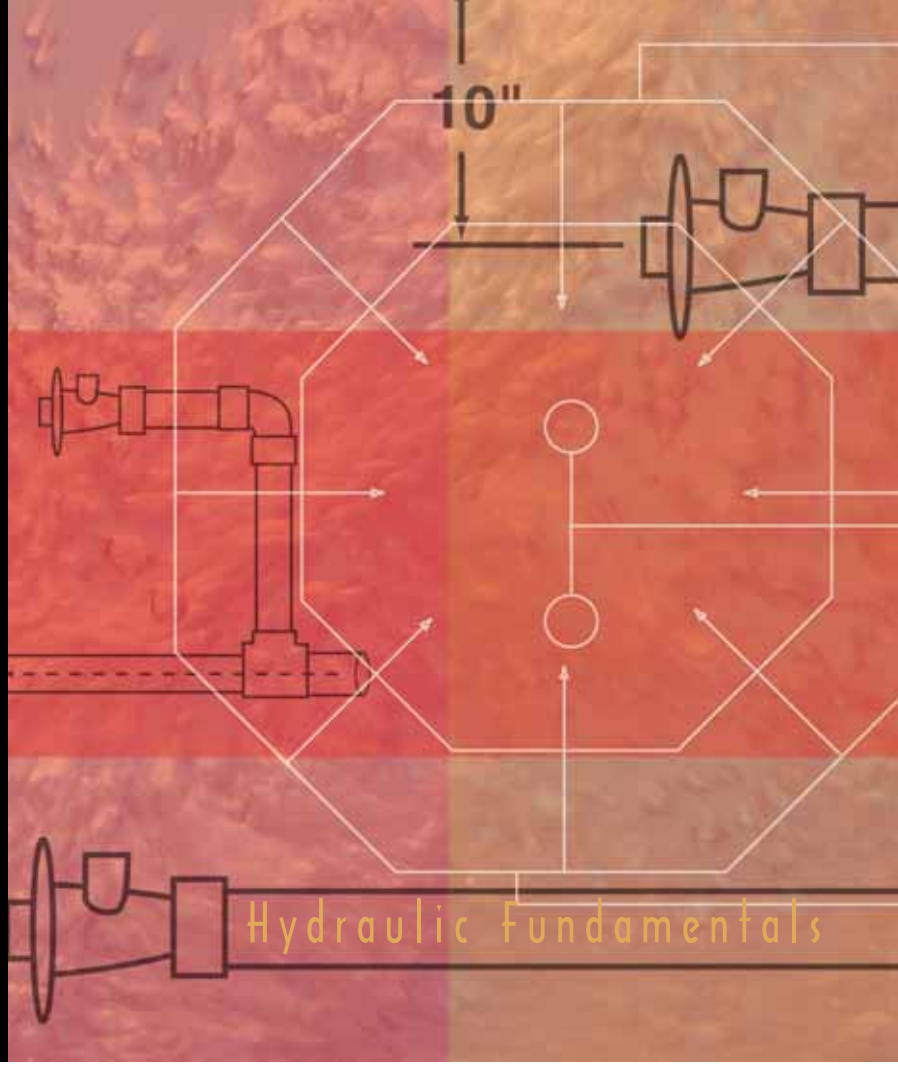
Crystalline Clarity

By Steve Gutai

The key to clear and clean water in just about any successful watershape is effective and efficient filtration. What this means for residential pools and spas in particular, says hydraulics expert Steve Gutai, is that the watershaper needs to understand the characteristics of available filter media as well as the nuts and bolts of how filters are installed. Here, he breaks down these basics with an eye toward matching systems perfectly with specific applications.



In conceptual terms, watershape filtration is about as simple as it gets: Water that picks up insoluble organic materials in the form of dirt, debris, dust and algae is drawn by the pump to pass through a filter medium of one type or another. The medium – whether sand, a cartridge or diatomaceous earth – traps these materials and lets only clear, clean water back into the vessel.

When the pump sends the cleaned water out of the filter, that water returns to the pool to dilute the dirty water in a continuous cycle of cleansing and dilution that ultimately results – when the system is set up the right way – in clear, clean water that's both aesthetically pleasing and safe.

Sand, cartridge and diatomaceous earth filters have long dominated the market, and each requires a filter tank with internal components specific to the filter medium it uses. There are common components (as discussed at the end of this article), but it's important for the watershaper to know that the three main filter types have different natures, different installation requirements, different applications and different sets of benefits.

