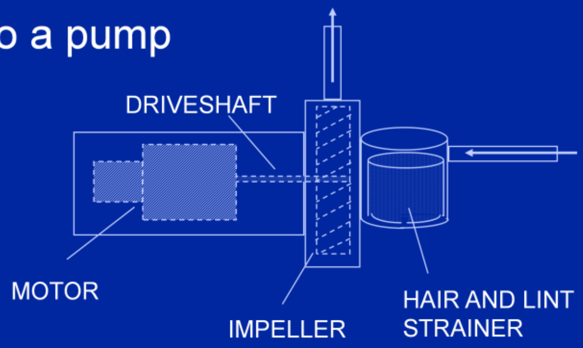
RECIRCULATION AND FILTRATION

The best way to ensure that your pool is being maintained at proper disinfection levels and kept clear from sediments is by continuously circulate and filter the water.

Circulation is the movement of water in the pool. In a pool this means the water is removed from the pool, filtered and disinfected, then returned to the pool. A proper circulation design will provide effective removal of surface water, which is where most of the contaminants are found.

PUMP

- “Heart” of recirculation system
- Pool pumps are centrifugal types
- Two sides to a pump
  - Influent
  - Effluent



The main feature of a circulation system is the pump. The pump provides the motion of the water through the piping. Once water is collected in the collection tank it is moved by the pump by either gravity or suction force. The pump provides the force necessary to move the water through the outlet fittings, piping, and back into the pool through the return inlets.

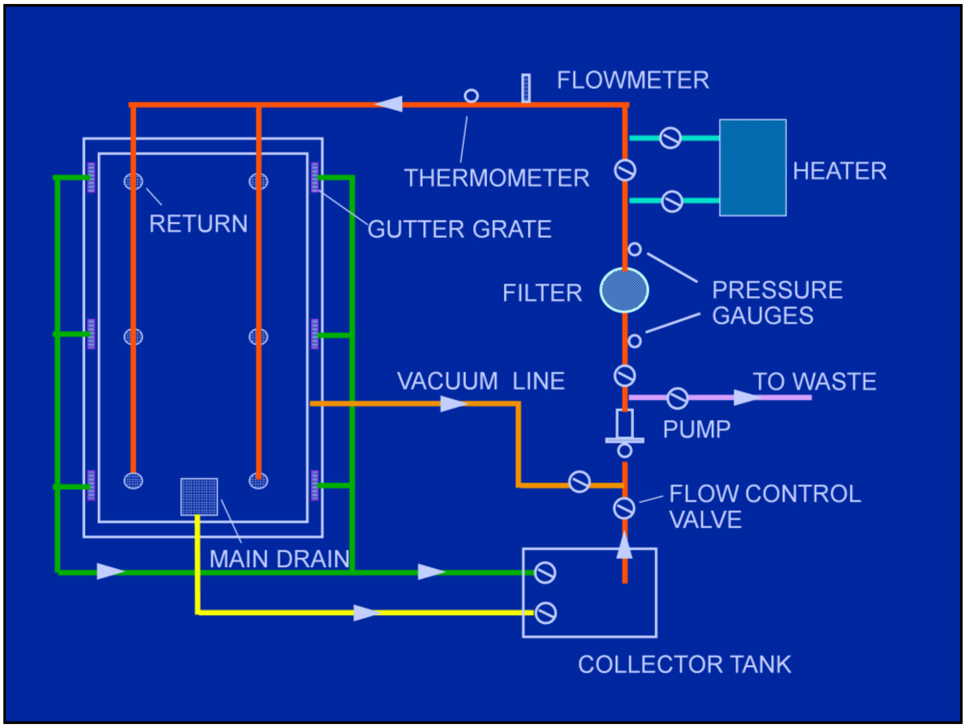
Pools use centrifugal (“Sen trif you gull”) pumps which is a rotating system. The parts of a pool pump include the motor, the driveshaft (which is an extension of the pump motor), the impeller, and a hair and lint strainer. The impeller causes the water to flow; as it rotates, the center of the impeller draws water in from the influent side. The water is collected and the pressure causes the water to exit through the effluent piping.

A licensed pool contractor should be contacted for repairing or replacing circulation pumps.

PRESSURE SYSTEMS

- Water removed from pool by flowing through:
  - Main drain
  - Skimmer system
- Water flows via gravity to collector tank
- Pump takes water and pushes it through filter(s) and heater
- Water is returned to pool

In a pressure system, water is removed from the pool by route of the main drain and the skimmer system. Gravity will cause the water to flow to the collector tank. The filter is placed after the pump in a pressure system and so the pump takes the water and pushes it though the filters and heater after which it is returned to the pool. A large amount of the work being performed by the pump impeller is on the effluent side of the pump.



This is an example of a pool with a pressure system. In the pool, the water will be removed through the main drain and the gutter grates.

Here is the water flowing from the main drain to the collector tank.

Here is the water flowing from the gutter to the collector tank.

From here the pump draws in the water and pushes it through the filters. A pressure gauge must be present before and after the filters.

The water then passes through the heater unless the heater is being bypassed using the proper valves. The use of the heater may not interfere with the required flow rate of the pool.

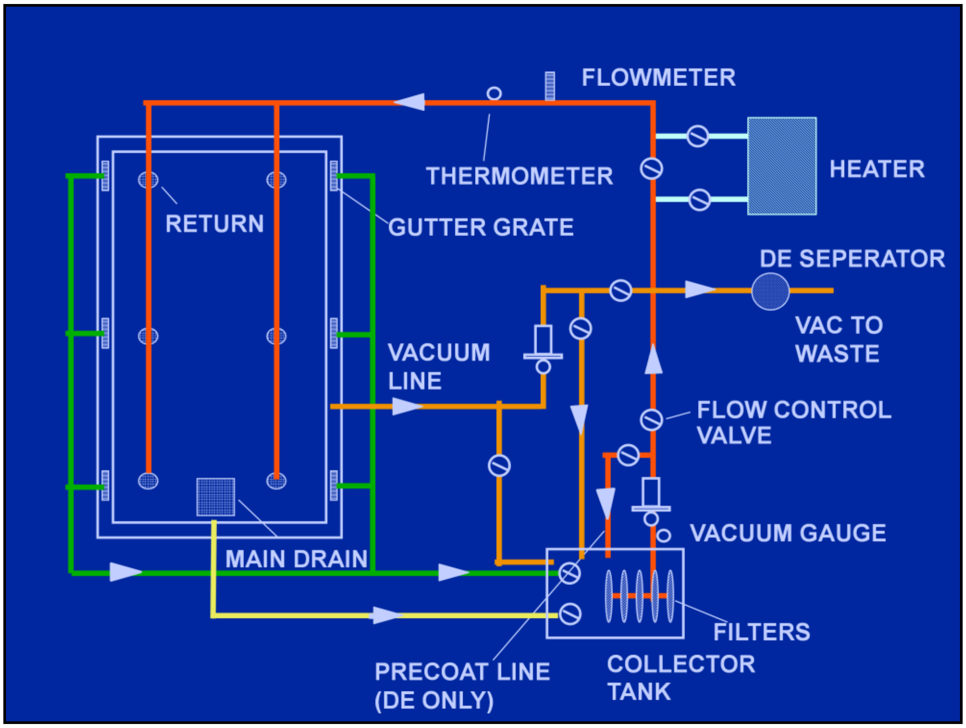
From the heater the water returns to the pool through the returns in the pool. The return line is where the flowmeter and thermometer must be located.

