

Chapter 5

Filtration

KEY CONCEPTS

- Sand Filtration
- High Rate Sand
- Sand and Gravel
- Pressure Filters
- Vacuum Filters
- Filter Rates
- Channeling
- Mud balls
- Freeboard
- Backwashing
- Flocculants
- Multiport valves
- Diatomaceous Earth
- Regenerative DE
- Precoat
- Slurry Feeding
- Filter Septa
- Cartridge Filters

A key to good filtration is the ability of the filter media to screen and trap dirt. Different filter medias have different entrapment capabilities. Before discussing each filter type specifically, a closer examination of filter media will now be undertaken. The following chart will help to illustrate how effectively different medias filter swimming pool water.

Grain of table salt:	90 to 100 microns*
Human hair:	70 microns
Visible to the naked eye:	35 microns
Sand filtering capability:	20 to 25 microns
Talcum powder:	5 to 10 microns
Cartridge filtering capability:	5 to 10 microns
Red blood cells:	8 microns
Average bacteria:	2 microns
DE filtering capability:	1 to 3 microns

*1 micron is equal to .0000394 inches or 1 millionth of a meter.

Filters, which do not allow particles of 15 microns or larger to pass through, produce outstanding water clarity. Water clarity results from a lack of turbidity, which is colloidal or particulate matter in suspension. A nephelometer measures water clarity by assigning turbidity units. Good water clarity does not exceed 0.5 nephelometer turbidity units (NTUs). Remember, when the view of the pool bottom becomes obstructed because of poor water clarity, the pool should be closed.

Different filtration systems will be discussed in the following order: sand, diatomaceous earth, and cartridge (Fig. 5-1).

Sand Filtration

Although sand filters are perhaps the most widely used filters in the swimming pool industry because they are the easiest to use, they are probably the least efficient when it comes to trapping dirt. The permanence of the sand as a media and the ease of backwashing are just two reasons for their popularity. When maintained properly, sand filters produce high water clarity. It should also be understood, the faster the water travels through the filter, the lower the filtration efficiency. Slower filtering rates and deeper filtering beds of sand naturally keep more dirt in the filter and out of the pool.

Sand filters use a sand medium that seldom needs replacing, and they come in a variety of designs. Sand filters include pressure sand and gravel, pressure high rate sand, vacuum sand, and in rare instances, gravity sand. Alternatives to sand will also be discussed in this section.

Pressure Sand and Gravel

Between the 1920s and 1950s, large sand and gravel filters were used to filter the water in many swimming

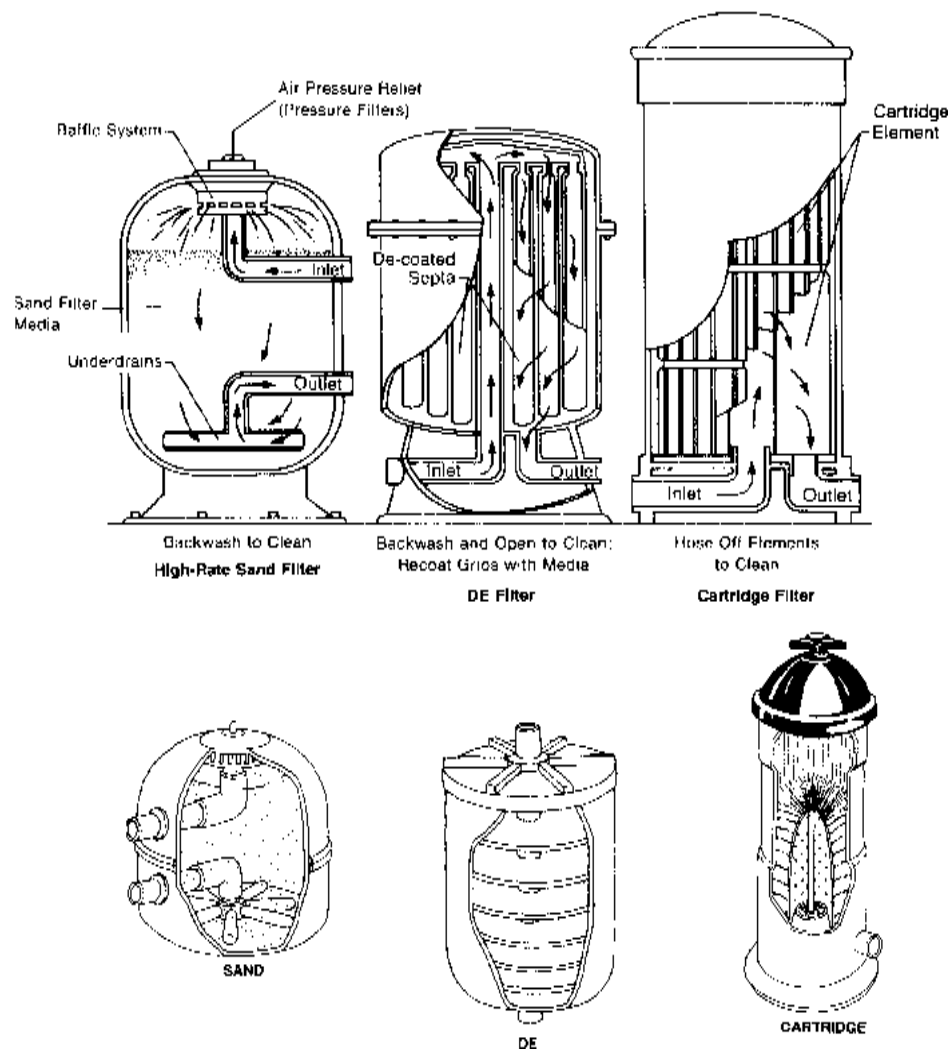


Fig. 5-1. Types of pool/spa filters. (From NSPI: Basic pool and spa technology, Second ed., Alexandria, Va, The Institute.)

pools throughout this country. This filter system uses the layering of sand on top of differently sized gravel and stone. The filters themselves are extremely large, requiring large quantities of sand and gravel in the filters and a great deal of space in the filter room to store them.

Pressure sand and gravel filters are often called “rapid” sand filters, but compared with today’s filtering rates, old sand and gravel filters are quite slow. The old “rapid” sand filters have filtering rates that vary between 1.5 to 5 GPM/sq ft of filter surface area, whereas the popular high rate sand filter systems of today filter at a rate of between 12 to 20 GPM/sq ft of filter surface area. When speaking of a conventional sand and gravel filter, the term rapid should probably be avoided. Too many pool operators confuse rapid filters with high rate filters, thinking they are the same, when in fact, they are significantly different.

Sand and gravel filters are rarely installed in today’s pools because they are too large, too costly to install, and require extensive amounts of time and water to backwash. Only older, larger pools still use pressure sand and gravel filters. In many cases, sand and gravel filters in older pools have filter tanks that are taller and wider than the pool

operator. For instance, a 180,000 gallon pool would require two sand and gravel filters, 11 feet in diameter.