Sand Solutions

Filtration via sand is the oldest form of water filtration and has historically worked well in residential and commercial swimming pools and particularly well in ponds, whether fish are present or not – although it's not typically used with spas for reasons discussed below.

A sand filter works through what is known as *depth filtration*. In this process, an internal *diffuser* evenly distributes the water coming in from the pump over the surface of a sand bed. The water travels down through the sand bed, driving the dirt and debris into the layers of sand, and finally reaches the tank bottom. Stripped of dirt while moving through the sand bed, the water is now collected by an *under-drain* or *laterals assembly* and returned to the vessel.

❑ **The Medium:** The most common sand used in these filters is #20 standard silica sand. The rough edges of these sand granules are what collect the particles of dirt. Over a long period of time (generally five to ten years, depending on usage, weather and other factors), the rough edges erode and become smooth, at which point the sand needs to be changed. This is a major undertaking that requires disassembling the filter.

Supplementing the sand bed and increasing the efficiency of backwashing, pea gravel is often placed at the tank's bottom to cover the laterals. This material should have diameters between 1/8 and 1/4 inch.

To clean the sand bed, a *backwash cycle* is initiated in which the flow of water to the filter is reversed: The water is pumped to the under-drain laterals at the bottom of the tank and flows upward, disturbing the sand bed and effectively sending the top six inches of sand into solution while flushing the dirty water up through the diffuser and out the backwash valve to waste.

There are several options when it comes to this backwashing step. The sand fil-

ter on a residential pool, for example, may be equipped with either a push-pull, full-flow or top- or side-mounted multi-port valve, while commercial pool systems will tend to use a series of butterfly valves or an electronically controlled auto-backwash system.

The backwashing cycle on most sand filters typically takes somewhere between two and five minutes. As for timing, backwashing should always be based on an increase in filter pressure rather than on a time frame. In other words, there's no such thing as a "weekly backwash."

❑ **Installation:** When installing a sand filter, it's important to keep a few points in mind. First, plumb the filter after the pump (but before the heater). Second, make sure as well that the filter is sized to accommodate the pump's flow.

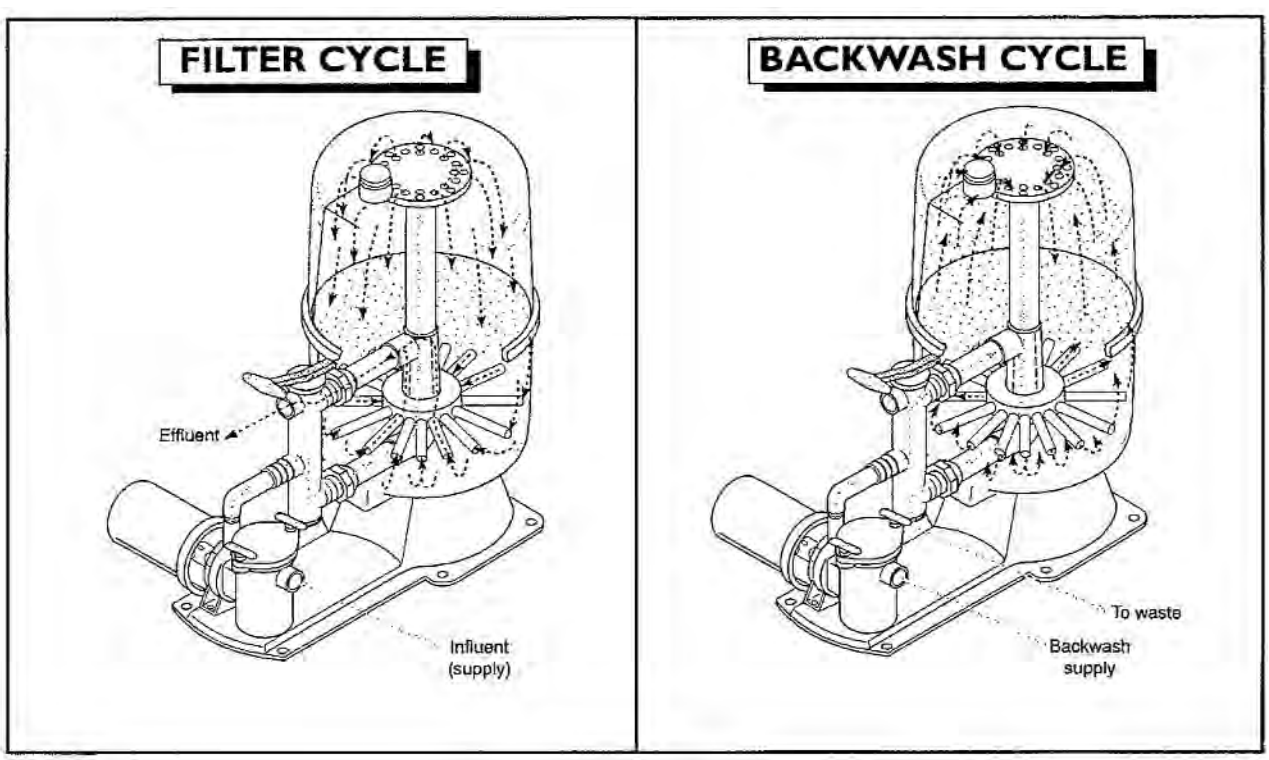
This is a very important point. The National Sanitation Foundation (NSF) requires a maximum of 20 gallons per minute per square foot of surface area for residential pools and a maximum of 15 gpm per square foot for commercial pools. If the flow rate is too high, it will cause *channeling* – that is, free-flow pathways through the sand bed that significantly reduce the filtering action. If, by contrast, the pump is undersized, then the backwash cycle will not have enough flow to disturb the sand bed and little of the debris will flow to waste.