VACUUM SYSTEMS

- Water removed from pool by flowing through:
  - Main drain
  - Skimmer system
- Water flows to collector tank
- Pump pulls water through filters
- Water is pushed through heater
- Water is returned to pool

Vacuum systems have the filters placed before the pump. This requires an impeller that has more suction capability. A large amount of the work the impeller performs is now on the influent side of the pump.

In a vacuum system, the water is still removed through the main drain and the skimmer system. Water flows to the collector tank and is pulled through the filters by the pump, and then pushed out through the heaters and back into the pool.



Here is the example of a vacuum system pool.

The water flows from the main drain to the collector tank where the filters are located.

Water also flows from the gutter grates to the collector tank. The filters could be DE or cartridge.

The water is then pulled through the filters by the pump, then pushed back out the effluent side of the pump. A vacuum gauge must be installed before the recirculation pump on a vacuum system.

If the vacuum system has DE, you will also have a precoat line.

The water is pushed through the heater after being pulled through the filters.

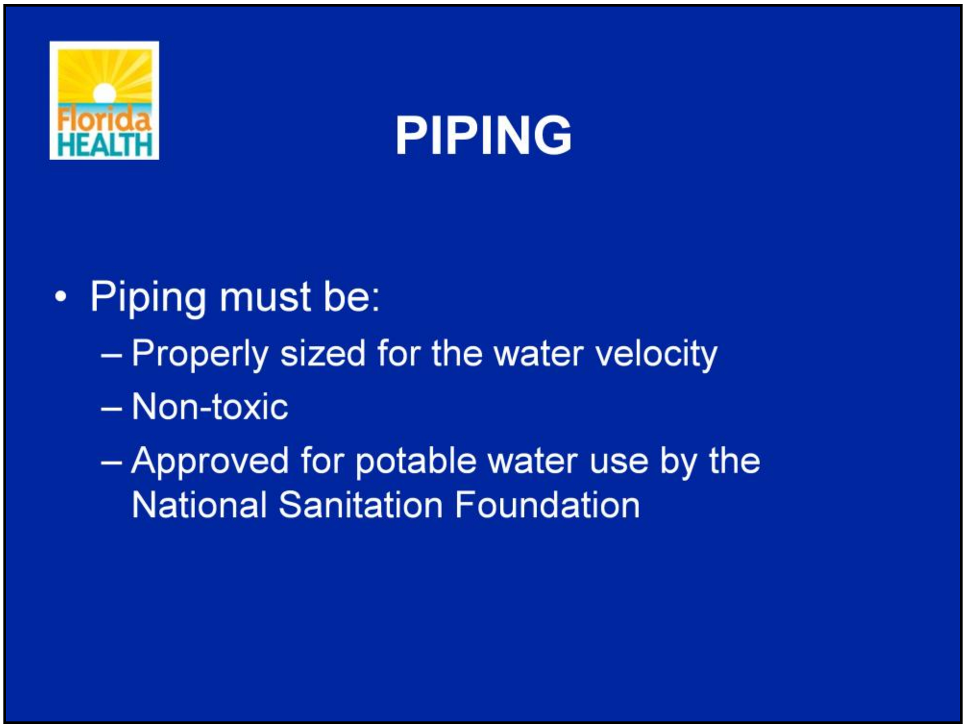
From there the water is returned to the pool.

The vacuum line has its own vacuum pump which is used for vacuuming debris from the bottom of the pool. For DE, a separation tank must be used to collect the used DE so that it is not being dumped into the environment or sewer systems. After the separation tank if the vacuum to waste line which much have an air gap.

The skimming system of the pool can consist of either gutters or surface skimmers. The purpose of the skimmer is to collect the debris from the surface of the pool. The surface of the pool is where the highest concentration of contamination exists.

In order for a gutter system to operate properly, the water level must be carefully controlled. This allows for a surface tension that draws the top layer of the water and surface debris and contamination are quickly removed from the pool and sent to be filtered. The image shown on the slide is an example of a perfectly skimming gutter type pool.

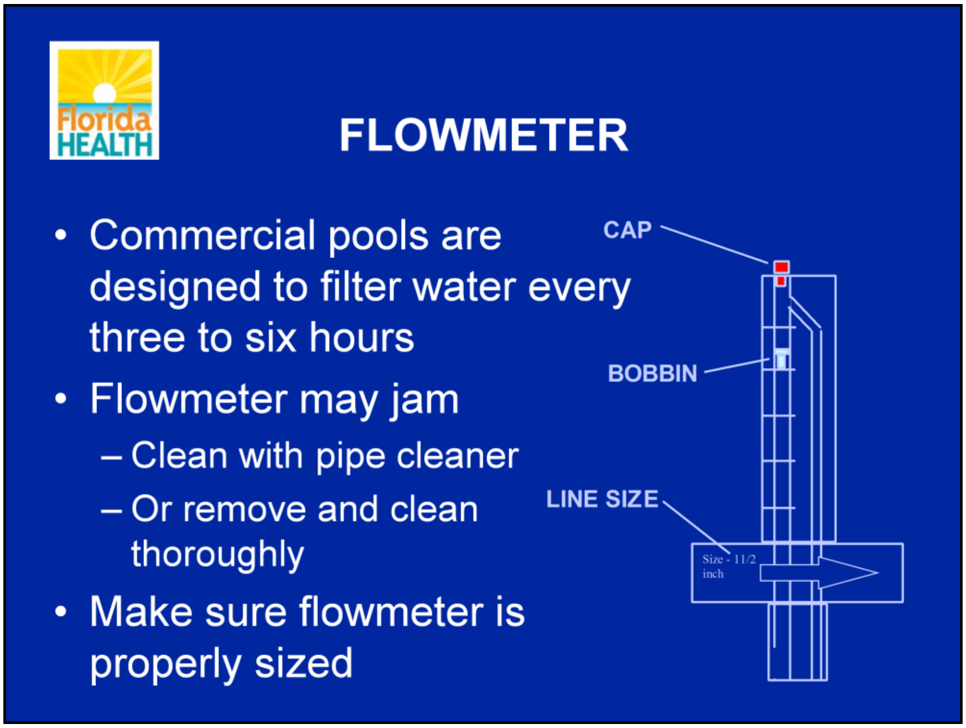
A surface skimmer is a box-like opening in the pool wall, located at the surface. Pools must have one skimmer for every 500 square feet of water surface. The entrance of the skimmer will have a floating weir which will adjust to the level of the water, providing the skimming or sheeting action. The weir prevents the water from backing into the pool. A skimmer basket is found inside the skimmer housing and is used to collect larger debris. The skimmer basket must be cleaned on a regular basis to maintain the proper water flow. Some skimmers may have an equalizer line. The equalizer line becomes active when the water level falls below the skimmer wall outlet. This makes sure that the pump will have adequate suction flow and will not lose prime. If the water level in a pool has fallen below the skimmer opening, it will be posted closed.



