Monthly Manager Moments - by Greg Schmidt, Aquatics Manager

Monthly Manager Moments Article #17

Part 2 of a Series on How Pools Work - Filtration vs. Oxidation

Overview -

Filtration is of course the term for filtering the water in a pool. We'll briefly discuss filter types commonly used in commercial pools, and specifically the filters used here at EWU. Oxidation refers to reducing and/or eliminating organic compounds that cause "chlorine smell" and eye irritation. Oxidation is measured in ORP (oxidation reduction potential) by an electronic probe. Chlorine is the most prevalent oxidizer in the pool industry, although other oxidizers are also used. The most common enemy of oxidation is monochloramine NH_2Cl. Although this compound of chlorine provides a little oxidation, it is dramatically less than "free chlorine" which is hypochlorous acid or HOCl. There are other forms of combined chlorine besides monochloramine, but we'll just refer to all forms as combined chlorine.

Why filtration vs. oxidation?

It's because as an operator, we have to keep in mind that oxidation is about 65% of the formula in maintaining pristine, clear, sparking water; whereas filtration is really only about 35%. The filters must work, of course, to keep particulates out of the water, but to get the sparkling quality that some pools have, it requires excellent oxidation. When first filling your pool, crank up the chlorine to provide outstanding oxidation prior to the introduction of swimmers, who will also introduce organic contaminants that must be oxidized. I recommend seeding your pool with granular chlorine (calcium hypochlorite) before you start your pump. If you start with oxidation at a high level, you'll find that the filters are able to clear your pool up very quickly. This pool went from "Shrek's Swamp" to crystal blue in just one day of filtering, thanks to good filters, and high ORP levels at the time of filter start-up. What's high ORP? I recommend 850 mV or higher, to provide essentially constant breakpoint chlorination and outstanding clarity. OK, then what's low ORP? Anything approaching 700 mV is low indeed. It takes just 650 mV to kill most bacteria, but well over 800 mV to get the outstanding clarity that you want.

Pool filters

Pool filters come in two main categories: vacuum filters and pressure filters. Vacuum filters are those in which the pump pulls the water through them; and pressure filters are those in which the pump pushes the water through them. As for types of filters, we see mostly hi-rate sand or DE in the commercial pool industry. Smaller pools and spas may use cartridge filters, similar to your car's oil filter. Regardless of the type of filter, it is either a vacuum or pressure system. Let's look at them individually.

- **Hi-rate sand** - This type of filter is quite possibly the most common in commercial pools, because of it's exceptional filtration rate, low maintenance and reliable performance. Hi-rate sand filters are composed of sealed tanks loaded with sand, all of the same size (#20 quartz silica usually, although some pools are now using tiny glass shards). Hi-rate sand is an improvement on the original sand and gravel filters, which were modeled after the standard river bed. Larger rocks to filter out bigger stuff to progressively smaller rocks to filter out progressively smaller stuff. The cool thing about hi-rate sand is just that - it's speed of filtration, about 20 gallons per minute per square foot of surface area. By comparison, our DE (diatomaceous earth) filters here at EWU filter at just 2 gallons per minute per square foot. Quartz silica sand is a special, very sharp sand - to catch particles as they try to pass by. Because the sharp edges eventually wear off, the sand must be replaced periodically. Smooth sand won't filter worth a darn, so it must be sucked out of the filter and reloaded. Follow the manufacturer's instructions for sand replacement.

Don't worry, it's not a weekly or monthly thing. It only needs to be inspected annually and replaced as needed. Both hi-rate sand and DE filters have some sort of baffle system to prevent the full force of the pool's flow from slamming into the media. Hi-rate sand filters usually have either a plate or sprinkler heads to distribute the flow evenly; and avoid blowing a hole in the sand bed. Hi-rate sand may have auto-backwash features which make maintenance almost non-existent. Although not always trouble free, boy it's great when it's working properly. An operator can backwash this system while at home asleep! Hi-rate sand filters are truly "backwashed" whereas DE filters are hosed down. The term backwash refers to reversing the direction of flow through the filter to lift the dirt off of the sand bed and flush it down the drain. This requires backwash pipes and manifolds, and additional valves to create the backwash cycle. The flow rate for filtration and backwash is about the same for most hi-rate sand filters. Other than replacing the media periodically, what other problems do hi-rate sand filters present? Just a couple. "Channeling" is a term that refers to mud balls hardening into rocks that can penetrate the sand bed and form a channel behind them. If the channel goes all the way through, or even quite a ways into the sand bed, the distribution of flow will be disrupted; because the water will seek the path of least resistance - which is the channel. That water will receive far less, if not zero filtration! Another phenomenon to watch out for with hi-rate sand is called tumbling. This refers to throwing sand down the drain when backwashing. Be sure to set your backwash flow rate exactly as the manufacture recommends. Too fast = tumbling and loss of sand, maybe even clogged up drain pipes. What you want is to lift the sand bed at the surface to release the dirt without throwing the sand down the drain. This system is usually driven by a flooded suction pump that pushes the water through the filters (pressure hi-rate sand).