Photo courtesy Commercial Pool Repair, Scottsdale, Ariz.

It's also important to think about convenience of repairs and maintenance in positioning the filter on the pad – and therefore to make certain that the drain plug on the tank bottom is accessible.

❑ **Considerations:** Sand filters aren't for every vessel. For starters, they remove only relatively large particles (in the 25-to-100-micron range), which means that there are some very small particles that will inevitably get through. This can be a concern in some applications.

You also need to consider the practical issue of how the backwashed water will be handled: If you tie the backwash valve into a drainage system or a P-trap, you need to know it can handle the flow. And if the body



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of water is small, you need to be aware that you'll end up draining away a good portion of the system's water during backwashing.

This last point is partly why sand filtration is not the best choice for spas: Because of the long backwash times and the fact that spas typically hold small volumes of water, you can end up draining most of the vessel during backwashing. In addition, because of the high temperatures of spa water, bathers' body oils are more readily released and will tend to seal the surface of the sand bed. This will pack the filter and shorten filter cycles considerably.

Pleat Bargains

Although cartridge filters have been on the market for decades now, they remain the newest type of filtration used on swimming pools and spas. Cartridge filters work by means of *surface filtration*, meaning that the debris is captured solely on the surface of the filter media as the pump pushes water through a spunbonded polyester-fabric cartridge.

The main internal component of these filters is the cartridge (or a series of fabric cartridges). These units provide a great deal of filtering surface area compared to other filter types, which means longer filter cycles and less time spent in maintenance.

The cartridges are usually connected to a *manifold* and a *locating device* of some sort used to hold the cartridges in place. The water flows into the filter tank's body, where it is diverted through the cartridge or cartridges by a baffle. The particles of dirt and debris are deposited on the surface of the cartridge.

❑ **The Medium:** The filtering action with cartridges occurs on their pleated-fabric surfaces, which are capable of removing particles down to 15 or 20 microns – and even smaller in some cases, depending on the manufacturer and the medium.

For cleaning, the filter cartridges are removed from the tank and hosed off. If the cartridge is coated with body oil, suntan lotion, calcium, algae or rust, it must be soaked in a solution of tri-sodium phosphate or some other commercial cartridge-cleaning agent. Once it's clean, the cartridge is returned to the filter.

As with sand filters, cleaning times are dictated by internal pressure in the system. When that pressure rises by 10 psi from its initial (clean) reading, the cartridges need to be cleaned once again.

❑ **Installation:** Filters of this type are perhaps the easiest to install. They're plumbed on the discharge side of the pump (and before the heater) and require no drains or P-traps for any sort of backwash valve.

When installing these units, however, you need to keep in mind that they'll need to be disassembled frequently for servicing and that you need to leave enough space around the filter for easy access. Even so, the process is simplified because cartridge filters require no backwash valve, which means the plumbing ports can be located on different planes or tank locations.

Photo courtesy Premier Pools, Rancho Cordova, Calif.

❑ **Considerations:** There's great flexibility with cartridge filters in that their smaller tanks can be mounted in a variety of positions relative to plumbing connections. This is a big advantage when it comes to portable spas, for example, where under-skirt geography can get quite convoluted. A helpful spa variant involves installing the cartridge within the skimmer throat. (This sort of flexibility is why the spa industry uses cartridge filters almost exclusively.)

With cartridge filters, however, you must watch your flow rates carefully. If the flow rate is too fast, it will drive the dirt particles through the filter cartridge and back into the pool – and if it's *way* too fast, the cartridge's medium can fail.