The piping of the pool is like the veins and arteries of the system. The velocity of the water as it flows through the pipe is determined by the size of the pipe and the pressure from the pump. The velocity of the water must not exceed the standards in the code, which would be a part of the original engineered plans. Changes to piping may not occur without a modification permit.

PVC pipes must be non-toxic and able to withstand the design operating pressure. PVC piping in an equipment room that is exposed to sunlight must be properly coated to protect it from ultraviolet light degradation.

The piping must also be approved and comply with ANSI and NSFI standards for potable water use.



Commercial pools must meet their required flowrate in order to ensure the water is being properly filtered. All of the water in the spa or pool must be filtered every 3 to 6 hours, which is called a turnover. A flowmeter must be installed on the return line so that the flowrate of the pool can be measured. The flowmeter will give the flowrate in gallons per minute and must be accurate within 10% of the actual flow. The flowmeter must be properly sized for the pipe size it is installed on and must be capable of reading ½ to at least 1 ½ times the design flowrate.

Flowmeters becoming stuck is a constant issue that must be corrected. Sometimes the flowmeter can be cleaned with a pipe cleaner, other times it must be removed and cleaned in order to fix the jam.

VACUUM GAUGES

- Must be mounted between pump and filters
- Measures how hard the pump is working
- Must be proper size:
  - 2 inches in diameter
  - Range from 0 - 30 inches Hg

The flow of water to the pump should never be restricted; however, due to many possible reasons, this can occur. Clogged filters or hair and lint strainers and skimmer baskets filled with debris can cause this problem.

A vacuum gauge must be mounted before the pump, which is between the pump and filters on a vacuum system. That gauge will measure just how hard the pump is working on the suction side. An operator will need to be aware of the normal operating reading of the gauge is in order to know when the reading is showing an increase.

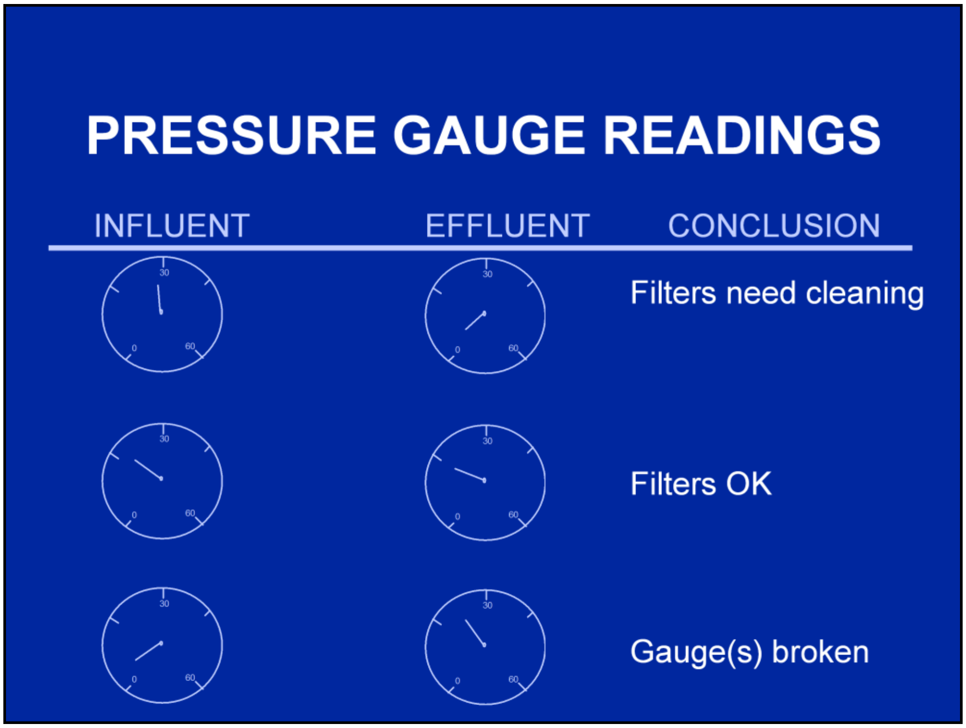
The size of the gauge must be 2” in diameter and should have a range of 0-30 in inches of mercury.

PRESSURE GAUGES

- Must be mounted:
  - Influent side of filter(s)
  - Effluent side of filter(s)
- Must be proper size:
  - 2 inches in diameter
  - Range from 0 - 60 psi
- Determine if filters need cleaning by the difference in pressure between influent and effluent readings

Pressure gauges must be mounted before and after the filters on a pressure system. The proper sizing for a pressure gauge it 2 inches in diameter and it must give a range of 0-60 psi.

Pressure gauges will help you to determine if your filters need cleaning. You can determine this by looking at the difference between the influent and effluent gauges. A higher pressure on the influent side than the effluent side indicates that the water pressure entering the filters is higher than the water pressure leaving the filters. This could mean that the filters need to be cleaned or replaced.