The dynamics of the pressure sand and gravel filters are discussed in the following paragraphs. Sand and gravel systems are usually found in banks of between two and four filters with most pools having three filters. The filters may be positioned either vertically or horizontally (Fig. 5-2).

By definition, water enters a closed pressure tank containing sand and gravel. The water enters the top of the tank through a distributor or baffle. At this point the water is spread out evenly with a shower head plumbing arrangement, so that the incoming water does not disrupt or “channel” through the filter bed. The water then travels downward through the top layer of sand and then the gravel and stone. When the water finally arrives at the bottom of the tank, it is pushed out of the filter through perforated underdrains or “laterals,” which collect the filtered water and return it to the pool. Before the filtered water is returned to the pool it is heated first, then treated. The top layer of sand is between 12 and 20 inches deep, but it is interesting to note that the majority of

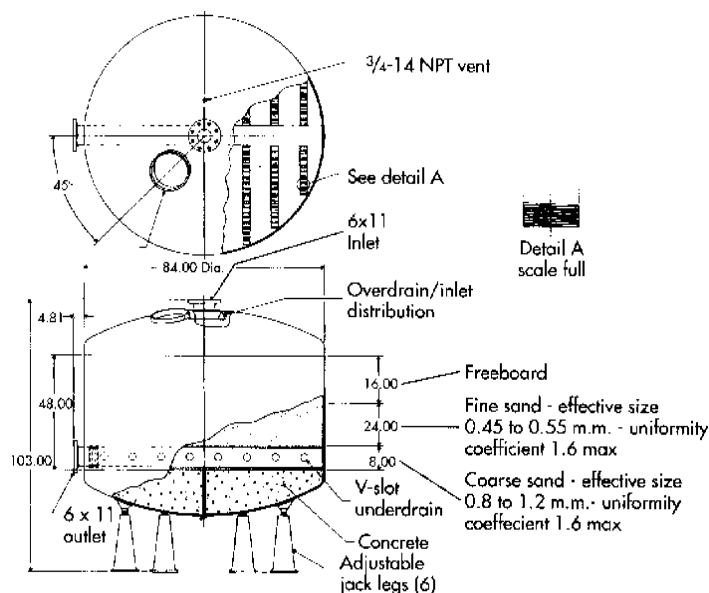


Fig. 5-2. Conventional sand and gravel (rapid rate) filter.
(Courtesy Filtrex, Wayne, NJ.)

filtering is accomplished in the first three inches. The particle size of the sand should be between 0.4 and 0.6 mm, which is approximately a number 20 grade sand.

Filtering rates for pressure sand and gravel filters vary widely, but on the average, sand and gravel filters water at a rate of approximately 3 gpm per square foot of surface area. This is a relatively slow filtering rate.

Freeboard refers to the amount of air space between the top of the sand and the ceiling of the tank. This freeboard is necessary, because during the backwash cycle, sand and water are forcefully displaced upward. When backwashing, this extra room is needed to allow the filter media to “expand.”

Backwashing refers to cleaning pressure filter systems by reversing the flow of water in the filter tank and pushing the accumulated dirt out to waste. Backwashing should be performed just before filtering effectiveness becomes impaired. An extremely dirty filter will be accompanied by a significant pressure increase inside the tank and a drop in the filter flow rate. The manufacturer’s recommendation should be followed for backwashing. When the pressure difference between the water pressure going into the filter (influent) and the water pressure leaving the filter (effluent) reaches a predetermined point, the filters should be backwashed. Many filters are not backwashed until a pressure differential of at least 5 psi occurs. Backwashing every Saturday, for instance, is not a recommended practice unless the swimmer load is consistent during the week. It should be remembered that a dirty filter can often be an effective filter, because dirt helps in filtering dirt.

One problem associated with backwashing a pressure sand and gravel system is that the backwashing flow rate

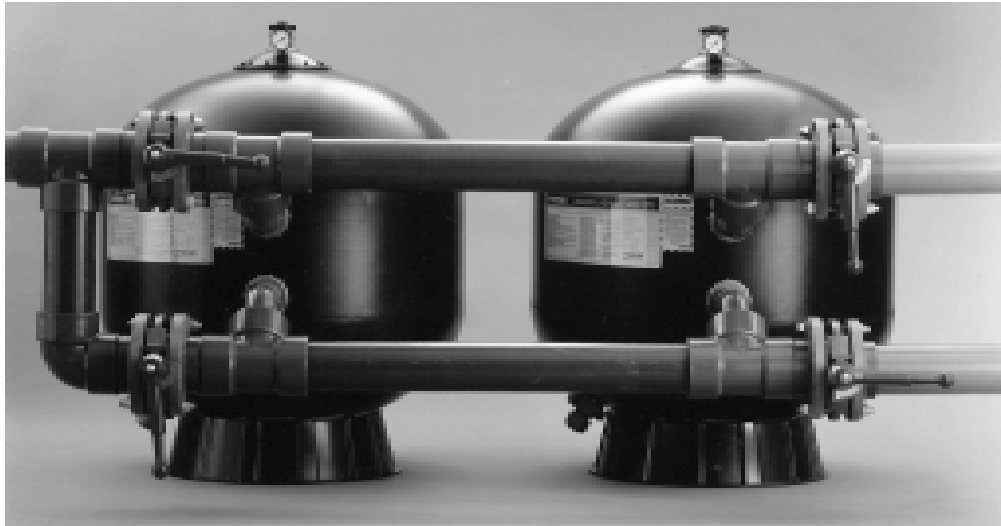
must be about four times greater than the filtering flow rate. Backwashing flow rates must be maintained between 12 to 15 gpm to remove all the dirt from the filters. This is in contrast to the normal filtering flow rate of 3 gpm. To attain such high backwashing rates, each filter in this system must be backwashed individually and successively. This is accomplished by isolating each tank so that backwash water only travels through one tank at a time. Backwashing all the filters in a sand and gravel system may last as long as 15 to 30 minutes.

Many pool operators keep the flow of water reversed until the backwash water, as viewed through a sight glass tube, becomes clear. Not surprisingly, backwashing sand and gravel filters is costly, both in terms of time and water. Conversely, lengthening the backwash cycle introduces much more water to the pool for healthy dilution.

Flocculants are sometimes added to the top of the sand and gravel filters to assist in the filtering process. Flocculants like Aluminum Sulfate create a gelatinous mass that floats on top of the filter and collects additional dirt. Flocculants are used only in conjunction with pressure sand and gravel filter systems and is somewhat difficult to do well; good flocs are dependent on the right pH.

