Chlorine Injection Guidelines

Chlorine is an effective biocide at very low concentrations, and can also act as an oxidizing agent at higher concentrations. It is available in various forms and strengths, but for our purposes, the liquid bleach formulation is recommended. It can be purchased as household bleach, ~6% sodium hypochlorite, and as ~12% concentration, which is used in the wine trade as a disinfectant. Either formulation will work, and they run around $2.00 per gallon. The 12% should be available in 5, 15, 30 and 50-gallon drums.

The pH of the water will have some effect on the biocidal activity of Chlorine. Hypochlorous Acid, HOCl, is up to 80 times more effective than the Hypochlorite ion, (OCl^-). At a pH 5.0, over 90% of the chlorine is present as HOCl. At pH 7.0, 60% is HOCl. At pH 7.5, 40%. For this reason, the water is often treated with acid to lower the pH while injecting chlorine. The acid will also dissolve calcium carbonate deposits. CAUTION: Do not add acid to chlorine in concentrations, as this will *rapidly generate deadly chlorine gas!* The two materials must be injected into separate ports in the system.

The amount of organic material (bacterial slime) in the system also has an affect on the longevity of the chlorine. The organics oxidize while the chlorine reduces to chloride. Heavy organic loads may reduce as much as 10 ppm or more of free chlorine to chloride before the end of the hoses. For this reason, rates of 15 to 20 ppm chlorine can be injected, and a much lower rate will be detected (with a swimming pool test kit) at the far hose end.

Rates of Chlorine vary with what we are trying to accomplish. A new system can be kept clean with a *continuous injection* of 0.5 to 1.0 ppm chlorine. If we are trying to massage out some dried slime from an emitter, perhaps 15 to 20 ppm for a few hours in a series of irrigations every day or so. If we want to actively oxidize the organics, rates up to 200 to 300 ppm can be used as a "slug" or "shock" treatment. At this rate we need to be conscious of potential vine damage, should any vine get an inordinate amount of water, which is highly likely with hillsides and coyotes. Again, acid may be a good idea to use in a slug treatment. In light of these options, we would recommend the 15-20 ppm chlorine injection rate for starters, monitoring the time it takes to reach the far hose end, and estimating the concentration at that point. It would be helpful to note these numbers for the file. Let the chlorine stand in the line a day or so, and then start the system, check the hose ends with a clear glass jar to determine the amount of

slime that has been dislodged to see whether an entire flushing sequence is warranted. If so, flush the hoses and then close them and inject for another few hours, shut down with chlorine and repeat the process. The massaging may be incorporated into the early irrigations, and continued monitoring, flushing and injecting will give us a good feel for how the system and the emitters are responding to the treatment. We would recommend at least four or five sequences of massaging before we consider a slug treatment. Not every sequence will require a flushing. The hose will clean up rapidly, leaving the chlorine to deal with the organics in the emitter pathways, which will take more time. Field notes should be taken for the file.

Calculating the amount of chlorine to add can be done with the equation,
IR = .006 Q C /S
where IR = Injection Rate in gal / hr
Q = System Flow in gpm
C = desired injection concentration in ppm
S = strength of chlorine bleach in whole number %

For example, let's say we want to inject 15 ppm chlorine into a 250 gallon per minute system (about one 48" media tank), and we are using a 12% Sodium hypochlorite bleach. The formula will tell us how many gallons per hour of 12% chlorine we need to add to achieve 15 ppm in a 250 gpm flow.
IR = (.006) (Q) (C) /(S)
IR = (.006) (250) (15) / (12)
IR = 1.875 gallons / hour

Let's say we want to simplify this, and inject 2 gallons per hour of 12 % chlorine bleach into a 250 gallon flow. What is the final ppm?
IR = (.006) (Q) (C) / (S)
C = (S) / (.006) (Q)
C = (2) (12) / (.006) (250)
C = 16 ppm

So, injecting 2 gallons per hour of 12 % bleach per 48" tank will give around 15 - 20 ppm chlorine. In a five-tank system, we would use 10 gallons per hour, and be pretty close. The 12 % bleach can be pre-diluted with water. For example, we can put 20 gallons of 12 % bleach in 600 gallons of water, and inject the 600 gallons over a two hour period, thereby maintaining approximately 15 ppm chlorine injection over 2 hours in a 5 tank battery.

