

Chapter 6

Design of Leisure Pool Filtration Systems

by Chuck Neuman

Editors Note: This informative chapter is a new addition to the 2nd edition. Chuck Neuman, a world-wide recognized expert is also a good friend of mine who has helped me often during my career. I thank him for his time and effort writing this excellent chapter.

The design of water-treatment systems for leisure pools has progressed tremendously in recent years. Widespread use of shallow-water pools for leisure use and activities, combined with high swimmer loads, has resulted in treatment systems much larger than those installed in conventional pools.

Many components comprise the successful design of a leisure pool, whether indoor or outdoor. In addition to special features, the proper design and construction of the filtration system is of utmost importance for both owner and operator. The real lesson here is that there are no inexpensive routes or shortcuts to safe, clean, sparkling water for your facility guests.

It is important to keep in mind that filtration and disinfection are two separate issues; they do, however, become dependent upon each other during this complex process.

The distinction between indoor and outdoor leisure pools is a valuable point of discussion that needs to occur for a proper design. Indoor and outdoor pools alike need to filter out particulate matter and, at the same time, disinfect the water. This certainly seems straightforward enough, especially if one is still thinking in terms of the traditional pool with its high water volume and a relatively light bather load.

But the products of high body loads need to be removed more quickly and efficiently than ever. This high load is common to both indoor and outdoor pools. Although there are some similarities, each type of pool is faced with different challenges that must be considered for the proper design of the filtration system.

It is impossible to discuss the design and proper sizing of leisure pool circulation and filtration accurately without

explaining the thought process that should be developed by agencies and operators considering either the renovation of an existing facility or the design of a new one.

Turnover

The discussion of turnover (the amount of time required to pump the nominal pool-water volume once through the filtration system) is one that will generate different opinions from designers, contractors and clients.

At a high (or fast) turnover, the treatment system is capable of dealing with large amounts of particulate matter and contaminants. There is a price to be paid to handle the higher flow, however, in terms of the filter area and the number of filter vessels required. The result may very well be an increase in the required mechanical space. An example: For a 100,000-gallon pool with a six-hour turnover, the flow is 278 gallons per minute (gpm), while the flow for the same pool with a two-hour turnover is 833 gpm.

The increased flow requires larger pipes, more supply inlets to distribute the treated water and a properly sized return system to feed the used water back to the filtration plant. The higher flows (with the correspondingly larger piping), the increased space requirement in the mechanical room, and the increased size and/or number of filters have become common in today's successful leisure-pool facilities.

Some of the more progressive state health departments have begun developing guidelines for leisure facilities that aim to lower the number of design variances required. As part of those guidelines, they recognize the

importance of lower turnovers and are attempting to develop rules to govern that issue. The newly proposed ANSI/NSPI-9 guidelines will also address turnovers, primarily for outdoor facilities, in addition to other areas. The design industry has developed some unwritten turnover-time guidelines that have been used on many past and proposed indoor and outdoor facilities. See Table 1.

Type of Pool	Outdoor	Indoor
Spray Areas	15 to 30 min.	15 to 30 min.
Children's Activities	15 to 30 min.	15 to 30 min.
Slide Pool	1 hr.	30 min. to 1 hr.
Tube Ride	1 to 2 hrs.	30 min. to 1 hr.
Zero-Depth Pool	1 to 2 hrs.	30 min. to 1 hr.
Activity Pool	1 to 2 hrs.	1 hr.
Wave Pool	1 to 2 hrs.	1 hr.
Slow/Action River	2 to 3 hrs.	1 to 2 hrs.

One can see that these times are dramatically lower faster than the traditional six to eight hours used in the past. They are, however, required to maintain clean water with high bather loads.

Filtration

For all filtration systems, regardless of the type of filter(s) used, the filter size is based on turnover and the associated flow per square foot of filter area.

At the previously calculated flow of 833 gpm (for a 100,000-gallon pool with a two-hour turnover) and a filtration rate of 8.5 gpm/sf, one requires 98 square feet of filter area, equivalent to two 96-inch-diameter single cell vertical filters or three 48-by-96 inch horizontal filters.