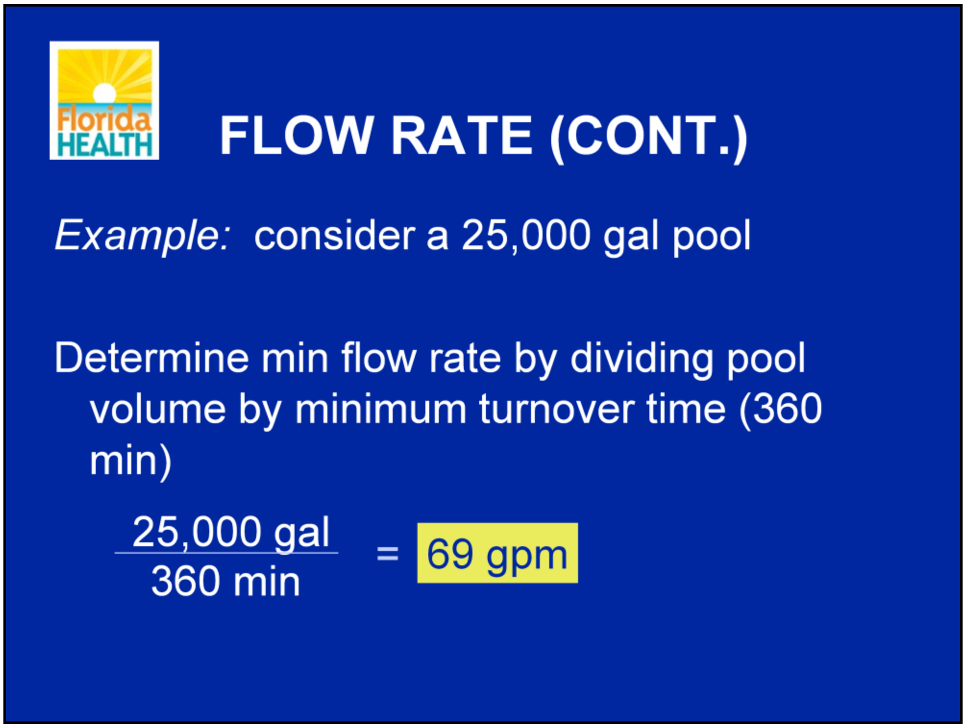
This slide illustrates what a pressure gauge reading could be telling you about your filters. When the influent reading is much higher than the effluent reading, your filters need to be cleaned. When the two gauges have about the same reading, the filters are fine. If the gauges show a lower influent than effluent it is possible that your gauges are not operating properly and may need to be replaced.

FLOW RATE

- Important in:
  - Promoting proper filtration
  - Promoting proper mixing of pool water
- Measured in gallons per minute (gpm)
- Minimum flow calculated by:
  - Pools: 1 full turnover every 6 hours
  - Spas: 1 full turnover every 30 minutes

The flow rate of the pool is the design flow that must be met in order to meet all the operational requirements of the pool. Maintaining the required flow rate is important for proper filtration and the proper mixing of the pool water.

Flowrate is measured in gallons per minute using a flowmeter. A flow meter must be installed on the return line downstream from all the equipment and just before the water is returned to the pool. You must have an adequate flow rate in order to achieve the proper turnover rate. A turnover rate is the amount of time it takes for the circulation equipment to move all the water in the pool through the filtration equipment. A pool must have a full turnover a minimum of every 6 hours; for a spa, every 30 minutes. Water is processed through the filter, chemically treated, and then returned to the pool.



We're going to try to calculate the flow rate for a pool. In our example we have a pool that is 25,000 gallons.

We can determine the minimum required flow rate by dividing the pool volume by the minimum turnover time (which is 6 hours, which is 360 minutes)

This gives us 25,000 divided by 360

Which gives us 69 gallons per minute.

The bather load of a pool is the maximum number of people allowed into a pool or spa at one time.

For a pool, the bather load is calculated using the required flow rate. 1 person is allowed for every 5gpm of flow. In a spa, the bather load is calculated depending on how much surface area is present in the spa. 1 person is allowed for every 10 square feet of surface area.

POOL BATHING LOAD

Example: Consider a 25,000 gal pool

Min flow rate = 69 gpm

At 1 person per 5 gpm:

$$\frac{69 \text{ gpm}}{5 \text{ gpm / person}} = \text{13 persons}$$

Now we will do an easy calculation to determine what the bather load of a pool should be.

In our example, we are using a 25,000 gallon pool.

For this pool we already determined that the required flow rate was 69 gpm.

We can have 1 person for every 5 gallons per minute.

So we just have to divide 69 gpm by 5.

This gives us a bather load of 13 people. It is important that the bather load isn’t exceeded. Exceeding the bather load will overtax the circulation system and will lead to low chlorine and poor filtration. The bather load should be clearly displayed on the Pool Rules sign.

Be aware that some pools and spas are overbuilt and are permitted on that basis.

This will occasionally result in* higher *flow rates and / or* lower *bathing loads than calculated

Sometimes a pool is overbuilt; this is usually due to the number of units or houses that the pool serves. A community with a very large number of units will require a pool with a higher flow rate. Always check with your inspector if you have any doubts about your required flow rate or bather load.

CHEMICAL TREATMENT

- Pools must have automatic chemical feeders
- Two common types of feeders
  - Liquid
  - Erosion

Liquid feeders

Pools and spas are required to have automatic chemical feeders. Pool and spa chemicals can be a gas, a liquid, or a solid.

The most commonly used feeders use stenners for liquid chemicals or tablets in erosion feeders.

Liquid chemicals can be delivered to the pool as either a liquid or a chemical and can be delivered as a dry chemical. Dry chemicals can be mixed with water at the site to create the liquid or slurry that is fed into the water. Liquid chemicals should be fed into the circulation downstream from the filters and into the heating systems, into the return line.

Erosion feeders are also called “flow through chemical feeders”.

Types of Feeders

- Liquid Solution Feeders
  - Positive displacement pump
    - Peristaltic pump
    - Diaphragm and piston pumps
- Erosion Feeders- four basic factors
  - Solubility
  - Flow rate of water
  - Surface area of pellets
  - Temperature of the water

Erosion feeder

A positive displacement pump is a type of liquid feeder which is commonly used for the injection of sodium hypochlorite and liquid chemicals for pH adjustment. There are two commonly used positive displacement pumps. The peristaltic pump uses rollers that squeeze a feed tube, moving the fluid through the tube. The piston or diaphragm pump uses check valves.

