

Wineries achieve control of mold growth

BY Tina Vierra

Control of airborne bacteria and odors on the International Space Station was achieved by use of a photocatalytic reactor invented by the National Aeronautics & Space Administration (NASA). The technology is now in public use, with many units in food-processing plants and hospitals across the United States, including more than 70 wineries in seven states (California, Michigan, Ohio, Oregon, Pennsylvania, Virginia and Washington).

Is it a "mold filter"?

John Hayman, director of science and technology at Akida Holdings (Kennesaw, Ga.) explains, "The unit is a photocatalytic reactor, not a filter. Unlike a filter, it can oxidize organic material and VOC gases to carbon dioxide and water vapor. When in use for the wine industry, it kills airborne mold and bacteria and removes odors."

The photocatalytic process requires a specific kind of ultraviolet (UV) light and a specific form of titanium dioxide (a naturally occurring oxide of titanium with a wide application range, from paint to sunscreen and food coloring). There are several forms of titanium dioxide. A particular crystalline form of anatase phase (TiO₂) is used in these units.

Ultraviolet light wavelength is measured in nanometers (nm), with visible light at 400 nm. TiO₂ is activated by UV from 385 nm to 180 nm. The problem with 180 nm is that it also creates ozone. The UV nm light in the photocatalytic reactor is limited to 254 nm to prevent this problem.

Mechanics of the reactor

A hydroxyl radical (the strongest oxidant known) is generated and held to the surface rather than becoming a gas. 3.2 eV

(electron volts) from a photon in the UV light cause the TiO₂ to create an electron hole—throwing off an electron that splits a water molecule.

When missing an electron in its outer shell, the hydroxyl radical is very unstable—but the fact that it is surface-bound means the reactor can control it and all reactions occur on the surface of the TiO₂. Nothing happens in a gaseous phase. There is no gas other than the byproducts of the TiO₂ reaction, which are carbon dioxide and water vapor. Inorganic portions of the molecules are blown off.

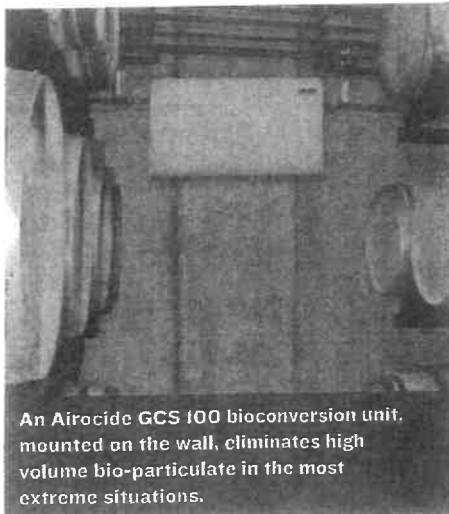
Mineralization

Destruction of a mold spore (or bacteria or odor compound) uses a process called mineralization. The OH radical is like a Pac-Man. On contact with the mold spore, it takes a bite out of it, then another bite until the entire organics of the mold spore are mineralized. It holds the intermediary hydrocarbons at the surface of the TiO₂, where another hydroxyl radical is going to form and further attack the spore. There is absorption on the surface of the TiO₂, and the oxidation process continues until the spore is totally destroyed.

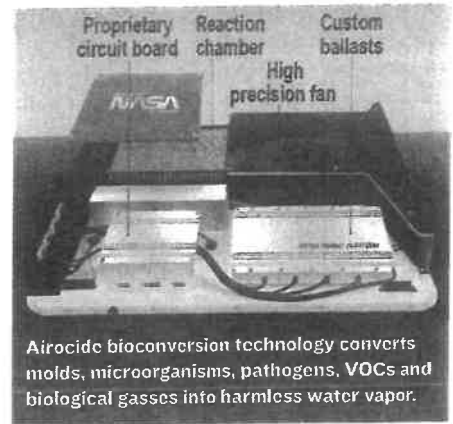
This particular form of titanium dioxide is hydrophilic, so it is going to pull water to its surface. This means that any relative humidity in the air is going to be pulled naturally to its surface, which also makes the catalysts self-cleaning.

This hydrophilic nanoparticle is a complete nanoparticle membrane that becomes a system. It totally coats a ratchet ring that is about 15mm long by 4mm in diameter and hollow to provide more surface area coat. The outsides, ends and centers are coated.

The largest photocatalytic reactor has more than 5 square meters of surface



An Airocide GCS 100 bioconversion unit, mounted on the wall, eliminates high volume bio-particulate in the most extreme situations.



Airocide bioconversion technology converts molds, microorganisms, pathogens, VOCs and biological gasses into harmless water vapor.

area catalyst. The rings are randomly packed in the reaction chamber, much like a box of macaroni purchased from a grocery store, so that the air does not have a straight path through the reactor.

In terms of relative humidity (RH), we are dealing in parts per million (ppm)—and sometimes parts per trillion (ppt). With the amount of water vapor involved, there is no condensate.

Ultraviolet lamps

There are 46 8-watt ultraviolet lamps in the largest photocatalytic reactor, mostly producing heat. This is the equivalent of less than three 100-watt light bulbs—very low BTU levels, but enough to increase the heat through the reactor bed.

"Because we limit the speed going through the unit," explains Hayman, "we actually 'reduce' the RH as we go through the reactor bed." As heat increases, RH decreases, and the photocatalytic reaction increases.