The top layer of sand in a pressure sand and gravel system may encounter some problems. Most of these problems are caused by ineffective backwashing flow rates. *Mudballs* may form by a combination of hair, lint, and other organic materials. *Channeling* is caused by holes in the sand bed that can result and lead to poor filtration. *Calcification* of the sand layer may also occur when the pool water is not balanced, particularly regarding high levels of calcium hardness and total alkalinity. To prevent these problems, the sand should be raked clean and inspected once a year. Maintaining balanced water and proper backwashing rates is sufficient to avoid these problems.

A



B

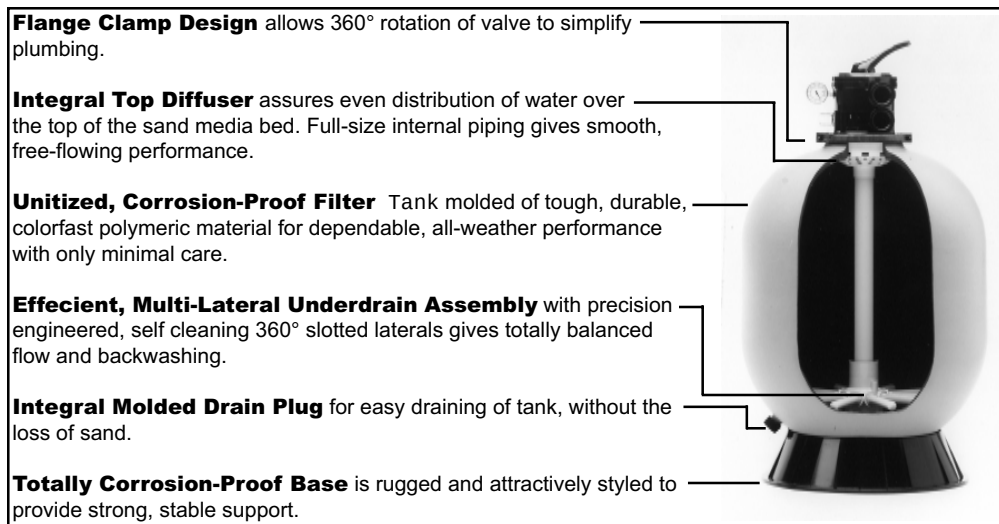


Fig. 5-3. A, Commercial high rate sand filters. B, Residential pool high rate sand filters. (A, Photo courtesy of Pac-Fab, Sanford, NC; B, Photo courtesy of Hayward Pool Products, Elizabeth, NJ.)

In summary, sand and gravel filters produce finely filtered water. They typically have long filter cycles, which means backwashing less frequently, and the sand media lasts at least 10 years, if not longer. But as sand and gravel systems age, they are often replaced by newer, more advanced filtering systems that take up less room and are far less costly to purchase and install.

Dr. Tom's Tip: If you still have older sand and gravel filters, don't get rid of them until it is absolutely necessary. Chances are the new filtration system will not produce water clarity equivalent to the older, larger sand system. When you finally have to replace the sand and gravel system with high rate sand, get bigger and larger tanks with more sand.

High Rate Sand

High rate sand filters became popular in the late 1950s and early 1960s primarily because of the reduction in both size and cost of the equipment (Fig 5-3). High rate sand systems filter and backwash at approximately the same rate, which is between 15 to 20 gallons per square foot of surface area. Because of these high filtering rates, less sand in smaller tanks is required, thus significant space is saved. Backwashing can also be accomplished in two to three minutes because all tanks are backwashed simultaneously.

High rate sand filters use *depth filtration*, that is, they use the entire sand bed to trap dirt. Cartridge and D.E. filters use only the surface of the media. Sand and gravel filters use the top three to four inches of sand.

Freeboard in a high rate sand filter can vary, but too much sand in the filter tank will find its way back to the pool through its inlets during the backwash cycle. An insufficient amount of sand will result in a filtering bed that is too small to trap sufficient amounts of dirt.

Mudballs, channeling, and calcification of the filter bed can also occur in high rate sand filters, but generally these problems are easier to correct because of the smaller size of the tank and the increased accessibility to the filter bed. High rate sand filters do require the sand replaced more often than other types of filters. This is because at high filtering rates the individual sand granules in this system become smooth and lose their ability to trap dirt. The life in a high rate sand filter will vary from pool to pool but should last a minimum of three to seven years.

It is not uncommon for some high rate sand filter systems to have oversized pumps. When this occurs channeling results and the powerful pool pump pushes the dirt right through the filter and back into the pool. If the pump size is in question, a local pool company or pump dealer should be contacted.

Backwashing should be performed whenever the flow of water becomes restricted through the filter because of an accumulation of dirt. This usually occurs when the pressure differential between the influent pressure gauge and the effluent pressure gauge on the filters reaches between 15 and 20 psi. The filter manufacturer's recommendations should always be followed, however.

As mentioned previously, dirt in the filter helps trap dirt that comes from the pool. Backwashing too often will keep the sand too clean and allow dirt to pass through the filter bed. Not backwashing enough will cause the flow rate to drop and will result in cloudy water.

Some swimming pools, especially smaller pools like those found in private residences, have only one high rate sand filter tank. Many companies now manufacture a *multiport valve* that requires the owner/operator to simply turn a handle to control all circulation functions (Fig. 5-4).

The various functions controlled by the multiport valve are clearly marked on the top of the tank and include the following:

Filter

The circulation system is in the filter mode most of the time. The filtering cycle is used for normal filtration and in some pools is also used for vacuuming.

Backwash

Backwash is used for cleaning the dirty filter media as indicated by a rising pressure gauge reading on the tank. Some high rate sand filters are backwashed when the pressure in the tank increases by 6 to 8 PSI beyond the start-up pressure. When backwashing a multiport filter tank, the pump must be turned off first. The dial is then turned from "filter" to "backwash" and the pump is re-started. When the backwash water leaving the filter turns clear, as evidenced through the sight glass, the pump is turned off before the dial is reset.



Fig. 5-4. Multiport valve.

Rinse

The rinse cycle is used following each backwash. Once the dial is positioned to the “rinse” cycle, the pump is restarted and the filter media is rinsed clean for 30 to 60 seconds.

Waste

The waste mode is used to bypass the filter when draining or lowering the pool level and for vacuuming unusually heavy debris. During this cycle the water leaves the pool and goes directly to waste.

Recirculate

The recirculate cycle moves the water through the swimming pool system by bypassing the filter. This cycle is often used when adding chemicals.

Closed

When the filter is below the deck level, pool water may be lost if the filter is not closed when the pump is not running. This mode is used only when the pump is turned off.

Vacuuming

The vacuuming cycle is used for vacuuming directly back into the filter. Water is returned to the pool during

vacuuming in this cycle. Sometimes it may be wise to vacuum directly to waste, particular with heavy debris.

In some regions it may be possible to recycle backwash for gardening, washing cars, or some other uses. Chlorine levels in backwashed water dissipates rapidly, particularly if it is sprayed out of the system. Health codes must be checked, however, before reusing treated swimming pool water.

