

# A Conservator's Approach to Maintaining a Recirculating Water Fountain

by Robert Krueger

No matter the size or design, the one common element in all fountains is water. A fountain's water chemistry can have the most degrading effect on an associated artwork, the basin, or the mechanical system. To maintain the optimum fountain performance in regard to appearance and preservation, some common basic approaches need to be undertaken. After presenting some background information on water, monitoring, and maintaining water chemistry in fountains, this article will present a step by step outline to make the ongoing maintenance as simple as possible.

## Background

Maintaining mineral content in water is of prime importance. Minerals held in suspension are measured in hardness, a term derived from the effect of particular water on soap. Hardness can be compared to levels of saturation, which is the state where a solution contains the maximum amount possible of dissolved solute in a stable situation under prevailing conditions of temperature and pressure. Soft water can be compared to unsaturated water. When the water is unsaturated it has the ability to hold more dissolved solids. Unsaturated water will leach minerals from stone, metals, masonry, or any available source including artwork. The opposite extreme is very hard or supersaturated water. In a supersaturated state the water cannot hold the amount of dissolved solids in suspension, and they will precipitate out of solution forming deposits referred to as scale. With fountains, mineral saturation is the goal (Smethurst 1988).

Hardness is affected by pH, temperature, and the amount of minerals in the water. These three things are interdependent. For example, in most cases a rise in temperature increases the solubility of minerals, meaning that if water starts off as balanced, but then the water temperature increases, the warmer water now has the ability to hold more minerals. However, the solubility of calcium carbonate decreases as the water temperature increases. To be sure that the water in a fountain is stable and at the point of saturation, the water is tested to measure pH, calcium hardness, temperature,

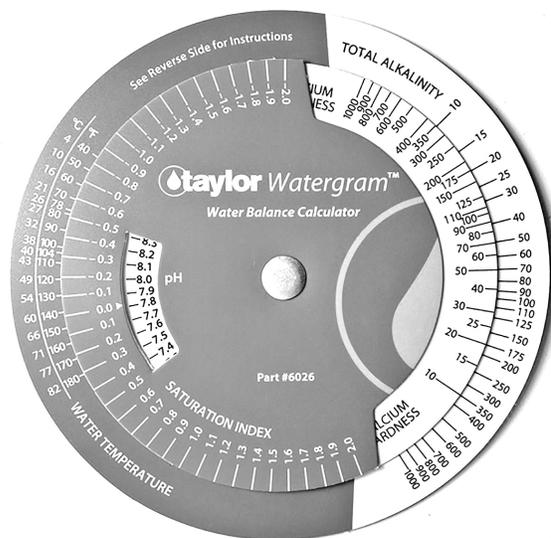
and ability to hold stable pH. The results of these tests are then plugged into a calculation to find whether the water is balanced. The key to this calculation is finding something called the saturation index. If the saturation index indicates a measurement of more than 0.5, then scale will form on the artwork and other surfaces. If the saturation index is -0.5 or lower, then the water is corrosive and will attack the artwork and other surfaces.

No matter what type of fountain you have, balanced water or proper mineral saturation is the starting point for having a fountain with clean clear water that is aesthetically pleasing and least likely to harm the artwork or the fountain itself.

To find the saturation index, use a Taylor brand K-2006 test kit. Taylor brand kits are reliable, easy to use, and accurately measure the water constituents within the desired ranges. Other methods for testing exist, and as long as the recommended factors can be reliably tested then other procedures may be used. The K-2006 is available from your local pool or spa supply store, or online. The kit comes with all the reagents needed. Each individual factor is tested, then using the results of each test and a slide wheel calculator, the saturation index is determined. The approach for simple fountains is to test the water weekly and make adjustments as needed. This should only take about 10 to 20 minutes depending on whether or not adjustments are needed.

After achieving balanced water the rest of the maintenance depends on the mechanical system and its components. A simple fountain made up of a small reservoir, a pump, and a rubber hose has a few options for maintenance. More complex mechanical systems bring even more options for treating the water to keep it balanced, clean, and algae free.

As water evaporates more water can be added to the fountain until the water becomes too hard. Because of the limited capabilities of the mechanical system in a simple fountain and lack of any filtration system, it is likely the fountain will need to be periodically drained and refilled.



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### Algae

In a simple fountain there are few options for algae prevention. One option is to drain and clean the fountain whenever algae appear. The other option is to use an algaecide.