The maximum flow rate for residential

usage is .75 gpm per square foot of surface area. For commercial vessels, the recommended rate is .375 gpm. There are no recommended minimums: the slower the water flow, the better.

Diatom Digest

Diatomaceous earth (D.E.) filters haven't been around quite as long as sand filters, but they have a long and varied history of use by the swimming pool industry.

The filter tank in a D.E. system holds an internal *grid assembly* set up in a wide range of sizes, shapes and configurations by various manufacturers. The grid itself is a plastic styrene frame encased in a specially woven polypropylene grid cloth. The pump draws water through the grid covering and the *cake* of D.E. that coats the grids.

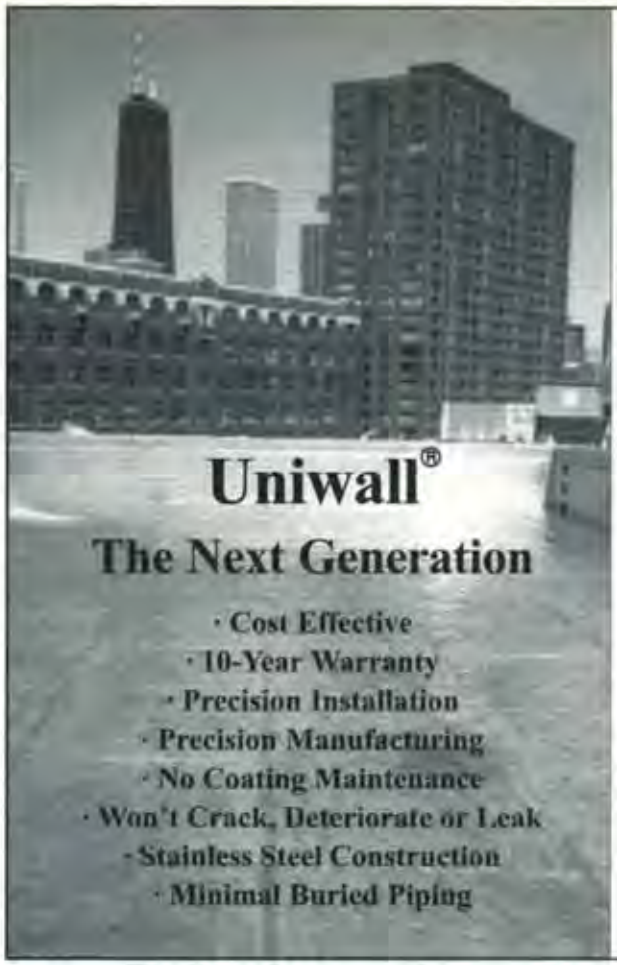
The cake traps debris at the surfaces as well as across the depth of the coating – hence these filters can be said to work by both surface and depth filtration. The water passes through the grid and then exits the filter through the manifold that holds the grids in place.

For the most part, D.E. filters are pressure filters and are set downstream of the pump and before the heater, as is the case with sand and cartridge filters. In some cases, however, D.E. filters are set up on the vacuum-side of the circulation system – that is, before the pump – but this is mostly true of older residential and commercial pool systems.

❑ **The Medium:** Diatomaceous earth is a powdery material made up of the fossilized remains of ancient aquatic microbes known as *diatoms*. These tiny fossils are extremely porous and have rough surfaces that catch dirt and debris as water passes through it under pressure.

They make a wonderful filtering medium, removing particulates from swimming pool water down to 3 to 5 microns. The resulting water clarity is extremely sharp, which is why this form of filtration is so dominant in some regions.

As with sand filters, D.E. filters can be cleaned by backwashing. Here, the water flows through the manifold and up into the grids, blowing the caked D.E off the grids and sending it to waste. When backwashing is complete, fresh D.E. is added to the system to recoat the grids. (Note:



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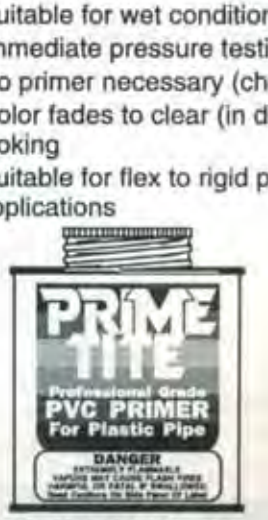