Vacuum Sand

The original vacuum sand filters used in the swimming pool industry, also known as gravity sand filters, filtered water at very slow rates and required a lot of room. Today’s vacuum sand systems are open, high-rate filter systems in which the filter media and water flowing through the filter can be viewed by the pool operator (Fig. 5-5). As mentioned previously, there is no hair and lint strainer in this arrangement, because the pump follows the filter.

Many vacuum sand filter systems come in two configurations: “wet well/dry well” or “wet well only.” The filter tank is a large, open rectangular tank, usually made of stainless steel to resist corrosion. The wet well houses the filtering sand, while the adjacent dry well contains all the required piping, gauges, valves, and controls. A collection manifold or lateral is located at the bottom of the sand.

The sand in the vacuum filter tank is as much as eight feet below the water level of the pool. To protect the surface of the filter bed, a water flow diversion screen is placed just above the sand bed. The filter tank provides ample space between the sand bed and the top of the filter tank. This extra space serves as a surge tank to store water when excessive bather loads are experienced. Water flows by gravity from the pool outlets to the wet well with sand



Fig. 5-5. Wet and dry wells for vacuum sand filters. (Photo courtesy of Tim Gervinski.)

media, and then is drawn by the pump through the sand and pushed back to the pool. The pump is located in the dry well adjacent to the sand in the wet well. Vacuum sand filters can filter up to 20 gallons per minute per square foot of surface area. This filter also uses most of the filter bed for filtering. Backwashing can be accomplished in as little as two minutes.

The vacuum sand is a rugged, efficient, and low-maintenance system. It allows for easy inspection, access, and maintenance of the filter bed. One disadvantage of the vacuum system is the dry well, which houses the recirculation equipment. To access this equipment, the pool operator must use a ladder to climb down into the dry well. Once in the dry well, the operator has little room in which to work. However, newer vacuum sand systems have eliminated the dry well and placed the recirculation equipment in the open and accessible mechanical room.

New Alternatives to Sand Filtration

Two new exciting alternatives have been introduced to sand filter technology; *zeolites* and recycled glass. Zeolite has been used since the time of Julius Caesar but only recently in swimming pool filtration. Zeolite uses a combination of natural minerals and volcanic material to fill the filter tank rather than sand. According to manufacturers, Zeolite collects more dirt and in addition traps ammonia in the media. Lacking ammonia in the pool means significantly less chloramines production in the pool. Zeolite filtration produces improved water clarity and significantly reduces chloramines. *Recycled glass* is also becoming popular as a replacement for sand because it is lighter, and supposedly the sharper edges of the glass catch more dirt.

DE Filtration

DE filters use the fossilized skeletal remains of marine life sometimes referred to as “diatoms.” DE is a white powder composed of billions of microscopic skeletons that are millions of years old. Under a microscope, DE resembles small sponges or snowflakes. Each diatom is actually 90% air space and only 10% fossil. DE filtration produces superior water clarity because of the ability of this irregular shaped filter media to screen out the smallest of particles. Unlike sand, DE filters dirt by trapping dirt *within* DE pores and holes, as well as between particles.

DE is a light, porous, white powder that clings to a fiber filter septum that allows water, but not dirt, to pass through the media before returning to the pool. The filter elements come in a variety of shapes and sizes. Tubes or cylinders are often used in pressure systems, whereas rectangular and circular leafs are common in vacuum systems. Most DE filters are designed to filter at the rate of one to three GPM per square foot of surface area.

Although DE produces great water clarity, its disadvantage is that DE as a medium is temporary, meaning it must be replaced often. Many DE filters require a new batch of DE after every backwashing. In addition, the filter septa to which the DE filter cake clings must be cleaned periodically. Disposing of old DE is becoming more of a problem in many municipalities throughout the country. Finally, when handling DE, pool operators must wear protective masks so that the diatoms are not inhaled into the lungs.

The three types of DE filters discussed are the *pressure* system, using a closed, pressurized tank; the *regenerative* DE filter, which is also a pressure system and readjusts the DE in the tank to extend filter cycles; and the *vacuum* system, using an open tank. The filter septum to which the DE clings are composed of porous fabrics that come in a variety of shapes and sizes. It is important to note that DE leaves and discs filter on two sides instead of one. The DE filter septum holds the DE but allows filtered water to pass through it. Manifolds are attached between filter elements (septa) that allow the filtered water to return to the pool.

Pressure DE

DE is a temporary filtering medium, whereas sand is a permanent medium. This difference is highlighted during the backwashing cycle. Although the filtering process for pressure and regenerative DE filters is similar to pressure sand systems, the backwashing cycle is significantly different. Pressure DE filters reverse the flow of water for backwashing, but when this is done, the DE in the tank is flushed out to waste and must be replaced (Fig. 5-6). Thus new DE must be placed on the filter septa after each cleaning requiring additional work. This new coating of DE is called the “precoat” and must be accomplished slowly and evenly. The plumbing layout of pressure DE systems are almost identical to pressure sand systems, because the hair and lint strainer and pump precede the filter. Both the sand and DE pressure filters are enclosed in tanks so the difference is somewhat subtle to the untrained eye. Another problem associated with pressure DE systems is that the filter septa is difficult to inspect and to clean.

