Pools, Spas, & Fountains

Pools, spas, hot tubs, fountains, and other types of decorative water features can waste large volumes of water if not properly designed and equipped for efficient operation. Four principles govern good practice:

- design the mechanical equipment to filter, clean, and operate the pool
- design the pool to minimize water loss
- choose alternatives that use less water
- install decorative water features only where they provide tangible benefits

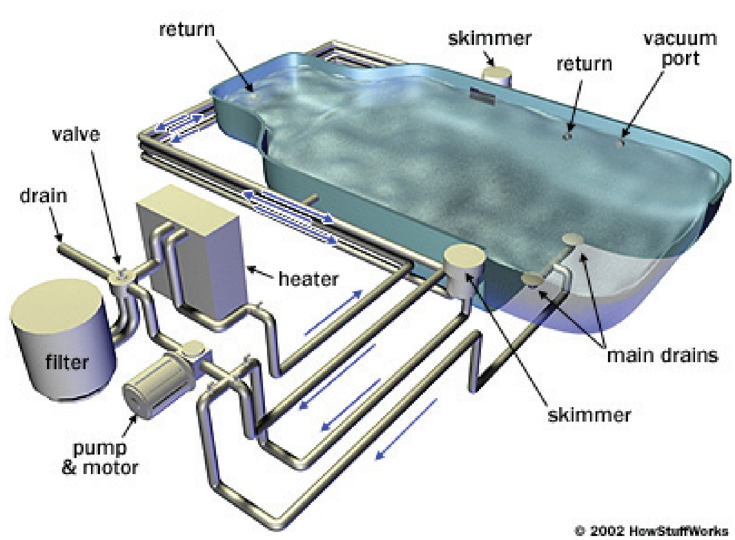
Pools, spas, and fountains require water for make-up, evaporation, splash-out, filling, backwashing the filter, and replacing water lost to leaks.

Six practices and considerations will result in more efficient water use:

- install a meter on the pool make-up line so water use can be monitored and leaks can be identified and repaired;
- choose a filtration system that will minimize water use while accommodating cost considerations;
- include splash troughs that drain back into the pool;
- use a pool cover if it is practicable to do so;
- carefully monitor backwashing to ensure that excessive backwashing times are not used; and
- reuse backwash water for irrigation where possible. The reuse of backwash water for irrigation of a park can make sand filters, which use more water than other types of equipment, the most water-efficient choice, if the backwash water replaces potable water otherwise used for that purpose.

If it has been determined that a pool or a water feature will provide tangible benefits, the physical design of the feature and the mechanical components chosen can contribute to efficiency and water conservation.

The following diagram shows how a pool works.



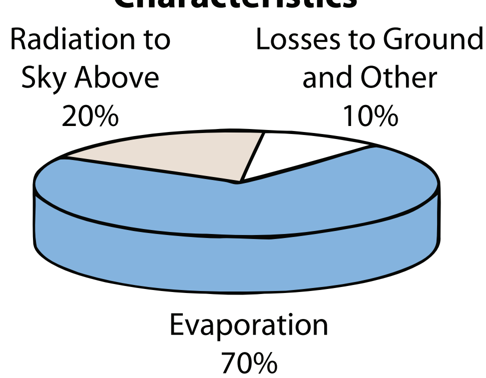
Description of End Use

Refilling Pools: Water is used to refill a pool, spa, or fountain both to make up for water lost through evaporation and splash-out and to replace water lost during filter backwash. Refilling occurs when the pool, spa, or fountain is drained either for periods of non-use or when the dissolved solids (mineral) content of the water has become too high. It is typical to drain and refill a pool every three to six years for maintenance and control of dissolved solids. Drained water can be used for irrigation as long as the dissolved solids are controlled and chemical and chlorine levels are not too high. Allowing a pool to settle until the chlorine concentration of the water is below 2.0 milligrams per liter will place the water within municipal potable-water parameters, at which time it is safe to use for landscape irrigation. It is important to keep the basin, pool, spa, or fountain clean and the water properly treated to avoid needing to drain or dump the water prematurely.

Water and Energy Loss: Evaporation and splash-out vary based upon both weather conditions and activity. In the summer, evaporation alone can amount to five to twelve inches a month, and splash-out can add several inches. This water must be replaced to keep the pool at proper levels. To reduce evaporation:

- design pools to incorporate splash troughs along the edge to catch water that would normally be splashed out onto the deck. The troughs should drain back into the pool system.
- avoid using sprays and finely divided streams of water in fountains and waterfalls. Aeration causes a significant amount of evaporation.
- use shrubs and fences as windbreaks to reduce water losses due to wind evaporation.
- cover pools when not in use to reduce evaporation and keep water cleaner. In the summer, evaporation ranges from five to ten inches a month (The Association of Pool and Spa Professionals). Using a pool cover eliminates almost all evaporation. If a pool is heated, as much as 70 percent of heat is lost through evaporation (U.S. Dept. of Energy – EERE Consumer's Guide). Covers range from single sheets of plastic to insulated materials. Costs vary from under $80 for a single-layer vinyl cover to several thousand dollars for covers with automatic retractors. Many pool operators resist using pool covers. Therefore, one advantage of higher-cost retractable covers is that, since they are more convenient to use, they are more likely to be used.