In swimming pools it is practical to use halogens such as chlorine and bromide or metals like copper or silver to control the unwanted growth. When chlorine is added to water, it forms hypochlorous acid. The formation of hypochlorous acid is considered the most germicidal of the chlorine compounds.

The current belief is that the chlorine penetrates the cell wall and then attacks the enzyme group within, resulting in the death of the organism (White 1992). However, chlorine can have undesired effects, for example, leaving the gallery smelling like a swimming pool. Chlorine and other halogens such as bromide can deteriorate the mechanical systems and the artwork that is in contact with the chlorinated water or vapor from these waters (Butler and Ison 1976).

Copper and silver are commonly used to control biological growth in water. Some studies have shown that for particular growths, a combination of silver and copper work better. Copper acts as an algaestat rather than an algaecide, retarding or preventing growth, but not actually killing established algae. Silver is an algaecide for pink algae, but otherwise is a better bactericide (Young and Lisk 1972).

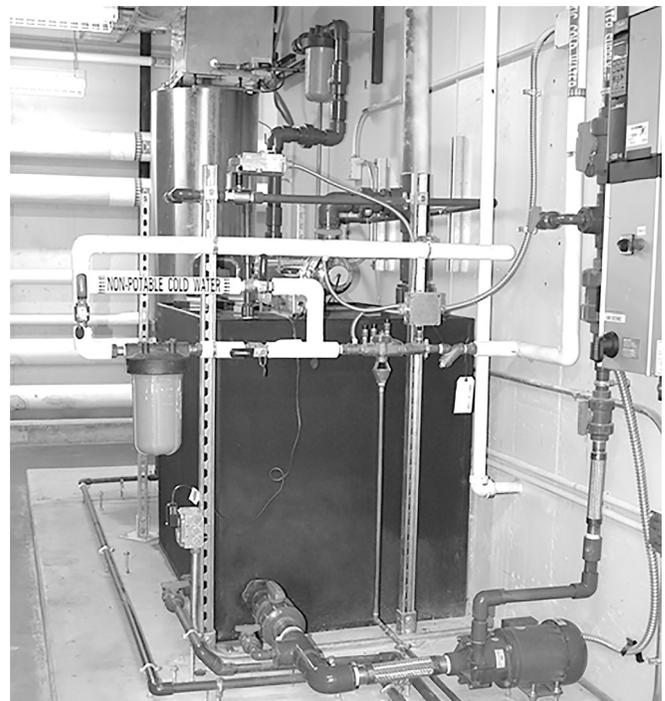
Pool supply companies caution that the use of metallic algaecides can cause staining on hard surfaces. The use of metallic algaecides will eventually cause staining on hard surfaces such as basins or artwork. In swimming pools this is generally not a problem because there is an expectation that a pool will be re-lined at about the same time staining becomes apparent.

Another option for killing algae is to use a quaternary ammonium, also referred to as a "quat." Quats are effective at killing algae by disrupting the cell wall. The downside of

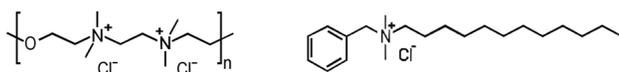
using a quat is that they have limited effect on a variety of biological growth and even more important, they can cause foaming in the water. An alternative to a quat is a Polyquat. Polyquats, like quats, are surface-active chemicals. Polyquats kill algae by adhering electrostatically to the outer cell membrane blocking them from nutrients. Polyquats will also act as a floccing agent for other organic matter.

Polyquats are sold for use in swimming pools, spas, and ponds. The bottles are never labeled as polyquats, but the active ingredient is poly[oxyethylene(dimethyliminio)ethylene(dimethyliminio)ethylene dichloride]. The directions on the bottle tell how much to add to the water each week. Rather than weekly measured doses of polyquats, use a Taylor K-1582 test kit to test for parts per million (PPM) quantities of available polyquat. The more organic matter in the water, the more polyquats will be used up. If the water is relatively clean, the polyquats will then continue to be available for an algaecide effect.

More advanced mechanical systems have a greater ability to control the water and restrict the water's ability to support life. Adding a filter to the system will increase the ability to maintain balanced, algae free water. There are many levels of filtration, such as screens, activated charcoal, particulate filtration via pleated media, sand filters, and diatomaceous filters.