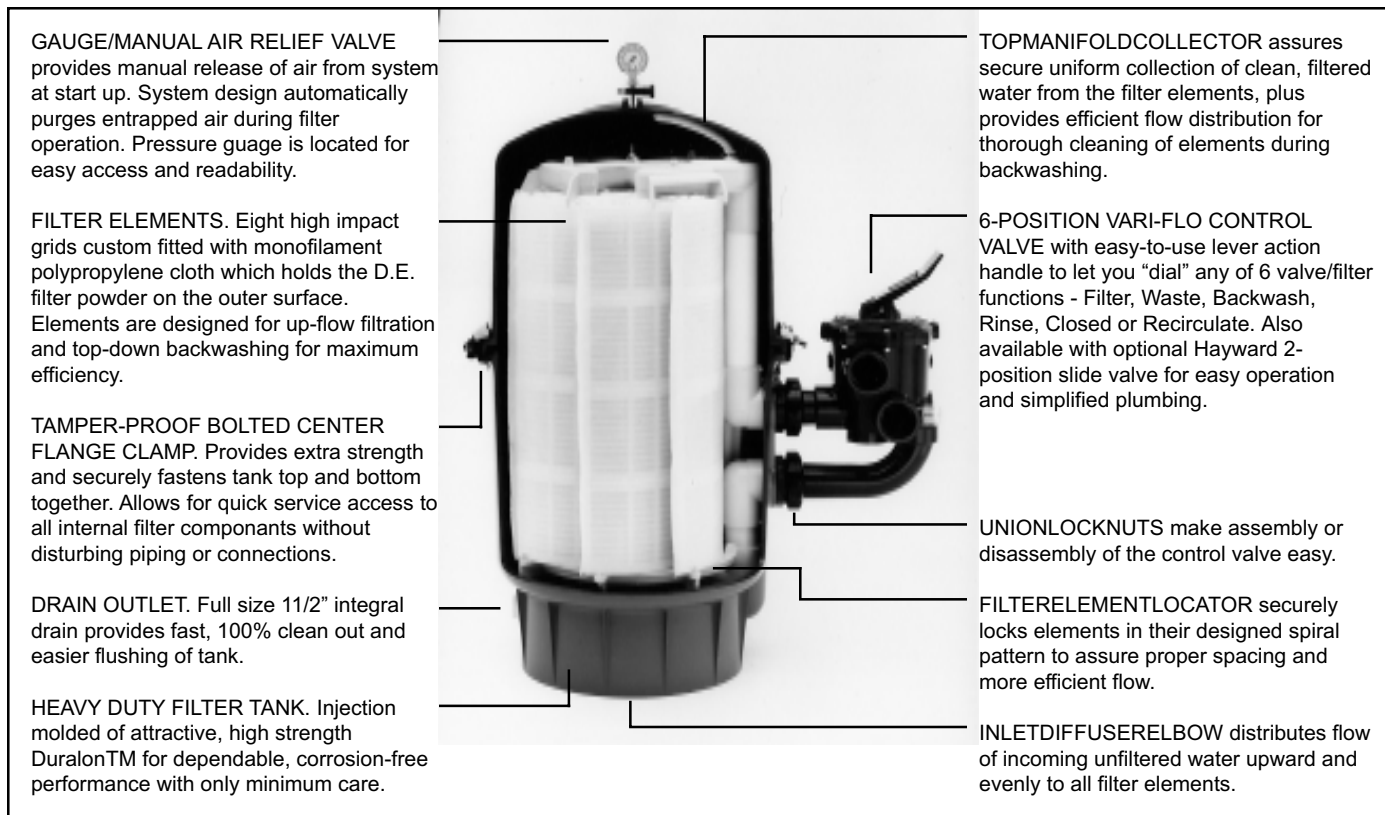


Fig. 5-6. Vertical grid pressure DE filter. (Photo courtesy of Hayward Pool Products, Elizabeth, NJ.)

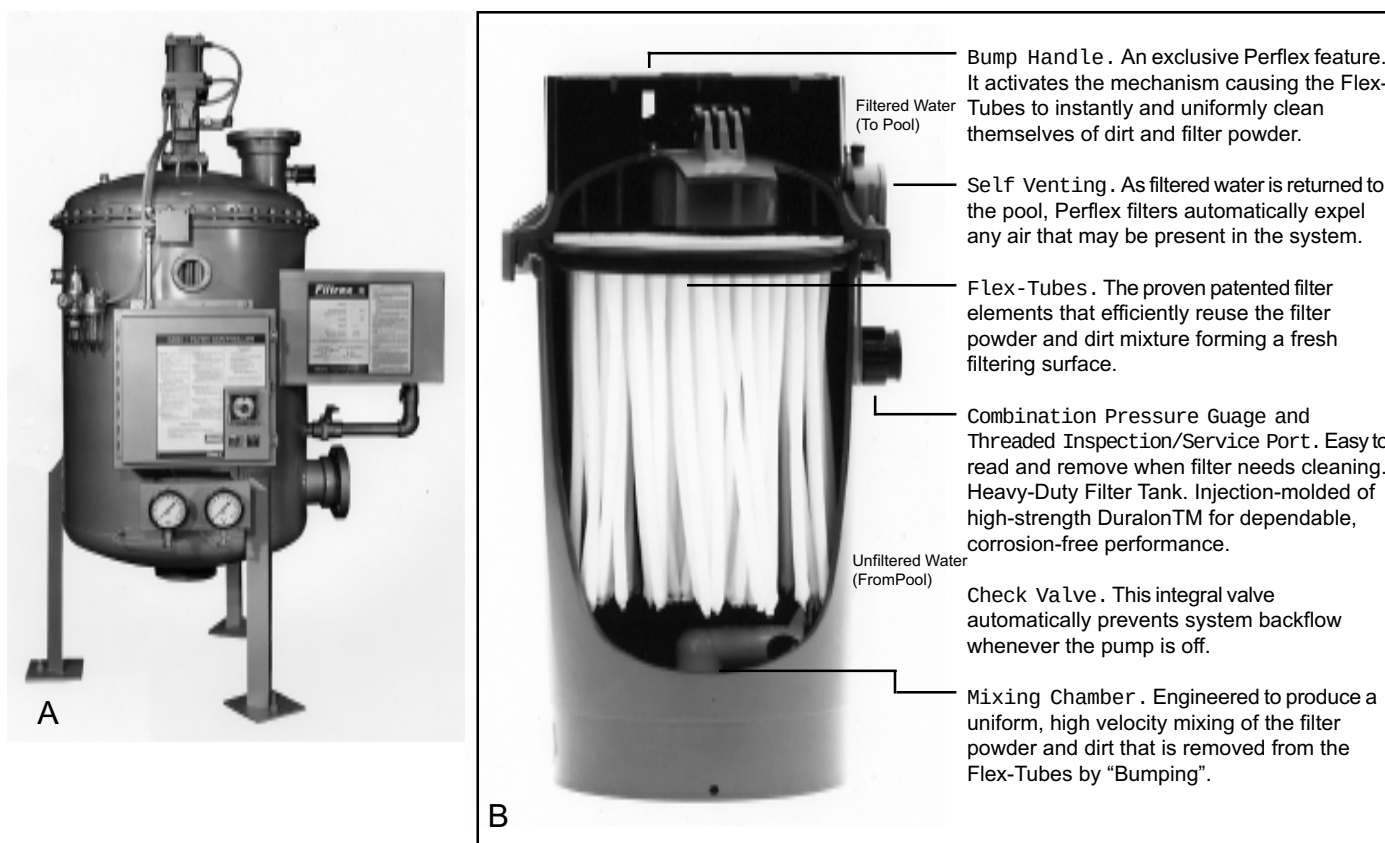


Fig. 5-7. A, Large commercial regenerative DE filter. B, Extended (regenerative) cycle DE filters. (A, Photo courtesy of Filtrex, Wayne, NJ; B, Photo courtesy of Hayward Pool Products, Elizabeth, NJ.)

Before purchasing or installing a pressure DE system, easy access to the filter septum should be a requirement.

Regenerative DE

The newer regenerative DE filter systems add a feature that extends the filtering life of the DE in the pressure tank. It is important to note that because only the surface of the DE does the filtering, only 10% of the filtering capability is attained. By realigning and reusing existing DE in the filter tank, filter cycles can be significantly extended (Fig. 5-7).

Under normal procedures, as DE filters accumulate dirt, an increased resistance to flow through the media is experienced. When the pressure in the tank increases to approximately 10 PSI above the precoated pressure, the regenerative DE filter is “bumped.”