Outdoor Pool Energy Loss Characteristics



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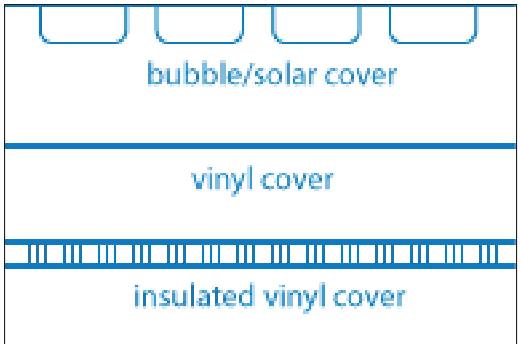

Types of pool covers

Filtration and Disinfection: All pools, spas, and fountains should have properly sized equipment to filter and disinfect the water. The three main types of filters are sorptive media, sand, and cartridge. Each has advantages and disadvantages. For two of these, a backwashing system is required to clean the filtration system. Depending upon the type of filtration used, a substantial amount of water may be discharged during this operation. The frequency of backwashing depends upon the level of usage for the pool. Heavily used municipal pools need more frequent backwashing than lightly used motel or even school pools.

Pool Filtration Equipment Comparison

Characteristic	Sorptive Media	Sand	Cartridge
Filtration efficiency	5 microns	30-40 microns	10-20 microns
Media replacement cost	\$0.15 - \$0.50/lb	\$0.50 - \$1.00/lb	\$15 - \$100 each
Use in large public pools	Yes, with proper design	Yes	No, too labor intensive

- Sorptive media filters include conventional diatomaceous earth (DE) or perlite filters and regenerative filters that reuse the filter media. These filters remove particles down to 5 microns in size, while sand and cartridge filters work in the 10- to 40-micron removal range (Pool-Plaza.com). Sorptive media filters have hundreds to sometimes over 1000 fabric-coated tubes inside a pressure container. The medium (DE or perlite) is made into a slurry and mixed with the water in the filter. The medium is then deposited on the tubes by the water being pumped through the filter. Conventional sorptive media filters must have the DE or perlite replaced after each backwash. With regenerative sorptive media filters, the medium is periodically "bumped" off of the filter tubes by backflow, air agitation, mechanical shaking, or a combination of the three. It is then recoated onto the filter cloth. In an example from the Neptune Benson Corporation, the internal filter media recycling occurs about thirty times before the medium is dumped and replaced. No water is lost in the recoating process. When the medium is flushed, only a few hundred gallons of water are needed (Neptune Benson). This makes regenerative sorptive media filters very water-efficient.
- The amount of water used to backwash a filter depends upon the size of the pump, which in turn depends upon the size of the pool. Pool filters are designed to turn the total volume of the pool (pump it through the filter) in a specified amount of time. For large pools, the volume of water is designed to pass through the filter in six hours. Smaller wading pools, spas, and spray-scapes have much higher turnover rates. The filter pump for a 100,000-gallon public pool must have a capacity of 278 gpm. When a filter is backwashed, the same pump is used. Since back pressure is less during backwash, the flow rate of the pump may be slightly higher, but still in the range of 280 gpm. Backwashing the filter for five minutes uses approximately 1,400 gallons of water. Some larger pools are backwashed longer than that because of the size of the filter. Pool filters should be backwashed based upon pressure drop and never on a timer.

Coated Flex Tubes as seen through Defender Viewing Window

Manufacturing specifications will tell when to backwash, but the normal range is when pressure drops 10 to 15 psi. Automatic backwash equipment will not backwash a filter until the proper pressure drop has occurred. This minimizes the number of backwashes to only what is needed. The sand needs to be inspected once or twice a year. Sand may last for several years before needing to be completely replaced; however sand may need to be added periodically to replace any lost during backwash (Williams).

- Cartridge filters are not designed for larger size pools like municipal pools. Cartridge filters cost less than sand filters, and the replacement filters range from $15 to $100, depending upon the quality and type of filter. Some types of cartridge filters must be replaced each time the pressure falls outside pressure-differential limits; these are not recommended because of the waste of materials. The better type has a reusable filter cartridge. Two sets of filters are needed. When one set is removed for cleaning, it must be soaked in a cleaning solution and then brushed and rinsed off. A significant advantage is that no backwash water is used, and the cleaning process requires less than ten gallons. These filters last two to five years. Drawbacks to cartridge filters are expense and that cleaning is labor intensive.

Hayward Cartridge Filter

Reuse of Backwash Water: Where backwash water is produced, it can be used for landscape irrigation if the chlorine content is less than 2.0 milligrams per liter and the dissolved solids are not greater than the plants can tolerate. Lists of plants and their salt tolerance can be found at most land-grant universities. Some entities have proposed to recycle the backwash water back into the pool after settling and filtration. Most health codes prevent this.