At a flow of 15 gpm/sf, one needs 56 square feet of filter area, meaning one 102-inch single cell vertical filter or two 48-by-72 inch horizontal filters.

If a full ozone system is used for additional disinfection, taller vertical tanks with special ozone linings are recommended.

All filters are based upon a specified flow in gallons per minute (gpm) and square foot (sf) of filter area. Pressure sand filters, depending on their design, will handle from 3 to 20 gpm/sf, as do vacuum sand filters (open tank filters). Diatomaceous earth (DE) filters, with a much thinner active filter depth through the coated leaves (or septums), typically are rated at 1 to 2.5 gpm/sf.

Flow rates for all filters are set by an independent testing agency; the most prominent in the United States is the National Sanitation Foundation. Approved filters are listed in an NSF publication that provides sizes, models and flows that have been tested. Today, most local health departments recognize the NSF as the accepted standard.

The most common type of filtration in the United States is *pressure sand filtration*. It is primarily used for ease of operation, space efficiency and durability.

Some of the most successful applications use the mid-range filtration rates of 7.5 to 12 gpm/sf, which result in excellent efficiencies for the removal of particulate matter, allowing the sand bed to hold larger amounts of dirt, and extending the backwash cycle.

Backwashing can be a frequent occurrence for these leisure facilities, depending upon the bather load, although that is not necessarily a nuisance, it may actually be a benefit because some dilution with fresh makeup water is effective in handling the heavy bather loads, both with respect to particulates and bacteriological contaminants.



(Photo courtesy of Water Technology, Inc.)



(Photo courtesy of Water Technology, Inc.)

Pumps

The increase in turnover, from six to eight hours in the older pools to one hour or less in modern leisure pools, results in a corresponding increase in the pumping capacity.

While the head pressure of the pumps barely changes, the increased flows require a proportional increase in pump size. Not only do leisure pools have much higher flows through the filtration system, but there also is an increase in the size of the return piping and the number of outlets in the pool. That means that the proper design of the supply flow system (the treated water piping to the pool and the location of the return inlets) becomes a critical element of the design process.

Most state codes specify the allowed velocity of the water throughout the piping system. The overall consensus seems to be a maximum of six feet per second for water on the suction side of the pump, and eight feet per second after the pump discharge, throughout the circulation treatment system.

Some states allow up to 10 feet per second; check your state and local guidelines for specifics. Keep in mind, higher velocities can mean higher head and increased electrical operating costs. Gravity flow usually is limited to 1.5 feet per second or less.

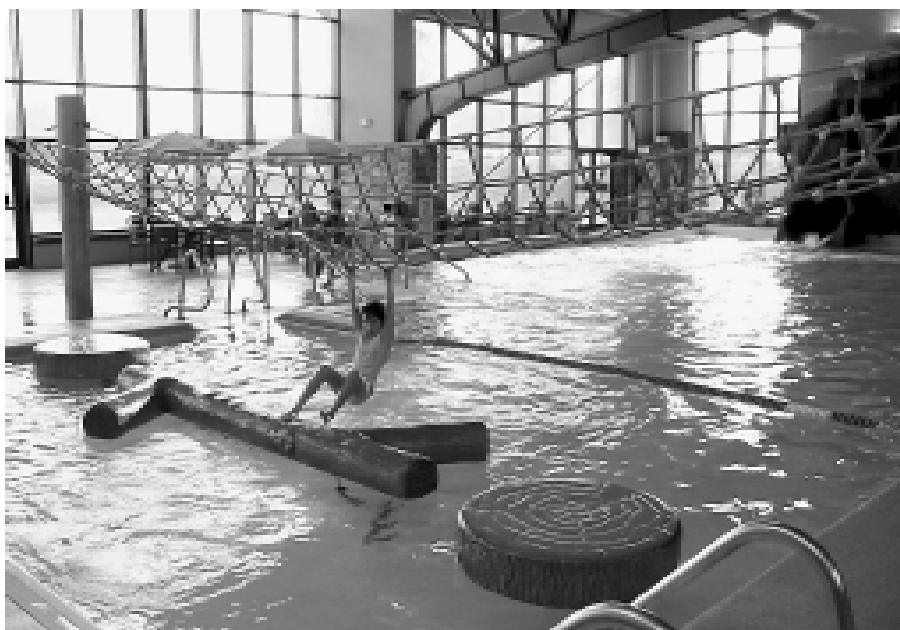
An integral part of the design of a high-flow filtration system is the selection of properly sized pumps and a quality hair-and-lint strainer constructed of noncorrosive materials, with a see-through top and quick-access fittings. Today, most facilities are using flooded suction and centrifugal pumps, usually running at either 1,750 rpm or 1,150 rpm, with the low rotational speeds contributing to both durability and efficiency equipped with soft starts or VFDs (variable frequency drives).