Along with filtration, some systems have UVC sanitizers, which are very effective at killing bacteria, viruses, and fungi. In these systems the killing of organisms is expressed as a product of the UVC energy and time. The effectiveness can be obtained with high-intensity UVC energy in a short



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amount of time, or a longer exposure to a low-intensity of UVC radiation. The germicidal effect happens between the wavelengths of 205 and 265nm. When the UVC radiation penetrates the organism, it disrupts unsaturated bonds, causing a lethal biochemical change (Huff et al 1965). UVC is easily blocked and can only penetrate a certain amount of water before losing its effectiveness. In order for UVC systems to work optimally, the water must be filtered before being exposed.

Another method of controlling biology is to limit the nutrients within the water. Nitrogen, phosphorus, sulfur, carbon, iron, and trace minerals are required for algae to grow.

When waters are enriched with an abundance of these elements, the water is considered eutropic. In the eutropic state the water is highly productive for biological growth. In terms of water quality, eutropic waters are considered poor. Mesotrophic water has these nutrients, but in limited quantity, allowing some plant growth. In the mesotrophic state the water is considered good quality. For most fountains the goal is to have very non-productive waters, or oligotrophic water. Oligotrophic water is considered to be of excellent quality and very well suited for clean, algae free water in a fountain.

The nutrients required in large quantities for algae to grow are carbon, nitrogen, phosphorus, sulphur, and iron (Waite 1984). These nutrients are absorbed by plants in a fixed stoichiometric ratio. Limiting any one of them will limit algae's ability to grow (refer to Snoeyink, Vernon, and Jenkins 1981. *Water chemistry* for more on the carbonate-carbon equilibrium system).

Phosphate is used in the formation of cell walls and is a crucial part of the DNA backbone structure (Seager and Slabough 2000). Limiting phosphate from the water will therefore limit organic growth (Waite 1984). Unless a fountain is supplied with a distiller or has a sand or diatomaceous filter, then practical control of phosphate is difficult.

### Beginning of Maintenance

If possible, begin by draining the fountain's water and clean all surfaces that come into contact with the water and those near the water. Using an appropriate brush, Triton X-100 (or other surfactant) and water, clean the surfaces until the visible algae is removed. D/2 may be used as the surfactant to be sure the algae are killed. Rinse until all the surfactant has been removed. If there is scale on the fountain or insoluble mineral salts, this would be the time to remove these too.

Refill the fountain with water. Most often a fountain will be filled with municipal or tap water which has both minerals and organics from plants and also from human sources such as fertilizers and other chemicals. If the water is supplied from a distiller, minerals will most likely need to be added to the water. No matter the source of the water, it will have to be tested, and the water's chemistry will need to be adjusted.

### Maintenance

The following maintenance procedure applies to all fountains. The maintenance may sound time consuming, however, once the system is regularly maintained and these procedures become habitual, maintenance will be a relatively quick process.

Use a checklist and keep a written record every time maintenance is performed. This will be helpful in the long-term to establish patterns of change. Start by checking the condition of the water weekly. After a couple of months of testing and making adjustments, it may be found that twice or even once per month is enough. The larger the body of water, and especially if it is indoors, the more resistant to change it will be. Outdoor fountains will likely need more attention, and the amount of attention needed may also be seasonally adjusted. Record observations and the water chemistry test results. In time a relationships between the test data and recorded observations will begin to appear.

Begin with a visual and tactile inspection. Inspect for any algae visually and by feeling the wet surfaces. If surfaces feel slimy or slippery, then organic growth is beginning.

#### Example of Weekly Maintenance Checklist

Inspect:

Date:

surface of sculpture

plumbing / mechanical

temperature Fahrenheit

total alkalinity PPM

pH

calcium hardness PPM

pH of saturation

saturation index

Polyquats PPM

Notes:

If applicable, wash away dust and accumulated debris that settle around the fountain and may fall into the water. Also use a net to remove any debris from the water.

Inspect the mechanical system for anything out of the ordinary via a quick overall visual inspection of the exposed plumbing and mechanical system. If limiting phosphate is desired, then test for phosphate using the Taylor K-1106 test kit. Algae thrive at phosphate levels above 125 ppm of orthophosphate. Before overall water chemistry is adjusted, the phosphate level needs to be corrected if possible.

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The easiest way to lower phosphate levels is by draining some of the water from the fountain and refilling with phosphate free water. If the fountain is supplied with municipally provided tap water, test the tap water before adding it to the fountain. If the tap water contains levels of phosphate above 125ppm then this method will not work. If the fountain is filled with distilled water, then this method will work.

Removing phosphate from water is possible using a chelating agent. Chelating is usually not practical in a fountain because once the phosphate is chelated, it must be removed or it may be released back into the water. If sand or diatomaceous filters are being used and they have the ability to be back-washed, then this might be worth exploring, otherwise it may not be reasonable to attempt lowering the phosphate levels.