Please note that chlorine solutions are not very stable, and an open tank can loose a great deal of chlorine in one day. Chlorine gas will also accumulate in tanks, so caution must be used when opening tanks with chlorine solutions.

Where to inject the chlorine is also an important consideration. Generally, the best place is after the filters. Continuous injection ahead of the filters is not necessary, and the filters are capturing high organic loads that would reduce the concentrations of chlorine. Occasional slug treatments of the filtration system are necessary, probably on a 4 to 6 week schedule. This can be done by opening the tank port, inspecting the media sand levels , and adding 1/2 to 1 gallon of 12% bleach into a 48" tank. The tank should be full of water. Let it stand overnight, and backflush the tanks the next day. This will keep the tanks clean and well inspected. Field notes should be taken for the file.

How to inject begins with the injection port. A probe injector should be used, which injects into the center of the pipe or manifold. This greatly reduces the corrosion of the equipment by the chemicals caused by laminar flow of the chemicals along the inside pipe wall. The injectors may be purchased, or fabricated from PVC pipe and fittings. The use of a check valve on the injection system is highly recommended to prevent back flow of irrigation water into the chemical injection tank. Inexpensive PVC in-line check valves are satisfactory, if they are constantly inspected for corrosion on the springs and seats. When injecting below the media filters, a 200-mesh screen should be used on the injection line to prevent emitter plugging. Concentrated chlorine and acids are very rough on equipment. They also should be handled according to their safety labels. Full protection, like a pesticide mixer, is highly recommended, and most likely a legal requirement as well.

Injection equipment options vary with the maintenance program and the particular system design. These include

- Mazzei™ injectors work on the Venturi principal, and require a pressure differential of 20% to 40% to power them. Typically this differential is supplied by a small booster pump, 3/4 to 1 HP, which provides the motive flow. This pump should be slaved to the irrigation pump, so it cuts out when the main pump goes off. Their main advantage is their low cost, less than $60. The injector is the only equipment that "sees" the concentrated chemical, and can be replaced annually if needed. You should expect a 2 to 3 year life per unit. The booster pump and wiring will approach $1000 per unit, which is a one-time cost. The booster pump never sees the chemical. Mazzei™ injectors may also be shunted across main booster pumps or pressure reducing valves. This practice

can cause pre-mature pump wear or be very inefficient, and can only be recommended after close analysis of the given situation.

- Amiad injectors utilize the system's pressurized water to power a hydraulic piston. For every one gallon of chemical it injects into the system, it drops 3 gallons of irrigation water to atmosphere. These injectors are simple, easy to calibrate and cost around $600.00. In situations where you can deal with the discharge water, they are a viable option.

- Piston type injectors come in many styles, materials and costs. Some are easily calibrated, some are quite frustrating. Often, the most successful types that we have seen used in vineyard operations have been standard spray rigs. This is because the grower knows and understands the equipment.

Safety equipment is an important consideration in any injection system. Some of the key points are

- secondary containment of chemical tanks to prevent soil contamination if your tank leaks, tips, overfills or a fitting breaks.

- a check valve to prevent system water from flowing back into the injection tank, overfilling it.

- an anti-siphon valve / vacuum breaker to prevent chemical from draining into the system during shut down.

- an interlock device to stop the injection pump if the system shuts down or looses pressure. This device is mandatory when injecting certain pesticides.

- a filter on the injection line. Often we will use a filter between the chemical tank and the injection pump.

- a hose bib on the filter block to rinse equipment.

- worker protective clothing, gloves, face shield.