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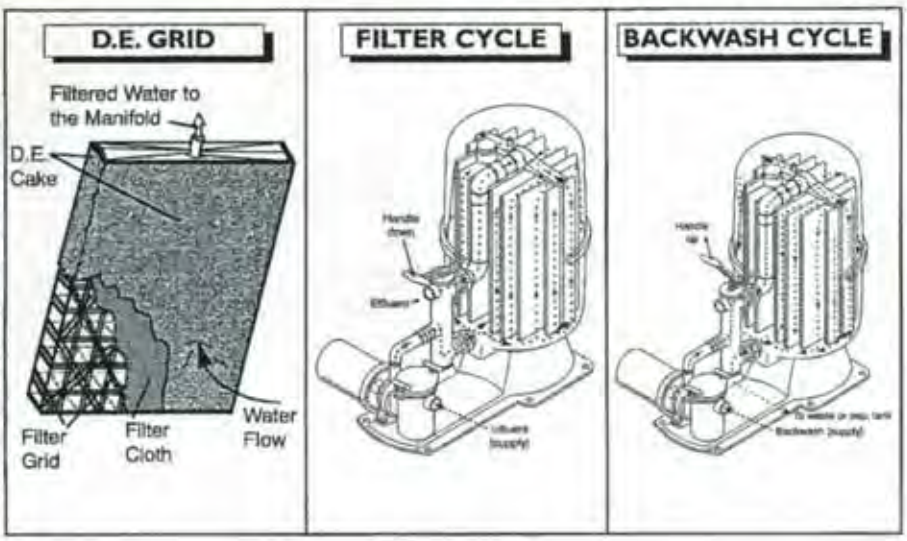

In commercial applications, systems can include auto-backwash valves equipped with special slurry-feed systems that add D.E. to the filter after it's been cleaned.)

D.E filters use a variety of backwashing valves. Push-pull valves (or piston-style backwash valves) are connected directly to the filter tank's inlet/outlet ports via unions. Multi-port valves are another option that permits the operator to winterize, rinse, and bypass the filter water to waste. Some models of D.E filters have a rotor-style backwash valve in the tank bottom. There are also full-flow backwash valves – increasing in popularity because they are designed to function with minimum frictional losses. Multiple gate or butterfly valves are also used in some applications.

Separation tanks are a water-saving option that give the operator the ability to send the backwashed water back to the swimming pool rather than to waste. The water coming off the backwashing is sent to a tank where a fine-mesh polyester sack catches the debris before sending the clean water back to the pool.

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❑ **Installation:** Because D.E. filters need to be taken apart for service at least once or twice annually – and because the process of cleaning old, caked D.E. can be a messy proposition – installing these filters away from landscaping is a good idea. When the D.E. dries, it becomes a fine dust that gets into everything and may carry some health issues with it as well.

For those and other reasons, it's best to leave enough room in the equipment area for proper servicing of these filters.

❑ **Considerations:** The drainage system used for D.E. filters is a special concern. Not only do you need to make sure that the drain is adequate for the flows involved in filter cleanings, but also you need to be sure the lines flow well enough that they won't allow the D.E. to settle out and collect to create clogs that will be difficult to remove.

Charging the filter with D.E. is also a messy chore. The material must be mixed with water to form a slurry that is slowly fed into the skimmer at the level of one pound of D.E. for every 10 square feet of filter surface area.

Flow rates for D.E. filters are 2 gpm per square foot of filter area for residential applications, 1.5 gpm per square foot for commercial projects.

Common Bonds

Despite the basic differences among the three main filter media and the technologies used to put them to work, filtration systems of all types have certain key features in common.

For the most part, for example, modern residential swimming pool filters are installed *after* the pump (that is, on the pressure/discharge side of the pump) and before the heater. They can all be installed on the suction side – that is, *before* the pump – but this will change the filter's performance because more debris will be introduced to the filter – as if it were being asked to act as a pump strainer. Flow rates are reduced in these configurations, and filter cycles are shortened as well.

In addition, all filters look similar, with a main tank body that sits on a base. The tank body itself will have one or two pieces. If there's just one piece, you'll find a small lid that clamps or threads onto the top. Some sand filters and most D.E. and cartridge filters, by contrast, come as two pieces held together with a tank band or a series of bolts or clamps – although smaller D.E. and cartridge filters will sometimes be single body with a threaded or clamped top lid.

These filter tanks are manufactured using a variety of different materials, including plastic, fiberglass, stainless steel and various composite materials. No matter the type, each will have a pressure gauge to indicate operating pressure and an air-bleed assembly to relieve pressure from the build-up of air in the tank body. Finally, at each tank's bottom, no matter the type, you'll find some sort of drain for servicing purposes.

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