“Bumping” shakes the dirty DE off the filter septa but does not allow it to escape from the tank. The individual diatoms then realign on the filter elements, enabling clean sides and edges to face the dirty water. Bumping the filters in this fashion recycles the DE in the tank to extend the filter cycles before backwashing is required. This regenerating process returns filtration to near original flow rates (Fig. 5-8).

Regenerative DE filters may be bumped several times before backwashing. Therefore, backwashing does not take place nearly as often as with the typical pressure DE system, thereby saving significant DE, water, time, and money.

Pool owners and operators should understand that many DE filters, including some older DE systems, are capable of being “bumped.” By simply closing the valves to and from the pool and turning off the pump for three to five minutes, the DE will fall from the elements. When the pump is restarted, the DE will once again reattach itself to the filter elements, producing excellent filtration with the same DE.

Dr. Tom's Tips: Don't always go with the lowest bidder! I purchased and installed a pressure, regenerative DE system for a large, million-gallon pool from the lowest bidder and the system fails regularly. Rather than replacing the DE every six months, we replace it every six days! Of course, the company is now out of business.

Vacuum DE Systems

DE vacuum filters use open tanks with the pool pump following the filter tank (Fig. 5-9). No hair and lint strainer is required because the filter protects the pump. The major

difference between the DE and sand vacuum systems comes when the filter elements must be cleaned. Concerning vacuum DE systems, when the filter media becomes dirty, it is manually hosed off the filter elements. Backwashing is not an accurate term to describe cleaning vacuum DE filters, because the flow of swimming pool water is not reversed to clean the filter media.

An advantage of this system is that the filter elements as well as the DE filter cake can be easily inspected. As the white DE becomes dark brown, pool operators can get a better feel concerning when to backwash. Additionally, if there are any holes in the filter elements, allowing DE to pass back into the pool, this problem can be easily detected and repaired. Cleaning the filter septa also becomes easier because the filter elements are easier to remove.

Because DE is the only temporary filter medium discussed in this text, several unique features associated with DE use are now discussed.

Filter Cake

Filter cake is the DE layer that clings to the filter septa or leaves and strains the dust, algae, oil, and other swimming pool debris. The filter cake catches just about everything that passes through it, including some large bacteria, and as a result produces outstanding water clarity.

Precoat

Precoat refers to the layer of filtering DE placed on the filter septa to initiate the filtering process or after each backwashing or filter cleaning. *Precoating* filter cake should be between 1/16 and 1/8 of an inch thick. The amount of DE needed in any DE filter is measured by volume instead of weight. Although many formulas are available, a good rule of thumb is a one-pound coffee can of DE for every five square feet of filter area. If a 40-square-foot DE filter needs to be recharged, it would require approximately eight cans of DE. There are a variety of methods of precoating, but most include simply recirculating the water within the tank without sending it back to the pool.

Slurry feeding

Slurry feeding is a procedure used to extend filter cycle on DE systems. During normal filtration the porous DE becomes saturated with dirt quickly and eventually becomes impervious. This occurs more quickly during heavy swimmer loads. By constantly adding small amounts

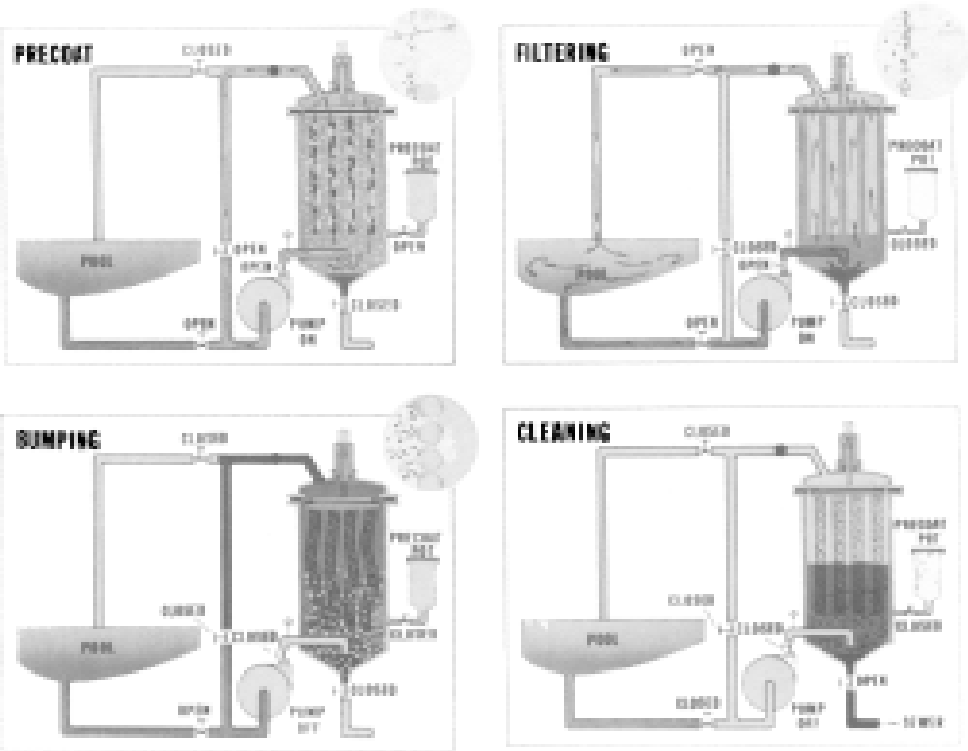


Fig. 5-8. Four cycles of regenerative DE filtration. (Courtesy Filtrex, Wayne, NJ.)