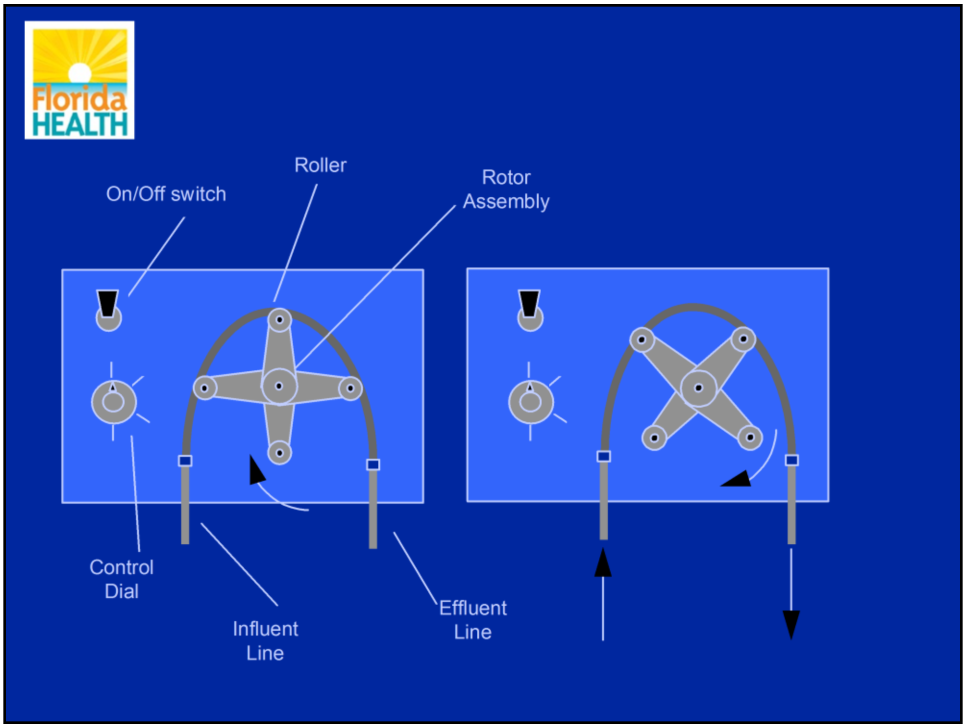
Peristaltic pumps have a motor-driven roller assembly which squeezes a flexible tube. As the rollers rotate, the chemicals are discharged under pressure for each cycle of the rollers. These feeders require a feed line that is free of sediment clogging in the tube and at the injection point where the chemicals are fed into the return line. The most common cause of a feeder to fail is a problem with the stenner tubing. It is a good idea to keep extra tubing with you to address this kind of problem immediately. The flexible tubing is expected to operate for about 400 hours before needing to be replaced. Clogged lines will shorten this time. Be careful when cleaning your stenner tubes; should the chlorine and acid chemicals contact each other, dangerous chlorine gas will be released.

These pumps should be placed properly in the equipment area. For example, the pumps should not be mounted directly over the chemicals; this is because over time, the fumes from the chemicals could damage the equipment. You also should not mount the feeders over other equipment; should a stenner tube fail, you could end up with chemicals dripping onto and damaging the equipment.

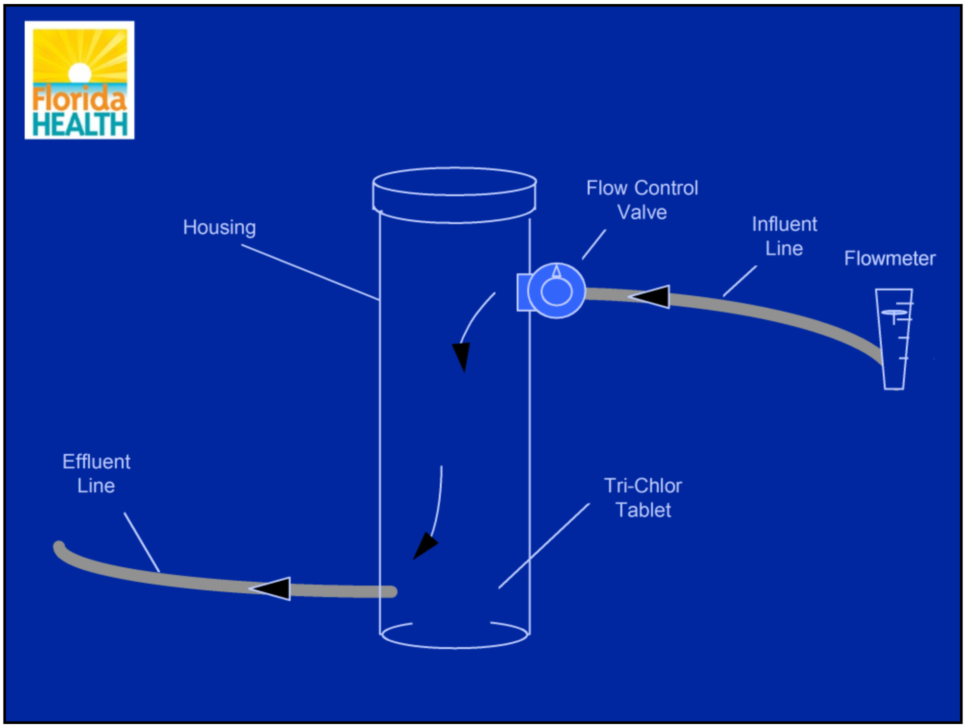
Diaphragm and piston pumps use check valves and cams. The diaphragm uses a flexible membrane that displaces fluid as it moves in and out. The piston pump is activated by a cam. Both the diaphragm and piston pumps operate with the use of check valves. It is important to flush the diaphragm pump as often as once a week to avoid failures.

Erosion feeders are also called “flow through chemical feeders”. There is a gradual wearing-away (erosion) of the solid tablet in the feeder. As the tablet erodes, the chemicals dissolve. The effectiveness of this type of system is dependent on four basic factors. These factors include the solubility of the chemical product (how quickly does it dissolve in water); the flow rate of the water through the erosion device; the total surface area of the exposed chemical pellets; and the temperature of the water flowing through the erosion feeder.

With these factors in mind, the water flow must be carefully controlled to maintain the proper amount of disinfectant output. The water flow is controlled through the use of a flow control valve and can be monitored using a flow meter.