The ultraviolet lamps are separated by quartz sleeves, with coated glass rings packed between them. The quartz is used so that when a user changes the lamps (annually is recommended), they never come in contact with the reactor bed. The rings are packed in between the lamps at just the right distance to give maximum kill zone, or maximum mineralization zone.

Changing off-the-shelf lamps in the latest photocatalytic reactor system requires about five minutes per machine.

The photocatalytic reactors are now in their fourth generation of commercial use and development, with several upgrades made in each generation for better performance in each industry.

Wineries prevent mold growth

At Bergstrom Wines (Newberg, Ore.) three photocatalytic reactors were installed and triangulated in a 2,800-square-foot barrel cellar (400 barrel capacity) in 2008. The owner was first attracted to the technol-

ogy because of its ability to kill microorganisms, to help prevent TCA issues and reduce mold growth. The cellar has concrete floors and dry wall and is not humidified, but there was still moisture in the room, so they saw mold growth around the bung holes and on the floor when water puddled.

"Mold growth is controlled," reports Travis Bonilla, Bergstrom's assistant winemaker. Two years passed before the winery first changed the bulbs, and some mold growth was observed. Once ultraviolet lamps were changed (it took staff about 30 minutes), the mold disappeared.

Chateau Montelena (Calistoga, Calif.) has nine photocatalytic reactors: four in the fermentation cellar, one in each of two bottled wine libraries, two in a case goods warehouse and one mobile unit to move around in the caves where wine is in barrels. The first installation was in 2005. The filter and ultraviolet lamps in each unit are changed once per year.

"The reactors help with controlling odors and preventing mold growth," says Cameron Parry, Chateau Montelena winemaker. "We are very pleased with them. We had a problem with musty cellar odors, and the units removed those odors."

Corliss Estates (Walla Walla, Wash.) purchased a first-generation unit in 2007 to help control mold in one of their smaller storage rooms. "Once the unit was installed," reports winemaker Andrew Trio, "we no longer had a problem."

"We made an addition to the winery in 2012, including a new 120,000-cubic-foot production area, 62,500-cubic-foot barrel storage room and a 100,000-cubic-foot case goods storage room. A good portion of the winery sits underneath ground level and we benefit from the cool temperature and high humidity that this naturally creates. Once we began working in the new

space, we noticed a sharp increase to our usual cellar humidity due to the high moisture content of the freshly poured concrete.

"Upon recommendation from the supplier and doing our own research, we installed several new generation GCS50 units: two in production space, two for one barrel room, three for one case goods storage room and three more units to be mounted at other locations throughout the cellar. The rooms now smell much fresher, and we have not found any signs of mold since. We are feeling confident and very happy with our purchase."

Debonne Vineyards (Madison, Ohio) installed four photocatalytic reactors in the 70,000-gallon, 15,000-square-foot winery in 2005, following manufacturer recommendations for unit sizes based on the cubic feet of each room. There are two units in the barrel room, one in the fermentation cellar and one in the bottling room that operates 24/7.

Before installation, winemaker Ed Trebets said there was a lot of moisture in the cellar and mold on the walls and ceiling—plus surface yeast on the wine. After scrubbing all surfaces, painting with mildewcide and installing reactor units, Trebets reports that he has had no problems in seven years. There has been no moldy smell, and the amount of surface yeast has declined.

"Wines made from hybrid grapes are more susceptible to surface yeast," Trebets says. Debonne wine production is approximately 48% hybrid and 52% *vinifera*.

Trebets says that one pass through the reactor kills all organisms in the air moving through the unit. The filter and ultraviolet lamps in the units are changed annually.

Two photocatalytic reactors were installed at **Distefano Winery** (Woodinville, Wash.) in a 1,568-square-foot barrel cellar (400 barrel capacity) in 2011. The cellar has tilt-up concrete walls and flat floors with drains added, but puddles of water are a problem. Distefano owner/winemaker Mark Newton uses fans to evaporate the water and also to humidify the cellar.

Concerned about mildew and TCA, Newton saw mold on the walls before the units were installed. The mold was cleaned off the walls, and there has been no mold growth since installation of the two units. Newton reports the units that hang on the wall use 110-volts and are quiet when running.

"They keep down the odors too, so that there is just a nice wine smell now in the room," Newton says. He adds that he has a background in engineering and took one unit apart, finding it to be well made.

Shafer Vineyards (Napa, Calif.) first installed a photocatalytic reactor in 2005. Today there are a total of 12 units in caves, the bottling area, lab, wine library and fermentation cellar. "After the first four units were installed in the caves, we tested the atmosphere for mold growth and concluded the units were doing their job," reports Elias Fernandez, winemaker.

Fernandez reports no mold growth in the caves, and the units control odor as well. "We retrofitted the covers of the older units to make annual changing of the ultraviolet lamps and filter easier."

"We have one photocatalytic reactor in a 160-square-foot room where we propagate yeast and ML cultures," says Patrick Bernard, enologist at **Williams-Selyem Winery** (Healdsburg, Calif.). "It is there for insurance to prevent contamination." The filter and ultraviolet lamps are changed every year before harvest. "The lamps are easy to change. We installed the unit on the ceiling, and we bring it down to change the ultraviolet lamps. We are satisfied that the unit is doing what it is supposed to do." **PWV**

Photocatalytic reactors for winery use are made and sold by Airocide of Jacksonville, Fla. For more information, visit airocide.com/wine.

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