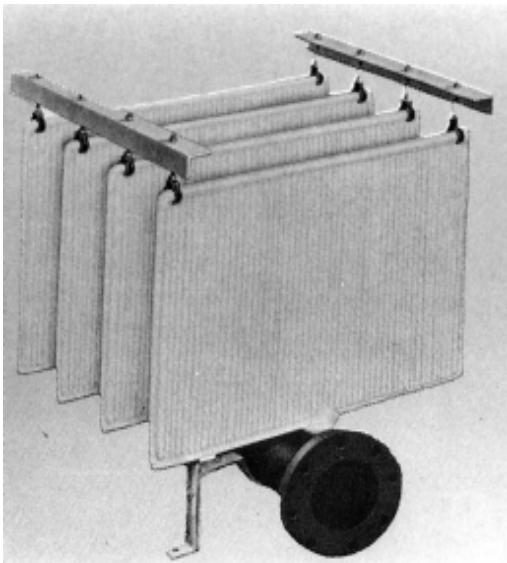
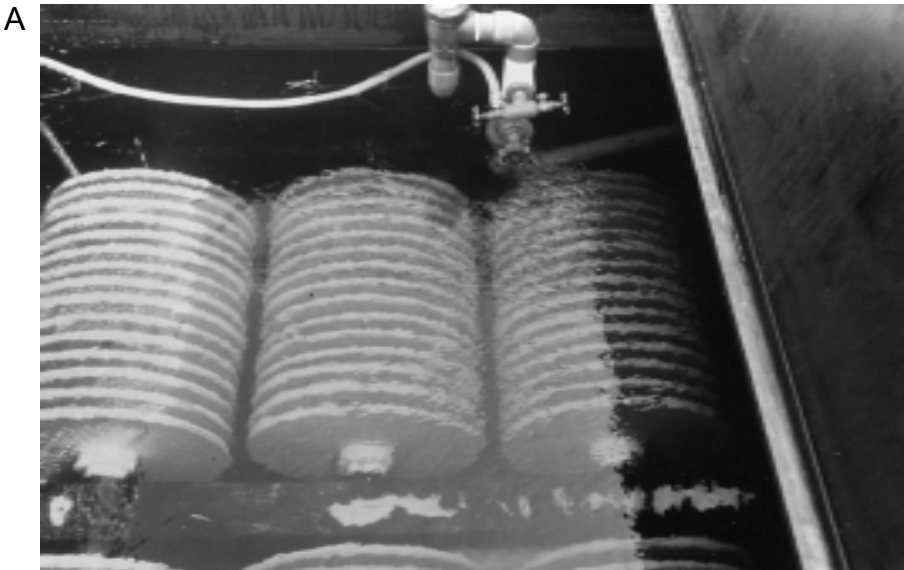


Fig. 5-9. A, Vacuum DE discs. B, Large, rectangular DE leaves. (Photo courtesy of Brock Enterprises, Hamden, Conn.)

of diluted DE, the new DE helps the older DE in catching dirt. Slurry feeding systems must be designed so that the mixing equipment does not damage the fragile DE. High-speed agitators used to mix DE in water can pulverize the diatoms, rendering them less effective in filtering out dirt. Slurry mixers must be designed to dilute the DE in water slowly and gently.

A rough method of slurry feeding is to throw a coffee can or two of DE into the filtering tank periodically. When too much DE is added to the original precoat through slurry feeding, filtering water can be impeded. When excessive amounts of DE have been added so that the DE on one filter element touches the DE clinging to the adjacent filter septa, “bridging” has taken place and removal of all DE must commence. Regenerative DE filters accomplish what slurry feeds accomplish *without* adding DE.

Cleaning Filter Septa

Cleaning the filter septa is required periodically because scale, oils, and other organic materials eventually build up on the elements and must be removed with special cleaners. A strong cleaning agent called trisodium phosphate is often used to lift oil and grease from the septa fabric. After TSP is applied, muriatic acid is then used to remove scale build-up. If muriatic acid is used prior to TSP, oils and grease would be almost impossible to remove. Because of environmental concerns (TSP is not biodegradable and is banned in some states), alternatives to TSP are now highly recommended to avoid the use of phosphates.

Additionally, whenever muriatic acid is used, strong vapors are released. Care must be taken not to breathe these fumes.

Handling DE

Because DE is a light powder, if not handled carefully it can wind up all over the filter room. Caution must be exercised so that the fine powder is not inhaled. Protective masks covering the nose and mouth will help prevent breathing the DE. Some believe that breathing microscopic DE particles may cause silicosis of the lungs. The filter room floor should also have floor drains to permit the washing of DE from the floor. When wet and/or used, old DE does not have the same concerns.

In summary, although several disadvantages are associated with DE filters, DE still represents the most efficient filter medium that produces highly polished

water. Although it requires some additional work and special handling, DE produces sparkling clear water. Recently, a biodegradable cellulose DE substitute has become available to operators and shows great promise. According to manufacturers, the cellulose alternative to DE produces the same outstanding water clarity without the health concerns of handling the media.

If water clarity is the most important consideration when designing a swimming pool, then DE filters should be considered. Some swimming pool experts (and I’m one of them) claim they can actually tell when a DE filter is being used by the polished appearance of the water.

Cartridge filters

The latest technology in swimming pool filtration involves the use of cartridge filters. Cartridge filters have been used for many years in science and industry. Although the original cartridge filters were developed for residential pools during the 1950s, cartridge filters are now used in many different types of pools. The first generation of cartridge filtration used depth filtration, while the second generation (since 1970) moved to surface filtration. Cartridge filters utilize an artificial media. The filter element is composed of a pleated polyester cloth or other synthetic fabric that traps dirt. As the spaces and pores become clogged with dirt, the cartridge filter needs to be either cleaned or replaced. This usually occurs when the pressure rises to about 10 PSI above the starting pressure. Cartridge filters for pools somewhat resemble air filters that protect automobile carburetors (Fig. 5-10).

The advantages of cartridge filter systems include:

1. Cartridges are cleaned by hand and do not require much water to clean; therefore they conserve water.
2. Cartridge filter systems are very simple to disassemble, analyze, repair, and replace. Most cartridge filter maintenance does not even require tools.
3. Cartridge filtration systems require little space and eliminate much of the valving and piping required by more traditional pool filters.

The disadvantages of cartridge filter systems include:

1. The filters are difficult to clean and some technicians claim that only 65% to 75% of the cartridge filtering capacity is recovered after each cleaning. New filters are required often.
2. Plastic lid covers that hold the cartridge filters in their pressure tank have been known to crack. The plastic lids should be checked often and replaced when necessary. When O-rings and gaskets are used to secure the cover, they should be lubricated regularly.