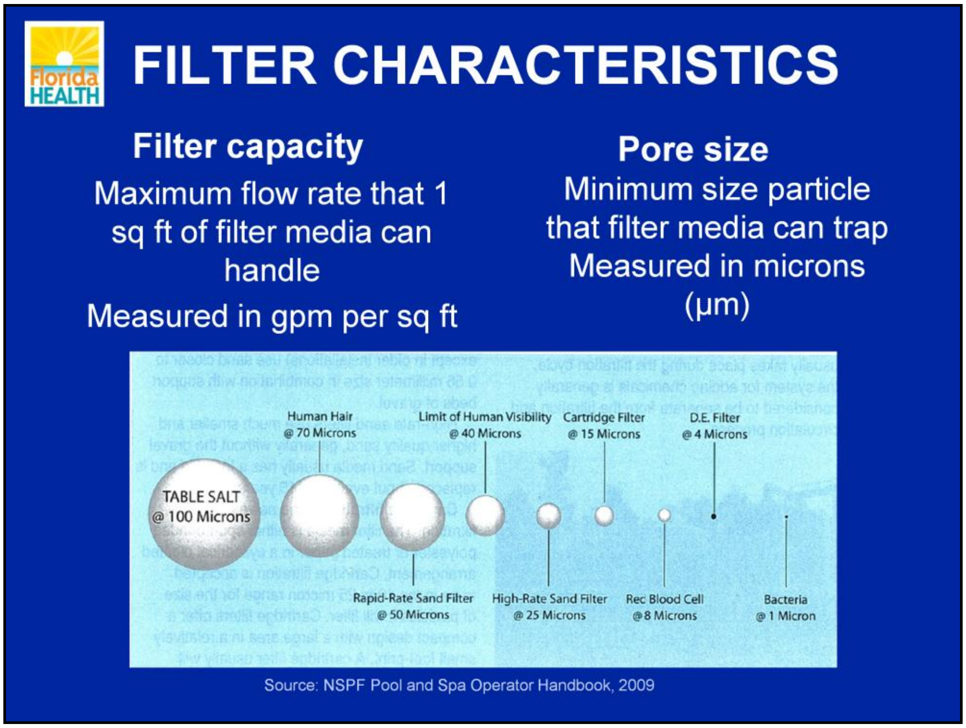


This slide demonstrates how a positive displacement pump works. The control dial determines the level of chemical that will be fed into the pool. The influent stenner tube draws the chemical from the barrels; the rotor assembly turns and through the squeezing of the tube the chemicals exit through the effluent line and into the return line of the pool.



Here we have a diagram of an erosion feeder. Water will flow depending on the setting of the control valve into the housing of the erosion feeder. The water will dissolve some of the chemical stored in the housing, and the chlorinated water will exit through the effluent line and into the pool return line. The rate of flow can be monitored by using the flowmeter on the influent line.

Filtration is a mechanical process which requires pumps, filters, and the gravity, vacuum, and pressure piping. Filtration and circulation are the means that provide the pool with clean, clear water. Filtration is very important because it removes contaminants that can promote the growth of bacteria or algae. Filters also remove particles suspended in the water that can make the water cloudy. Pool water is being physically cleansed by passing the water through a filter. The material doing the filtering is called media and is generally comprised either of sand, cartridge, or diatomaceous earth.



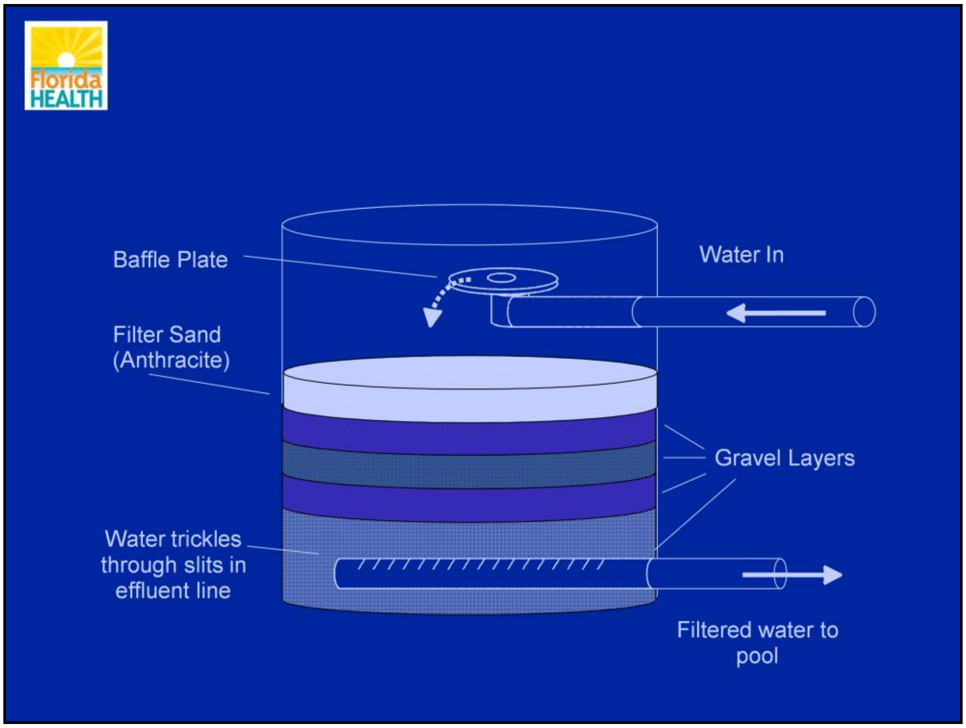
The capacity of a filter is the maximum flow rate that 1 square feet of the media can handle. This is measured in gpm per square feet. The pore size is the minimum size particle that filter media is able to trap, and is measured in microns. The chart on the slide shows the pore sizes for sand, cartridge, and D.E. filters. You can see that DE filters are able to filter down to 4 microns, making it the most effective filter media.

RAPID RATE SAND FILTERS

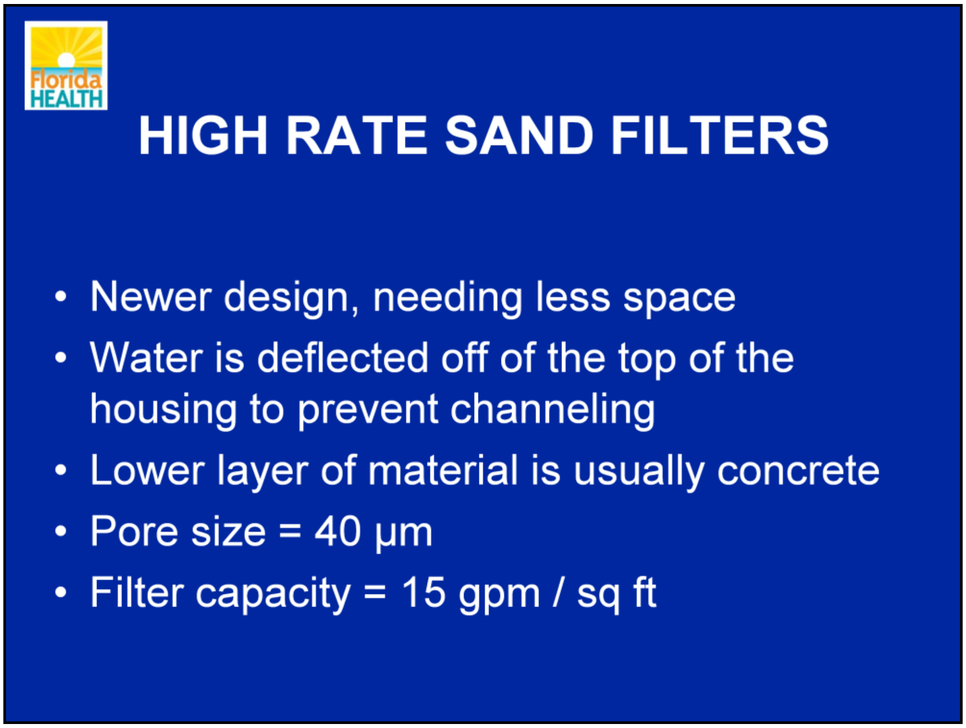
- Old design
- Take up lots of space
- Water enters through a baffle to prevent channeling of the sand
- Filter capacity = 3 gpm / sq ft

Sand filtration is the oldest type of filtration. Sand is considered a more permanent media, as it can last between 5 to 15 years before needing to be replaced. Sand filters tend to take up a lot more equipment room space than other types of filters. Rapid rate sand filters are a series of large tanks with diameters of 8 feet or more.