- **DE** - Traditional Diatomaceous Earth filters are usually vacuum systems. A vertical turbine pump pulls the water through the filters and then pushes it back into the pool. Vacuum DE systems are installed in an open surge tank/pit. The filters are attached to a manifold in the center, either directly or via laterals that come out from the manifold. Since DE filters at such a slow rate, much more surface area is required to do the same job as hi-rate sand. For example, if your pool requires 800 GPM of flow like this one, 400 square feet of filter surface is required. We have 480 square feet here. With hi-rate sand, only 40 square feet would be needed. Although DE was the super cool thing in the late 70s and early 80s, hi-rate sand replaced many old school DE systems as pools were renovated. Another DE system emerged about a decade or so ago - regenerative DE. This is sort of a hybrid between hi-rate sand and traditional DE. DE media is still used to coat filter elements to provide the filtration, but like hi-rate sand, the elements are contained in a sealed vessel and can be actually backwashed. Another cool feature of these hybrid systems is the ability to "bump" the filters. This refers to shaking the elements, or stopping the flow to allow the media to redistribute itself in a different pattern, thus opening new spaces for dirt to be caught. This practice is used on all DE systems, old and new to extend the filter run. DE filters very well, and is on the lower end of the micron range for filters, at around 10 microns. Although it won't catch bacteria or protozoa, it will catch some pretty small stuff. FYI: We cannot see anything smaller than 40 microns with the naked eye.
- **Cartridge filters** - These filters are rarely used in large commercial settings, but are pretty common in very small pools or spas. They are contained in a sealed vessel, like the filter in your shop vac, and are removed for cleaning the same way. Most operators will just have a couple of extra ones on site, to quickly substitute the clean one for the dirty one. They don't filter as fine as hi-rate sand or DE, but will do an OK job if you maintain high ORP.

- **Polymers** - Although not actually filters, they are certainly an effective filter aid. They attach themselves to objects in the water, including cryptosporidium protozoa, making them bigger than 10 microns so they can be caught in the filter. Some of the polymers can help catch things less than 1 micron in size. These are not cheap, however; and must be set up on a continuous feed system, to make them effective. For some pools where lots of small children and/or other high risk groups are frequent customers, polymers make a lot of sense. They're an alternative to medium pressure or low pressure amalgam UV systems.

Oxidation

Oxidation is probably the most important, and sometimes the most difficult part of the pool clarity puzzle to maintain. Our goal for oxidation is continuous breakpoint; which means that the water has so much oxidizing power that all organic compounds are constantly being eliminated/oxidized. No build-up of combined chlorine is allowed to occur. Combined chlorine is our main enemy, causing vitually 100% of eyeburn and irritation, plus the classic "chlorine smell" of many swimming pools. Why is it difficult? Because it depends upon many things, some of which you cannot always control. To maintain high ORP, at 850 mV or better, the following conditions must exist: low pH - around 7.3, 7.4 at most; zero or low cyanuric acid; zero or low combined chlorine; free chlorine of 3-5 PPM; predictable bather loads; reliable oxidizer feed system. You can see that any one of these conditions may get messed up and reduce ORP below the desired levels. When that happens, operators may need to superchlorinate their pool to again reach breakpoint chlorination level. What does that mean, anyway? Breakpoint is the point at which the oxidation has overwhelmed the combined chlorine and eliminated it, so only free chlorine remains.

Glossary of terms

Filtration - the process of filtering the pool's water to obtain clarity.

Backwashed - the term for reversing the flow to the filters, to lift the dirt off the surface and send it to waste. Traditional vacuum DE filters are not backwashed, but merely hosed down.

Hi-rate sand filters - 20 GPM/Ft^2 filtration rate, special grade #20 silica sand, creates a 3 dimensional filtering effect, due to the depth of the filtering ability. Filters composed of sealed tanks through which the water must pass to get filtered.

Bumping the filters - stopping the flow, or shaking the elements to redistribute the media and extend the filter cycle.

Mud balls - clumps of dirt that become hard and form "rocks" that can penetrate the sand bed, creating channels.

Channeling - see mud balls above.

Tumbling - too much flow on backwash cycle that results in loss of sand, due to flushing it away to waste.

Surge tank - a collection tank where surge is accommodated. Here, it's also the filter tank.

Vacuum DE filters - 2-2.5 GPM/Ft^2 nylon filter sleeves coated with DE or other media. Vacuum DE means that the pump is after the filters and the water is pulled through. System composed of a surge tank/filter pit in which the filters are positioned. Water must flow through the filters to get to the pump's impeller.

Vertical turbine pump - Tall, vertical pump system, with one or more impellers, typically associated with vacuum DE filters.

Oxidation Reduction Potential (ORP) - the oxidizing power of the water. Generally, the higher the better. ORP is about 2/3 of the contribution to pristine water, and filtration about 1/3.

Regenerative DE - a hybrid DE system, contained in a sealed vessel; with backwash capabilities.

Questions about filtration or oxidation? Send me an email: leos@ewu.edu