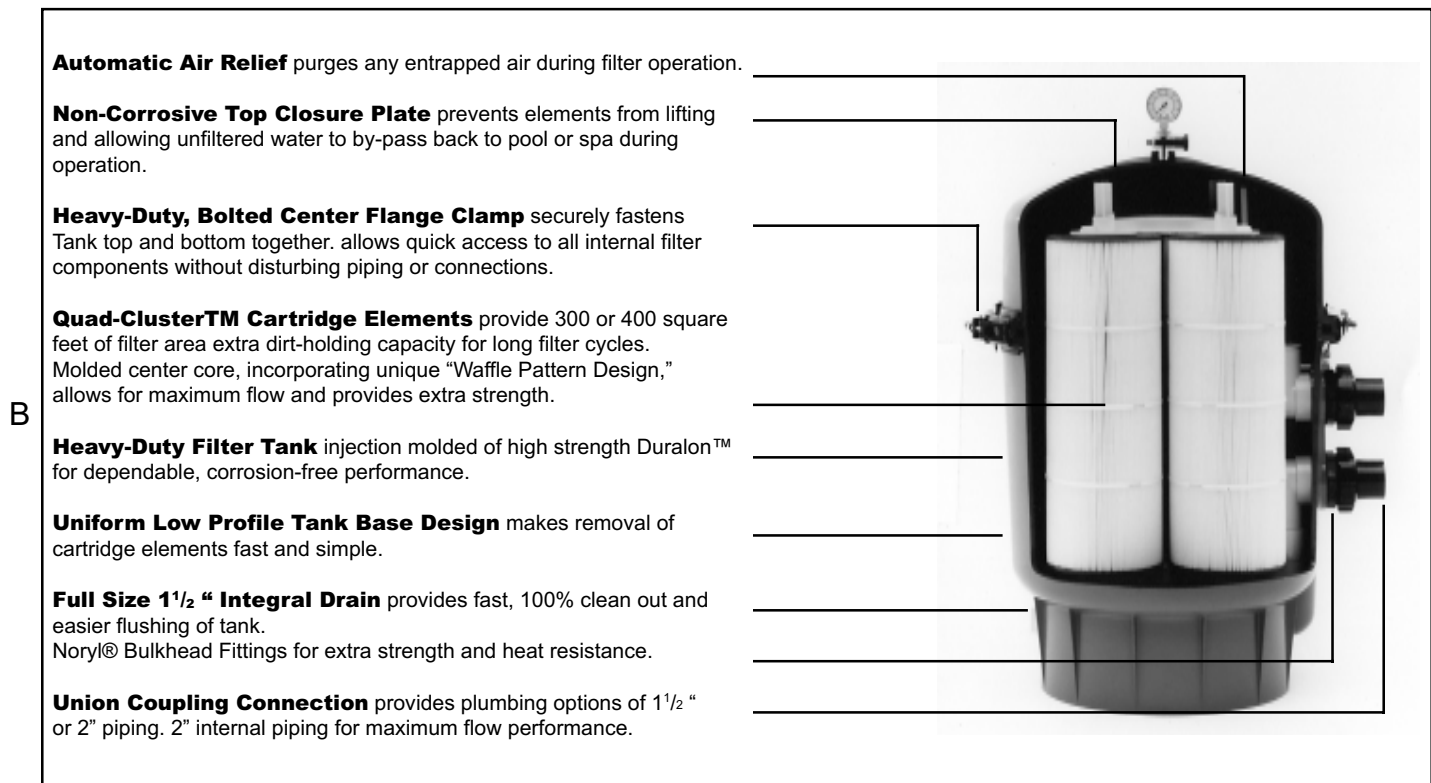
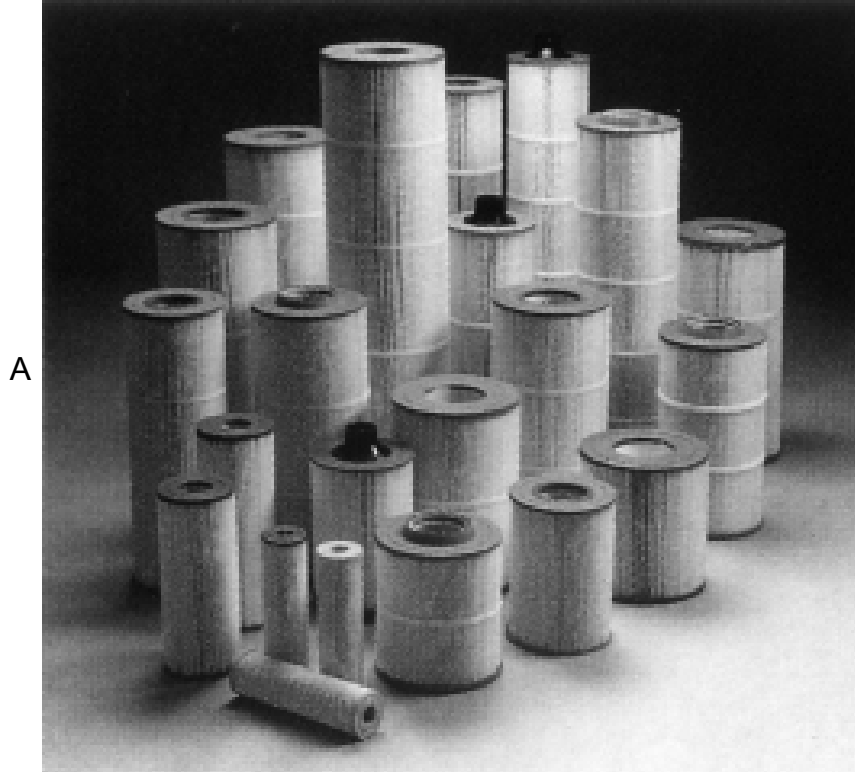


Fig. 5-10. A, Pleated, cylindrical cartridge filters of various sizes. B, Cartridge filters. (A, Photo courtesy of Brock Enterprises, Hamden, Conn; B, Photo courtesy of Hayward Pool Products, Elizabeth, NJ.)

Pool owners and operators utilizing cartridge filters recommend having plenty of extra filters on hand to replace the dirty cartridge being cleaned. Many dirty filters require soaking in trisodium phosphate (TSP) or a TSP substitute. Muriatic acid might also be needed after the oils are removed. Because a number of filters must be purchased during the swimming season, cartridge filtration becomes expensive in most applications. Cartridge filtration appears to be more popular with hot tubs.

Cartridge filters are designed to filter at a rate of between .375 and 1 GPM per square foot of surface area.

For example, a swimming pool with a flow rate of 475 GPMs would require a high rate sand filter bed with between 31 and 32 square feet of surface area. 475 GPMs divided by 15 GPM/FT² equals 31.66 square feet of filter surface area. When calculating the surface area for DE filters, it is important to remember that two sides of every DE filter element does the filtering; thus with DE filters the answer obtained with the above formula must be divided by two.

Summary

When selecting a filtration system for a swimming pool, needs must be prioritized first. Filters that produce the best water clarity may also require the most work. Ease of operation and backwashing must be weighed against how clear the water must be. Although filter media must be cleaned regularly, it is possible to clean or backwash the filter too often.

In summary, three filtering factors determine water clarity in a swimming pool: the filtering rate, the amount of filtering media, and the effectiveness of the media. Table 5-1 includes typical characteristics of common filter types.

Dr. Tom's Tip: When backwashing, extend the length of the backwash to purge the pool of extra water. This will require more fresh water to refill your pool after the backwash, but freshwater is your best chemical. Also, when sizing tanks for your aquatic facility, whenever possible, select tanks with larger, wider sand beds. Finally, inspect the sand in the filter tank at least once a year to prevent maintenance problems.

Filter Type	Filter Media	Filter Rate
Conventional sand and gravel	Permanent sand and gravel	3 GPM/ FT ²
High rate sand	Permanent sand	12-20 GPM/FT ² (15 GPM/FT ² average)
DE	Temporary DE	2 GPM/ FT ²
Cartridge	Semi-permanent fibrous material	.375 GPM/FT ²
To determine how much surface area of a particular filter media is required, the following simple formula is used: $\frac{\text{Flow rate in GPMs}}{\text{GPM/FT}^2} = \text{Square feet of filter surface area}$		

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