipes to run the ozonated water repeatedly through the blending tank. (We'll talk more about concentration capacity below.)

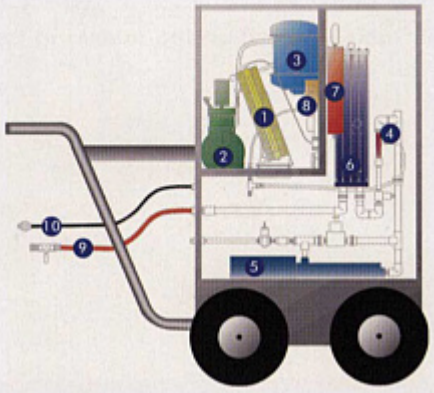
Safety and Efficiency

There are better safety features too. Off-gas destruct units vent off and destroy (turn back to oxygen) any ozone which is not fully dissolved in the water stream inside the generator. Waterproofing around high-voltage components and encasing sensitive parts in rugged materials help generators stand up to cellar environments. Airtight connections within the generator and inside barrel washing equipment reduce ozone off-gassing in the cellar. Dissolved ozone sensors and loggers measure and record the generators' output. Other

sensors sound alarms or shut down the generator if there is too little incoming water, if the water is hot, or if vacuum leaks or ambient ozone are detected. Note however that these safety components may be sold as extra-cost add-ons to ozone generators rather than being standard features.

Lee Ditzler, Founder, Inventor, and VP of Sales at Novazone, Inc. offers several important notes on ozone generator usage and safety. "First of all, be sure your generator is properly sized for the amount of water you will be treating. Also, all ozone generators are very temperature sensitive-they need to be cooled to sustain their highest output. Where generators are aircooled, warm air will significantly lower their output, so it's not a good idea to put generators outside in the sun, or even inside against a south-facing exterior wall. If you do decide to site your generator outside, be sure that the cabinet will stand up to weather. Remember, all ozone generators have high voltage internally, but they all are required by fire codes to have air vents. That's why it's important that your generator isn't hosed down or hit directly by high-pressure washers. Finally, good routine maintenance is really important. Don't skimp on this."

The AGW-0500's built-in ozone management system balances efficacy and safety by accurately controlling ozone dosage and minimizing ozone off-gas, complying with OSHA safety requirements.



1. Ozone Generation Module
2. Air Compressor
3. Oxygen Concentrator
4. Ozone Injector
5. Multi-Stage Water Pump
6. Ozone Mixing & Degas Chamber
7. Heated Catalytic Ozone Destruct
8. G.F.C.I.
9. Ozonated Water Out
10. 110V Power Cord with 3-Prong Plug

How Much Dissolved Ozone Can I Get?

As mentioned above, ozone generators should be appropriately sized for your expected usage. But whether you need 1 gallon per minute of ozonated water or 1,000 gallons per minute, what concentration of dissolved ozone should you be getting out of your generator? Before we answer that, we have to look at what you're putting into it- your cold water.

Any organic material in the water going into your generator will be the first thing attacked by the ozone. The consequence will be that the organics in water-bacteria, mold spores,

yeasts, algae, protozoa, sugar, alcohol, vinegar, enzymes, etc.-will be removed, and the just-added ozone will be reduced commensurately. Dissolved iron and manganese in the water also will be removed, with equivalent reductions in ozone concentration. So if your water contains organics, iron or manganese, you might consider sending it through a separate ozone-based water treatment circuit before piping it into your ozone generator.

And if you feed it only organic-free, iron-free and manganese-free water, what is the best ozone concentration your generator should achieve? Again, that depends on physics. The amount of ozone which can be dissolved in water varies with temperature and pressure. Colder water will allow more ozone to be dissolved into it, and as we discussed earlier, high-pressure systems closed to atmospheric air can force lots of gas into solution. But as soon as the cold or pressurized water hits normal cellar temperatures and atmospheric pressure, the extra gas bubbles out of solution.