After making adjustments to the water for phosphate levels, check the phosphate level again in 24 hours. Once the phosphate levels are acceptable, proceed with the rest of the water chemistry testing.

For all fountains, use the Taylor K-2006 test kit and a thermometer to test the condition of the water and find the saturation index number.

When the water chemistry test results indicate changes are needed, the additives should be placed directly into the holding tank or area where the most water is stored within the fountain. If the additives are dry chemicals, they should be diluted in water before being added to the fountain. This will allow for better dispersal. It is preferable to add too little rather than too much. It is easier to add more if needed than to remove excess. Be sure to measure the amount of water in the holding tank before calculating additions.

The following flow-chart goes along with the water testing and adjustments:

If adjustments are needed based on the saturation index results, **begin with the total alkalinity** because adjusting the total alkalinity will affect the pH. It may sound counterintuitive, but total alkalinity is not an adjustment for pH. Even though it affects the overall pH, it functions as a buffer to resist fluctuations in pH.

- If the total alkalinity is low, add sodium bicarbonate, baking soda, or a product called Alkalinity up. After 24 hours check the level again. If it is still low, add more sodium bicarbonate.
- If the total alkalinity is high, drain some of the water from the fountain and add fresh water to the fountain. After 24 hours check the total alkalinity again.

After total alkalinity, **pH is the next crucial adjustment.**

- If the pH is too low add soda ash, sodium carbonate, or a product called pH up. After 24 hours check the level again. If the pH is still low, add more calcium carbonate.
- If the pH is too high, drain some of the water from the fountain and add fresh water to the fountain. Test again after 24 hours. After adjustments are made to the pH, then recheck the total alkalinity.

Finally, test the water's **hardness as total CaCO<sub>3</sub>** (Calcium carbonate).

- If the hardness is too low, then add liquid calcium hardness up or calcium chloride. One should always question when chloride is used around a sculpture. In this case, the amount of free chloride being introduced into the system should not pose an harm to the artwork. NEVER add calcium Hypochlorite. This product is for adding chlorine to pools and will add harmful amounts of chloride to the system.
- If the hardness is too high, drain some of the water from the fountain and add fresh water to the fountain. After 24 hours check the hardness again. It may be worthwhile to also test the water supply for hardness.
- If adjustments were made to lower hardness, re-test the total alkalinity and pH.

Test polyquats levels. Using a Taylor K-1582 test kit one can rely on PPM quantities of available polyquat readings. 20ppm should be a good place to start for the first week. After the first week let the ppm of polyquats drop to between 5 to 10ppm.

Media filters should be inspected weekly. Installing pressure gauges on both sides of the filter affords a quick and easy way to judge if the filters are clogged and need replacing. Other types of filters can be more complicated so refer to their manual or a consultant.

If a UVC sanitizer is installed, read the owner's manual to find out how often the lamp should be replaced and how to maintain the unit. Many of the higher end units have built in cleaning mechanisms that will clean the quartz casing around the lamp so accumulated grime will not block the effects of the UVC radiation.

Some units also have ports built in that allow the attachment of a UVC monitor. If the UVC sanitizer has a "window," be aware that the window only tells you the unit is on, but is not an indication of the amount of UVC that is being produced. Usually after about 10 to 12 months of continuous use, the UVC output has dropped to a level where it is no longer effective.

When using a UVC sanitizer it is important to review the manual that came with the sanitizer to make sure the water is maintained in a way that maximizes the sanitizer's ability to radiate the water. To follow the UVC manufacturer's recommendations, they may ask that you insure the turbidity, manganese, total suspended solids, and iron are kept within a certain range. These are measured with a colorimeter. For these tests, rely on a local pool supply store. Many of the

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suppliers have colorimeters in their store, and they can provide these tests for their customers for a minimal charge.

Another sanitation device that can be found on a fountain is an ozone generator. These add ozone directly into the water. These systems also need maintenance which should be outlined in the manual that comes with the ozone generator.

Ozone generators are very effective at controlling biology, however the possibility of adding ozone to the surrounding environment should also be considered. Ozone can cause health problems for some people with asthma, and ozone can cause degradation in artworks. Ozone scavengers can be added to systems with ozone generators so the ozone will be destroyed before it is exposed to the atmosphere.

While this article may make fountain maintenance seem difficult, it is not. Within a short amount of time the procedure will become routine and simple. The maintenance outlined here applies to all recirculating fountains as the first place to start.

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