Sand filters work on a principle of water moving from the top of the filter to the bottom. Rapid –rate media consists of a series of multiple sand layers and gravel. The standard filter capacity for rapid rate sand filters is 3 gpm.



As we said, the rapid rate sand filter has multiple layers of sand and gravel. The finest sand is on the top and is supported by courser sand. The gravel is also graded and provides support to the sand, with the courser gravel on the bottom. The courser material is also the densest and after backwash settles more quickly. In this manner, the layering is maintained. The backwash rate is 12 to 15 gpm per square foot and is achieved by cleaning one filter at a time independent of the remaining tanks, using all of the system’s water flow.



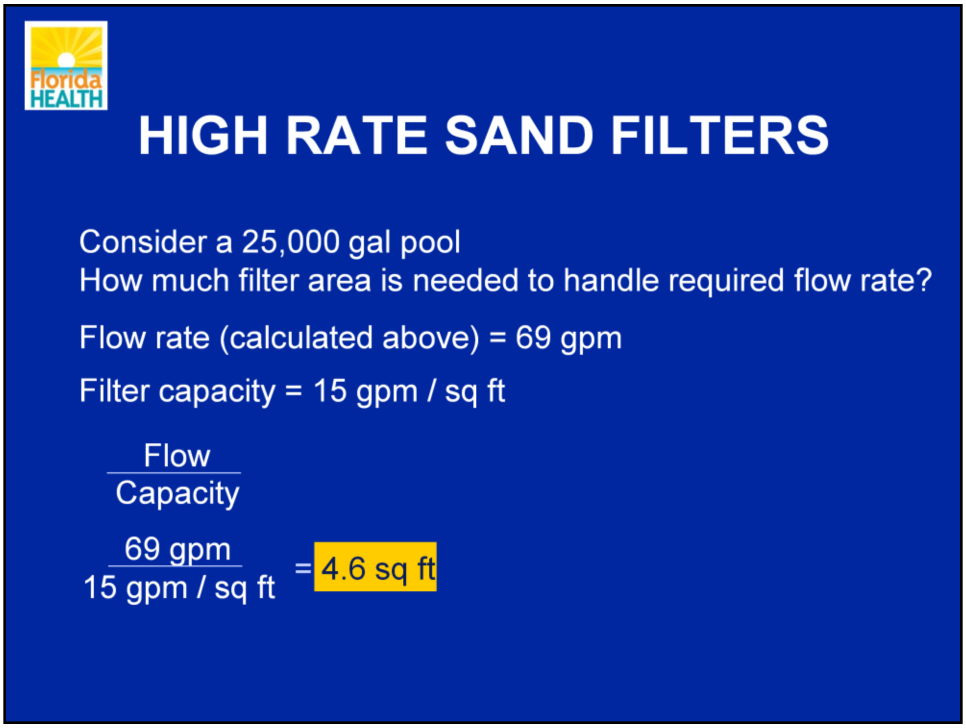
High rate sand filters are of a newer design, and able to filter water at a faster rate. These filters were developed in the 1950s.

Most sand filters are pressure filters, although vacuum ones do exist. The filter tanks are round with diameters that are usually between 2 to 4 feet. Large facilities may have filters that are as large as 10 feet in diameter. The filter housing can be made of stainless steel, plastic, fiberglass, or a combination of materials.

The water that enters the top of the filter housing goes through a fixture that spreads the water over the top of the sand bed. This is called the baffle or the distributor. Under the baffle is open space called a freeboard. The freeboard is what allows the sand bed to expand during the backwash cycle. When replacing sand, it is important to maintain the proper amount of freeboard.

Valves are used to direct the water flow in the proper direction.

The design flow rate for high-rate sand filters is 5 to 20 gpm/ft2 with 15 being the most typically used.



In this exercise we will determine how much filter area we will need for a pool when using high rate sand filters. For our example we have a pool that is 25,000 gallons. We must figure out how much filter area is needed in order to handle the required flow rate.

From our earlier calculations we know that the required flow rate for a pool of 25,000 gallons is 69 gallons per minute.

The filter capacity of our sand filters is 15 gpm/sq feet. So we just need to divide our flow rate (69) by the capacity (15)

To get an answer of 4.6 square feet.

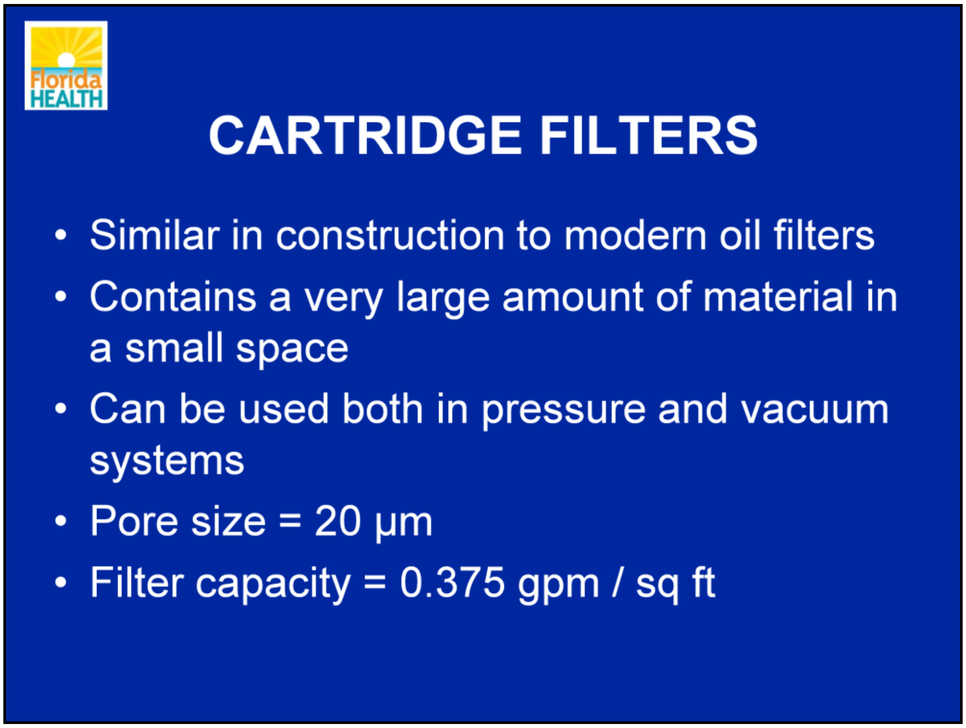
CLEANING SAND FILTERS

- Reverse flow through the filter so that accumulated dirt flows to waste (backwashing)
- Must have clear watch glass set into the waste line so that operator will know when the filters have been cleaned

Sand filters are cleaned through backwashing. Backwashing is required when the water entering the filter (the influent) and the water exiting the filter (the effluent) reaches a 10 to 20 pounder per square inch difference. This difference will be calculated by using the pressure gauges that must be mounted on each side of the filters.

