FILTRATION FUNDAMENTAL

Project-specific needs determine commercial pools' choice of filtration systems

By: Ken Ward and Scot Hunsaker

The process of choosing a filtration system for any aquatic facility starts with gaining an understanding of filtration basics and the options that are available. Making the right decision is then simply a matter of finding the best match between a system and the needs of the facility.

To begin, pool water is kept clean through two methods: Sanitation and filtration. Sanitation is achieved by using chlorine, ozone, bromine or other oxidizing agents to kill the microscopic dirt in the water – bacterial debris left behind by noses, diapers and algae spores blown in by El NiÑo, To keep larger particles such as hair, bugs and leaves from flowing endlessly through the recirculation system, the water has to be filtered as well as sanitized.

Filtration systems come in all shapes and sized, but there are essentially three filter media: Sand, diatomaceous earth (D.E.) and cartridge filters. These filters all work the same way. During normal operation, water from the pool enters a tank –a concrete chamber as big as a room or a fiberglass vessel tucked under a bush – where it is slowed down and distributed uniformly across the filtration media, and forced through the media by either gravity, pressure or vacuum. After passing through the filter, the water is collected and returned to the recirculation piping system where it continues back to the pool.

It is a good idea to backwash when the pressure gauges, not the calendar, indicate it's time.

Although the different systems work similarly, there are a number of reasons to choose one method over another, including variations in the cost to build, cost to operate and maintain, effectiveness and ease of operation. The decision will depend on the size of the facility, bather load, construction and operating budget, and an understanding of the knowledge and dependability of the operators.

Cartridge filters are primarily used in the technical industry and in residential pool and spa systems, as they can be designed to capture the tiniest particles. Commercial aquatic facilities rarely use cartridge filters and are more likely to use sand and D.E. systems.

SAND FILTRATION

In commercial aquatic operations, sand filtration is the most widely used filtering system because it is reusable and relatively easy to service, making it less expensive to maintain.

Sand filters have a distribution system typically on the top of the filter that disperses the incoming water uniformly over the sand bed. This slows the water and provides a uniform velocity approaching the sand bed. A distance is usually left between the underside of the distribution system and the top of the sand bed. This space, called the "freeboard," provides enough room to allow the sand bed to expand when backwashing.

Below the sand bed is a second set of pipes called "laterals". Lateral pipes have a protective screen around them, or small openings in the pipes, so they can collect the clean water without letting sand escape from the filter tank back into the pool.

As the dirty water enters the tank, passes through the sand and enters the laterals as clean water, there is a pressure drop, called "head loss". The drop in pressure is typically less than 3 psi in a clean filter (see "Particular Matters"). A filter's cleanliness is measured by monitoring the head loss with a pressure gauge. As dirt builds up in the sand, resistance increases and pressure drops. When the pressure, or head loss, reaches a level indicated by the manufacturer -- typically 10 to 15 psi -- it's time to backwash the system.

Some operators make the mistake of backwashing too often. As dirt builds up in the sand, it fills in the holes and actually helps the sand catch smaller particulate matter (dirt). Therefore, it's a good idea to backwash when the pressure gauges, not the calendar, indicate it's time.

It is also important to regularly inspect the filter sand, typically every five to seven years. The sand should appear flat, level and evenly distributed throughout the tank. Over time, however, a degradation of the sand media can occur, causing it to clump together, creating "channels" and "mud-balling" within the filter. These occurrences reduce the effectiveness of the filter, indicating it's time to buy new sand.

Filter sand should appear flat, level and evenly distributed throughout the tank.

The sand in the sand bed is specially selected for its grain size and uniformity, and it is important that the operator follow the manufacturer's guidelines in using the type of filter sand specified. If the grains are too big, they won't adequately filter out particulate matter in the water. If the grains are too small, they will inhibit adequate water velocity through the filter, and possibly pass through the openings into the laterals, ending up on the pool floor instead of in the filter.

The wrong size sand also will result in pressure readings that differ from those recommended by the manufacturer, and could result in damage to the pump motor. So if you're tempted to save some money and bring some beach sand home from your next vacation, be advised that it could be an expensive mistake.

There are three types of sand filters: gravity, rapid-rate and high-rate and. Gravity sand filters are frequently found operating at older swimming pools, but are rarely used in contemporary construction. Because they operate at an extremely low velocity – in the range of 1 gallon per minute per square foot of filter area (gpm/sf) – they require a very large area to meet today's codes and standards. Most projects can't afford this inefficient use of space.

Rapid-rate filters are somewhat more efficient, operating in the 3 to 7 gpm/sf range. In rapid-rate sand filters, the media is not one consistently sized sand grain, but rather several layers of sand and gravel, with smaller granule layers resting atop larger granule media. In practice, only the top layer does the filtering job, while the three to five layers of gravel under the sand merely support the filtering media.

Unlike sand, D.E. cannot be recycled. When the filtering media becomes dirty, it must be manually hosed off and discarded.

Since only the top few inches of sand are doing the work, another media, called a flocculent, is usually layered on top of the sand to increase its filtering capability. Alum and polymer/alum blends are two common flocculent materials used to improve the efficiency of rapid-rate sand filters.

Although they are an improvement over gravity systems, rapid-rate filters still have large area requirements, an inefficiency many modern projects can't tolerate, particularly indoor aquatic facilities. For that reason, the most popular sand filter system in contemporary construction is the high-rate sand filter.

High-rate filters, as the name suggests, operate at a much higher velocity –in the 15 to 20 gpm/sf range. The combination of this higher flow rate and a deep media bed consisting entirely of sand results in a system that efficiently traps dirt and debris deep in the filter, while allowing for the overall filter size to be much smaller than other systems. When calculating construction and operation costs for indoor aquatic center, space is precious, and extra feet gained from the filter room can be cut from building costs or added to revenue-generating spaces.

