SANITIZERS FOR CITRUS PACKINGHOUSE RECIRCULATED WATER SYSTEMS

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Proper sanitation of water (especially recirculated water) used in drenches, dump tanks, etc. of fresh citrus packinghouses is important for delivering quality produce to the consumer. Not only do unsanitary conditions promote direct product loss through decay, but rising food safety concerns regarding human pathogens are becoming increasingly important to consumers. Because water is one of the most common carriers of pathogens, it must be treated (either chemically or physically) to prevent the accumulation of pathogens in the water, and prevent inadvertent contamination of clean produce. Such chlorine treatments are not particularly effective at reducing pathogen levels already on the surface of produce; it is much more effective to prevent contamination in the first place.

Although chlorine is currently the sanitizer of choice for most fresh citrus packinghouses, other chemicals have been approved by the EPA for contact with food products. This article briefly lists some of the approved antimicrobial chemicals and discusses advantages and disadvantages of using each.

CHLORINE

Chlorine is currently the predominant method used by citrus packinghouses to sanitize water systems. Although chlorine is available in three forms - sodium hypochlorite, calcium hypochlorite, or chlorine gas - it is the resulting hypochlorous acid (HOCl) form in aqueous solution that is primarily responsible for killing pathogens. In high pH solutions, most of the hypochlorous acid disassociates to form hypochlorite ion (OCl^-), which is much less effective at killing pathogens than HOCl. Chlorine solutions with pH above 8 are relatively ineffective against pathogens. Free chlorine testing kits measure both HOCl and OCl^-. For this reason, both pH and free-chlorine must be measured in order to know the sanitizing strength of one's chlorine solution. For citrus, WAS recommends maintaining a minimum concentration of 75 parts per million (ppm) of free chlorine and a pH between 6.5 and 7.5. Recent studies suggest that greater than 100 ppm chlorine is needed to effectively kill some pathogens.

The main advantages to using chlorine are that it is effective at killing a broad range of pathogens and is relatively inexpensive. It also leaves very little residue or film on surfaces. However, chlorine is corrosive to equipment and water pH must be monitored and adjusted often to maintain chlorine in its active form. Continual addition of chlorine without changing the water can result in the accumulation of high salt concentrations that may injure some produce, though citrus does not appear to be sensitive to% concentrations below 10,000 ppm Na. Further, chlorine can react with organic matter to form small amounts of trihalomethanes (THMs) that are thought to be carcinogenic. However, the relative risks from chlorine-generated THMs on the surface of fresh horticultural produce is extremely low.

CHLORINE DIOXIDE (CLO_2)

Chlorine dioxide is a synthetically produced yellowish-green gas with an odor similar to chlorine. ClO_2 is typically used at concentrations between 1 and 5 ppm. However, it usually must be generated on-site since the concentrated gas can be explosive and decomposes rapidly when exposed to light or temperatures above 50˚C (122˚F). These concentrated gases also pose a greater risk to workers than sodium or calcium hypochlorite. Noxious odors from off-gassing can be a common problem, especially at higher concentrations, which restricts the use of ClO_2 to well-ventilated areas away from workers. Unlike chlorine, ClO_2 does not hydrolyze in water and is virtually unaffected by pH changes between 6 and 10. It does not react with organic matter to form THMs. Some generators produce free chlorine in addition to ClO_2, which may form THMS. ClO_2 may produce other potentially hazardous byproducts (e.g. chlorate and chlorite). One additional drawback is that simple assays to monitor chlorine dioxide concentration are not currently available.

PEROXYACETIC ACID (PAA)

Peroxyacetic acid (e.g. Tsunami) is a strong oxidizer formed from hydrogen peroxide and acetic acid. The concentrated product (40% PAA) has a pungent odor and is highly toxic to humans. PAA is very soluble in water with very little off-gassing and it leaves no known toxic breakdown products or residue on the produce. Unlike chlorine and ozone, it is stable in water containing organic matter, which can greatly increase the longevity of the sanitizer, and it is not particularly corrosive to equipment. PAA is most active in acidic environments (pH 3.5 to 7). Activity declines rapidly at pHs above 7-8. High temperatures and metal ion contamination also reduce its activity.

OZONE (O_3)

Ozone is a water soluble gas formed by splitting O_2 (with electricity or UV light). The resulting individual oxygen atoms further react with additional O_2 to form O_3. Ozone gas is one of the strongest oxidizing agents and sanitizers available and is highly corrosive to equipment including rubber, some plastics and fiberglass. It is approved for food contact applications. Although ozone is not particularly soluble in water (30 ppm at 20˚C or 68˚F maximum), concentrations as low as 0.5 to 2 ppm are effective against pathogens in clean water with no soil or organic matter. In practice, concentrations as high as 10 ppm are difficult to obtain, and concentrations of 5 ppm or less are more common. There have been reports that ozone may induce resistance to subsequent fungal attacks in some horticultural products.

Ozone decomposes quickly in water, having a half-life of 15 to 20 minutes in clean water, but less than a minute in water containing suspended soil particles and organic matter. Thus, ozonated water should be filtered to remove these particulates. The antimicrobial activity of ozone is stable between pHs of 6 to 8, but decreases more rapidly at higher pHs. Ozone breaks down to oxygen and no toxic by-products have been reported. Ozone efficacy is diminished when dissolved iron, manganese, copper, nickel, hydrogen sulfide, or ammonia are present in the solution.

Because of its strong oxidizing potential, ozone is toxic to humans and must be generated on-site. Prolonged exposure to more than 4 ppm ozone in air can be lethal. Ozone has a pungent odor that can be detected by humans at 0.01 to 0.04 ppm. OSHA has set worker safety limits in air of 0.1 ppm exposure over an 8-hour period and 0.3 ppm over a 15-minute period. At concentrations in water above 1 ppm, off-gassing can result in concentrations in the air that exceed OSHA limits of 0.1 ppm.