Thus, there are theoretical ozone saturation concentrations achievable by exotic generators in air-tight laboratories, manufacturer test-benches or clean-room environments with special ventilation systems and required worker breathing apparatus. But what should be important to you is the practical, real-world ozone concentration as it comes out of the generator in your cellar. Some suppliers quote dazzling ozone production ratings for certain generator sub-components. Fine. Just be sure to know how much ozone actually will come out of the 'tail pipe' for you.

How much can you expect? A typical amount of ozone that cold water in most winery environments can hold is somewhere around 2.5-3.0 ppm. Higher concentrations, perhaps up to 8-10ppm, can be created inside generators using special concentrators, super-chilled water or recirculating systems.

Photograph 2 & 3
Two ozone test kits are made by the Hach Company. The kit above will measure dissolved ozone concentrations of 0.2-4.0ppm and is good for about 100 tests. The kit below measures 0-15ppm ozone concentrations and is good for about 25 tests.

And how much do you need? Ozone is called a 'C·T' material-everything it does varies with Concentration times Time. As the ozone concentration gets higher, the time necessary to produce a given microbial kill rate goes down. But ozone off-gassing into ambient air also happens faster at higher concentrations. This means that high ozone concentrations are most efficient in closed sanitation systems like CIP, where the ozonated water doesn't come in contact with cellar air. High concentrations are least efficient in surface sanitation, where the ozonated water is sprayed through the air and splashes off of the surfaces being treated.

Observes David Mahaffey, winemaker and ozone expert at Carlsen & Associates, "There is a minimum amount of ozone needed for use in wineries. The generators work better if they produce more ozone. But they don't have to produce copious amounts, and there may be some down side to having a machine that is scaled too large, that is putting out more ozone than is really necessary for the task. Extra ozone is useful only if it can be applied to killing microbes. But if it is likely to be released as a gas into the air, then the

extra amount serves no useful purpose and it is just an irritant for the people who have to work around it. But not to worr y: 1.8-2.5ppm is more than enough."

Measuring Ozone

Ozone is a lot like chlorine in a swimming pool- you should never use it without measuring. Too little chlorine doesn't kill the bacteria and algae in the water. Too much irritates the swimmers. Since chlorine is invisible in the water, you must test the water to measure how much chlorine it contains. After testing, you use the chlorine measurement to calculate your additions. Ditto that for ozone.

What do you use to measure ozone concentration? There are electronic ozone meters which provide instant, digital accurate readings. But these devices are both delicate and expensive. They are best used by your ozone equipment supplier for the initial calibration of your generator and for periodic re-validation. More practical are the automatic monitoring and data logging systems some suppliers build right into their ozone generators.

But the most useful ozone concentration testing is that done manually by cellar personnel. It's just like testing pool chlorine-a small water sample is taken, a reagent or test strip is added, and the concentration of the dissolved ozone is determined by colors. Ozone test kits are inexpensive, fairly accurate and ideal for use in cellar environments. All ozone equipment suppliers offer them.

Now you know what to test with. But knowing where to measure ozone concentration is essential to its effective use in the winery. Test results will be irrelevant if you measure ozone in the wrong place. But measuring it in the right place is simple. There are two key principles: First, measure the ozone concentration where you use it. If you're sanitizing a closed CIPsystem as we'll discuss in Part 2, you measure the ozone concentration inside or at the outlet of the generator. These locations give accurate readings because the atmosphere never enters the CIP circuit. But inside-the-generator measurements aren't accurate for open-atmosphere ozonated water uses

like surface sanitation with a hose or wand or washing barrels with a spray ball. For these, you need to measure the ozone concentration of the water in ambient cellar air.

Here's how: Connect the output of your ozone generator as usual to the wand or spray ball, then use them to fill a 5-gallon bucket to overf lowing. Take some water from the bucket for your ozone concentration testing. Using this procedure accounts for the natural loss of dissolved ozone from the water when it hits the atmosphere of your cellar, and more accurately shows the concentration of ozone which actually touches the surfaces you're trying to sanitize.