The filtration pump selection itself is based upon the required flow and the total dynamic head (TDH, usually in feet of water column) that the pump must be able to deliver.

TDH is determined by the pressure drop from piping, fittings and valves, and by the static pressure from the elevation of the pool water level above the pump impeller. An additional consideration is the pressure required to pump the water through the filter, in either clean or dirty condition, and during the backwash cycle.

Adding all these values together results in the design TDH. This value, together with the required flow, allows for the proper selection of the filtration pump. For most leisure pools, the TDH is in the range of 55 to 70 feet. Again using the example of 833 gpm for the flow, one would end up selecting a 30-hp centrifugal pump with 833 gpm at 70 feet TDH. The desired efficiency should be in the range of 80 to 85 percent.

A number of factors influence a pool design, and there are some other basic design elements that should be



(Photo courtesy of Water Technology, Inc.)

considered. Some are specific to an indoor or outdoor pool and some may overlap.

Indoor and Outdoor

- **Bather load:** Estimate the projected daily attendance. Is the facility properly sized, or will it be overloaded from Day One?
- **Backwash discharge:** Today, many cities and public agencies require that chlorinated backwash water go to sanitary sewer lines with limited capacity, which may require a holding tank for an adequate discharge rate. If such a proper discharge rate capability is not provided, it may result in a “short cycling backwash” by the operator that can reduce the efficiency of the filter in a very short time.
- **Composition of makeup water:** High iron and/or manganese concentrations, high chloramines levels from the water treatment facility – these are among the contaminants that can make operations a challenge if not accounted for in the design phase. It’s also important to understand the water parameters to select the proper disinfectant and method of pH control.

Outdoor

Pool location: Rural or urban? This is important for estimating the potential amount of external contaminants, such as blowing soil or other products that may settle on the water’s surface.



(Photo courtesy of Water Technology, Inc.)

- **Suntan oils:** What are the amounts of oils and other skin-care products that will need to be dealt with? It is hoped that some can be removed prior to filtration because they will certainly affect the efficiency of the operation.

Indoor

The indoor pool area becomes an environment of its own. While there are none (or fewer) of the airborne particulate contaminants with which outdoor pools must contend, some interesting challenges arise.

HVAC system: The design of the heating, ventilating and air conditioning system becomes an essential element toward the success of the facility.



Indoor HVAC System, (Photo courtesy of Water Technology, Inc.)

The most powerful filtration and disinfection systems available will not perform adequately if the basic chemistry byproducts and airborne contaminants are not removed from the enclosure. That is less important in lightly used, high water volume facilities with low water temperatures (in the range of 79 to 82 degrees Fahrenheit) than in highly frequented, low water volume facilities with higher water temperatures (between 85 and 90 degrees).

Higher temperatures generally mean higher evaporation rates, higher bacteriological activity, higher heat loss and, if not properly exhausted, stale, uncomfortable air

that may lead to health concerns for patrons and staff. As if that were not enough, research has indicated that some chemical off-gases can actually be reabsorbed into the water, resulting in very interesting operations problems.

It is essential in the design of indoor pool facilities that the number of air changes per hour is carefully considered along with the proportions of fresh air entering the facility. The special operating condition of the indoor aquatic facilities require the marriage of proper water treatment, oxidation and disinfection along with air quality to achieve a successful facility.



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