Make-up Meters: Make-up water for keeping the pool, spa, or fountain full should be metered to determine whether leaks are occurring. Pools and fountains can leak with no obvious signs other than a mysteriously high water bill. A meter on the make-up (fill) line can quickly identify abnormal use and help monitor water use volumes for backwashing filters and other operations. A length of Plexiglas pipe on the backwash line can help operators determine that backwash valves are completely closed and water is not being lost through the backwash line during normal pool operation.

Alternatives to Pools: Water-saving alternatives include play-scapes that use sprays and other water features activated only when someone is going to use them. Since the water is never more that an inch deep, safety is increased. Although fine spray and mist can increase evaporation, efficiency is obtained when the water is captured and treated after each use. Water is stored in a tank with a filtration and disinfection system. Tank storage also reduces evaporation and chemical use over an open wading pool, where water is dumped and refilled every day (Communications with the City of Austin, Texas).

Water-Savings Potential

Water savings from leak detection are hard to predict, but an investment of less than $200 to install a meter when a pool is built is wise, since a pool can lose up to 50,000 gallons a month with even a small leak of one gpm. Pool and fountain leaks of over one million gallons a month have been reported (Truesdale). Choosing a proper filter and controls can also result in significant water savings.

A 35,000-gallon pool uses from one to several thousand gallons of water a month for backwashing, if procedures are poorly designed. In contrast, cartridge filters use almost no water, and DE filters use under 100 gallons.

Cost-Effectiveness Analysis

Evaporative loss over a year ranges from 30 to 80 inches. That equals 1.5 to 4.0 gallons per square foot of surface area per year.

Example: a 100-foot by 70-foot pool.

- Evaporative loss is 10,000 to 25,000 gallons per year.
- Pool covers:
  - » reduce evaporation
  - » delay pool draining
  - » extend the time before backwashing is needed
  - » reduce the amount of dust, dirt, leaves, and other material entering the pool
  - » prevent animals from contaminating the water.

Filter costs for a 30,000 to 40,000-gallon pool (not including the pump, which is in the same cost range for all three types of filters) are:

- DE — $400 to $800
- Sand — $250 to $700
- Cartridge — $200 to $400

DE- and perlite-filter operations — DE costs $0.50 to $1.00 per pound; perlite costs $1.00 to $1.30 a pound (review of costs posted on the web). About 0.125 pounds of DE will coat one square foot of filter (The Schundler Company). Perlite is much less dense. A cubic foot of DE weighs about 20 pounds, while a cubic foot of perlite weighs 2 to 8 pounds. Since the requirement for DE or perlite is based on volume, as little as 0.04 pounds of perlite will coat a square foot of filter. The flow rate through a filter is 1.5 gpm per square foot.

Using a 360,000-gallon pool as a basis, the flow rate would be 1,000 gpm and the filter area would have to be 667 square feet. Such a filter would require 84 pounds of DE or 27 pounds of perlite. Recharging the filter every 20 to 30 days will require dumping under 1,000 gallons to the drain (Filtrex, Inc.). Based upon 1,000 gallons per backwash and 60 backwashes a year, annual backwash use would be 60,000 gallons. If a pool were in use only part of the year, proportionally fewer backwashes and quantities of water would be required (Neptune Benson).

Sand-filter operations — A sand filter in a heavily used public pool needs to be backwashed about every three days. Using a 360,000-gallon pool as an example and a six-minute backwash, the pool will use about 6,000 gallons every time it is backwashed. In one year, the pool will be backwashed 120 times and will use 720,000 gallons, compared with 60,000 gallons for a regenerative DE or perlite filter. With a sand filter, such a pool would require 12,000 to 18,000 pounds of sand at a cost of $0.15 to $0.50 per pound, depending upon the filter design (Neptune Benson).

Filter cartridges cost from $15 to $100, depending upon the quality and type of filter. Typical life is 2 to 5 years, with the better (more expensive) filters lasting longer. Many cartridge-filter elements are needed per filter system for a large pool, and several filter systems are needed. Adding labor costs to hand-clean cartridge filters renders them not cost-effective for public pools, although they may be appropriate for small motel or apartment pools (PoolPlaza).

Recommendations

Proven Practices for Superior Performance

- Require all pools, spas, and fountains to be equipped with recirculating filtration equipment.
- Require in-ground pools to be built with splash troughs around the perimeter.
- Require make-up meters to be installed on all pools.

Additional Practices That Achieve Significant Savings

- Use sorptive media filters where possible for all pools, spas, and fountains.
- Use cartridge filters for smaller spas, where the costs of filters and cleaning make them economically feasible.
- Reuse backwash water for irrigation or consider retreatment and reuse in the pool.
- Consider use of alternatives to wading pools, such as spray-scapes.
- Use pool covers, especially during periods when a pool is not in regular use.
- Use shrubs or fences to shade pools and block winds that increase evaporation.

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