John McClain of McClain Ozone teaches his clients that ozone concentration measurement is essential for effective usage. "When you do barrel rinsing, one of the things you need to know is 'What concentration am I running today?'. You need that to calculate your rinse time. You have to measure ozone in the water that's going to the barrel, not how many grams per hour of ozone your machine is theoretically capable of creating."

The second ozone measurement principle is fully applicable only to CIP systems, but it still has relevance for ozone use in open-air: measure the ozone concentration both before and after it hits the surfaces you're sanitizing. Remember that ozone instantly oxidizes any organics it touches, and the ozone itself is destroyed (turned back to oxygen) in that process. Let's say you want to eliminate all of the organic stuff on the inside surface of a tank-wine, juice, yeast, bacteria, whatever. After you clean the inside surface of the tank, you treat it with ozonated water. While organic material remains in the tank, all of the ozone in the water is consumed as the organics are oxidized, and the ozone concentration of the effluent water coming out of the tank will be zero. But eventually, all of the organic material in the tank will be destroyed. From then on, there is nothing left for the ozone to oxidize, so the effluent water will still contain dissolved ozone. In fact, the concentration of ozone in the eff luent will be just a tad less than the concentration of the water going in. (Temperature and distance traveled will cause some dissolved ozone to be destroyed even without organics present. More will be consumed if the water is jostled through pumps, pipe and fitting junctions, just like shaking soda pop causes CO_2 to bubble out.)

In fact, measuring residual ozone in effluent water is one way that complete sanitation is determined with closed, air-free CIP ozone systems; the presence of dissolved ozone in eff luent means that no more organics remain and the surfaces touched by the ozonated

water have been fully sanitized. (Microbial testing verifies this.) But with open-air use, off-gassing of ozone into the ambient air can reduce the eff luent concentration to near zero, even from very clean surfaces. When your open-air effluent water does contain a significant ozone concentration, it means that you're spraying wastefully too long, with excess ozone serving only to irritate your cellar staff.

Contacts for Winery Ozone Systems

Contact	Company	Phone	Email	Web
Jon Johnson or David Mahaffey	Carlsen & Associates	707-431-2000	--	www.carlsenassociates.com
Beth Hamil	DEL Ozone	800-676-1335	beth@delozone.com	www.delozone.com
John McClain	McClain Ozone Inc.	707-254-0576	john_mcclainozone@sbcglobal.net	--
Lee Ditzler	Novazone, Inc	925-454-0303	sales@novazone.net	www.novazone.net
Joe Mendez	Piper Environmental Group	831-632-2700	joem@peg-inc.com	www.peg-inc.com

What to Watch Out For

What should you think about when considering or using ozone in your winery? Be sure your system is well designed and serviced, get your people trained, have sensible expectations and use ozone knowledgeably. Winemaker Jeff Virnig at Robert Sinskey Vineyards sums it up realistically: "There are several things winemakers should understand going in. Ozone won't replace all of the cleaning agents in the cellar. Ozone output is dependent on the water going in, so check your water quality for high biologics or minerals like iron or manganese. Be very sure you know how much ozone you are getting, what your concentration is- using the 'sniff test' to see whether the ozone machine is working is not a good solution. Ozone machines can be temperamental, so get one that's cellar- tested tough. Watch the seals in your cellar, and make sure to replace anything that you think might be damaged with ozone-safe materials. Most of all, nail down your service arrangements. I have had a very hard time getting qualified service personnel to take care of my needs. Be sure that you get a good service contract and warranty in writing, and make very sure that the service person actually will be available to help you."

What else should you know about ozone? Read Part 2 in the March-April issue when we'll discuss winery applications in detail, from barrel sanitation to surface and CIP sanitation, plus building-wide ozone systems, gaseous ozone treatment of water, storage rooms and caves, vineyard uses of ozone, current ozone research, and more.

CLICK HERE TO...