High-rate filters come in pressure and vacuum variations. The pressure system operates as described above and the vacuum system operates similarly, but with the filter located on the suction (or vacuum) side of the pump. As a result, water is pulled, rather than pushed, through the filtration media.

Selecting the right pool filtration system is more than just a matter of personal preference.

A vacuum sand filter is typically an open-topped tank, the top of which is located slightly above the water level of the pool. The water in the filter tank is kept below the pool water level. The filter operates by allowing water to flow by gravity from the gutter and main drain of the pool to the filter.

This system is one of the easiest filtration systems to operate and maintain, but because of its design, the overall depth of the filter must be looked at very critically and the dirt collected by the filter must be loosened from the particles of sand.

DIATOMACEOUS EARTH FILTRATION

Diatomaceous earth filters are extremely efficient, capable of capturing much smaller particulate matter (5 to 10 microns) than sand filters (40 to 50 microns). But there are drawbacks to the filters that can make them an inappropriate choice for many contemporary aquatic facilities.

D.E. is a white or cream-colored earth composed of the skeletal remains of single-cell algae called diatoms used in various industries as a filter, absorbent, clarifier and insulator – and, in the aquatics industry, as a filtration media.

The D.E. filter system consists of filter leaves, which are connected to individual septa, or main suction headers. These header, which can be located at the top or bottom of the leaves, are then joined together to lead out of the tank.

As with high-rate sand filters, there are pressure and vacuum D.E. systems. The vacuum system is usually an open-topped concrete tank located at the same level as the pool water level. Water drains by gravity into the tank, filters through the large D.E. –coated leaves and is pulled by suction back into the pool.

The pressure system is typically a stainless steel cylindrical tank. Instead of leaves, the filter elements are long, hollow filaments with D.E. caked on the outside. Water is pumped into the lower section of the cylinder, passes through the filter element and clean water is drawn to a chamber at the top of the tank. Each of the filaments terminates in this camber where the water is sent back to the pool.

In both systems, the D.E. material must be applied to the filter leaves in a precoat or precast process. In this process, the filter tank is closed off from the pool. D.E. is then introduced into the tank and the water is recirculated to coat the leaves. The pressure filters have a feature that occasionally “bumps” or dislodges the D.E. from the filter elements, then recoats itself to provide a new filter surface.

Diatomaceous earth filters are highly efficient, producing sparkling clear pool water under the heaviest bather loads, but they are certainly not perfect.

Unlike sand, D.E. cannot be recycled. When the filtering media becomes dirty, it must be manually hosed off and discarded. At one time, that simply meant flushing the used D.E. into the local storm sewer. Now, however, many local and state Department of Natural Resources policies require D.E. – contaminated water to be disposed of in sanitary sewers; some even require the wastewater to be handled as hazardous waste. These issues – along with the labor-intensive task of cleaning and recoating filter leaves, and the expense of replacing the D.E. – make diatomaceous earth filters less attractive to commercial aquatic facilities than cheaper and less labor-intensive sand filters.

DECIDING FACTORS

With their various benefits and drawbacks, selecting the right pool filtration system is more than just a matter of personal preference. Pool designers need to consider a wide range of issues in determining which system is right for each project. What are the bather load requirements? Is it an outdoor pool in a dusty prairie community or an indoor pool protected from the elements? What’s the budget for construction cost, operation and maintenance? Is space a limited factor” How sophisticated is your operating staff? Is total automation required, or can they handle labor-intensive maintenance?

By answering these questions, a pool designer can select the filtration system that will best serve the owner immediately and for years to come.

Scot Hunsaker is vice president of an aquatic design firm, Counsilman/Hunsaker & Associates, 4969 Ambs Road, St. Louis, MO 63128, 314-894-1245.

PARTICULAR MATTERS

The terms used in discussing filtration systems often demand more technical detail. Here’s additional information on a few of them.

gpm/sf

By definition, the filtration rate is the volume of water passing through a filter within a specific time over the surface area of the filter. The units are typically given as gallons per minute per square foot of filter area, or gpm/sf. This is, in fact, the velocity of the water as it passes through the filter media. The more general term of gpm/sf, however, has been adopted to simplify the calculations of the total recirculation rate a filter can accommodate, or the calculation of the total surface area of the filter required for a given recirculation rate.

Advanced Sand Filtration

The depth of the filter and the height of the backwash trough are very important. If the backwash trough is located too close to the sand bed, the trough will influence the sand bed of the filter. If the trough is too close to the elevation of the pool, the difference in elevation between the pool and the backwash trough will not be great enough to achieve the flow rate required to backwash the filter adequately (since the backwash is typically driven by gravity flow from the pool.)

Sand Standards

The type of sand that is most commonly used today is referred to as NSF Standard 50 sand. This sand has a coefficient of uniformity of 1.63 and a grain size of 0.45 to 0.55 millimeters.

National Sanitation Foundation

The National Sanitation Foundation (NSF) is a not-for-profit entity that approves aquatic facility systems, including equipment and how it can be used in the field. Sixty to 70 percent of state codes require NSF approval, and many manufacturers use NSF standards as governing rules for what equipment can be placed on pools. It is important to be aware of these standards and understand them when comparing, purchasing and installing equipment. For example, the head loss through a clean sand filter is typically less than 3 psi, and many pump manufacturers design their pumps to this standard. The NSF, however, currently allows filter manufacturers to build sand filter systems that require greater than the typical 3 psi initial pressure drop across the filter. If the pump is not designed to handle the pressure created by the filter, filtration performance could be adversely affected, or damage to the pump could result.

(filtrationfundamental.1)