You must always follow the written directions of the filter manufacturer when backwashing the filters. During backwash, the water flow is reversed. The flow is from the bottom laterals to the top. As the sand is lifted, it expands, becomes agitated, and fills the freeboard area. The agitation removes the trapped particles and material, which is flushed out the distributors to waste. In manual systems, the backwash waste water is observed through a sight glass until the effluent becomes clear.

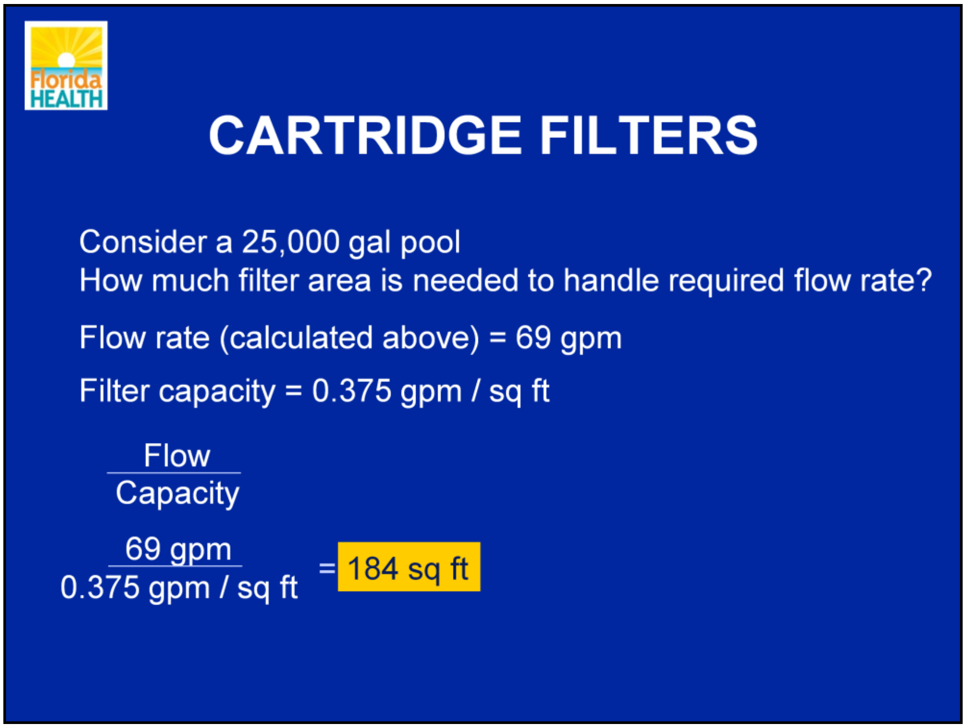
After the backwash cycle is complete, the cleansed sand begins the process of filtration again.



Cartridge filtration is a very commonly used filtration in swimming pools and especially in spas. The most obvious reason that cartridge filtration is used is due to the compact size. A large amount of filtration can be contained in small space. The normal installation of a cartridge filter system will require about half the floor space of an equivalent sand or DE system. Cartridge filters are also easier to clean; they do not require backwashing, which conserves water. Cartridge filters can be used in either pressure or vacuum systems.

The disadvantage to cartridge filters is a lack of dilution or replacement of dirty water with fresh potable water. Cartridge filters have a filter capacity between .375 and 1.0 gpm/sq feet.

In a cartridge filter system, water containing suspended material passes through the filter elements, leaving the debris on the filter surface. As the system continues to filter over time the debris accumulates, making it more difficult for the water to pass through.



Now we are going to find out how to calculate the filter area needed for a pool when we have cartridge filters. We are still using a pool that has a volume of 25,000 gallons. We need to figure out how filter area is needed to handle the required flow rate.

From before, we know that our pool has a required flow rate of 69 gpm.

The filter capacity of our cartridge filters is .375 gpm/ sq feet.

So all we need to do is divide the flow rate (69) by the capacity (.375)

To get our answer which is 184 square feet of filter.

Cartridge filters are not backwashed but instead have to be removed from the filter housing, hosed off, and cleaned properly. Be sure to shut off your pump and follow the manufacturer's directions.

Elements should be soaked in a commercial filter-cleaning product. Make sure to read the label directions because you might need more than one type of cleaner. One will remove the oils while the other will remove scale deposits. For example, tri-sodium phosphate detergent can be used to remove the oils and a dilute acid solution can remove the scale.

Often you must use the grease cleaner before the acid cleaner! Not following those directions can result in the oils being permanently set into the filter media.

Once the filters have been cleaned, they will be placed back into the housing and secured. Inspect your o-ring before closing the housing and apply lubricant when necessary. Not maintaining the o-ring will result in water leaking out or air entering the filter.

Eventually you will no longer be able to clean the filters to maintain adequate flow, and at that point the filters will have to be replaced with new ones.

DIATOMACEOUS EARTH FILTERS

- DE is made up of the remains of diatoms
- Held onto mesh supports by pump pressure or suction
- Most effective filter system
- Pore size = 2 µm
- Filter capacity = 2 gpm / sq ft

Diatomaceous earth, known simply as D.E., is a type of disposable filter media. When DE filters are cleaned, the DE media is discarded and replaced with new. The replacement process is called pre-coating.

DE is made of the skeleton-like fossils of diatoms; it has sponge-like qualities and can absorb huge quantities of water. The porous De particles are layered on top of one another to form a very fine screen. The DE powder is held onto the filter elements, which are called the septum. The septum is covered with a fine weave cloth material made of a synthetic fabric. The De powder forms a cake on the septum that should be between 1/16 to 1/8 of an inch thick.

It is the flow of the water that holds the DE in place. Insufficient water flow will cause the DE to fall off the grid. The openings of the DE cake are extremely small, allowing the passage of the water but trapping even the smallest of suspended solids. This gives DE the smallest pore size and makes it the most effective of the filter systems.

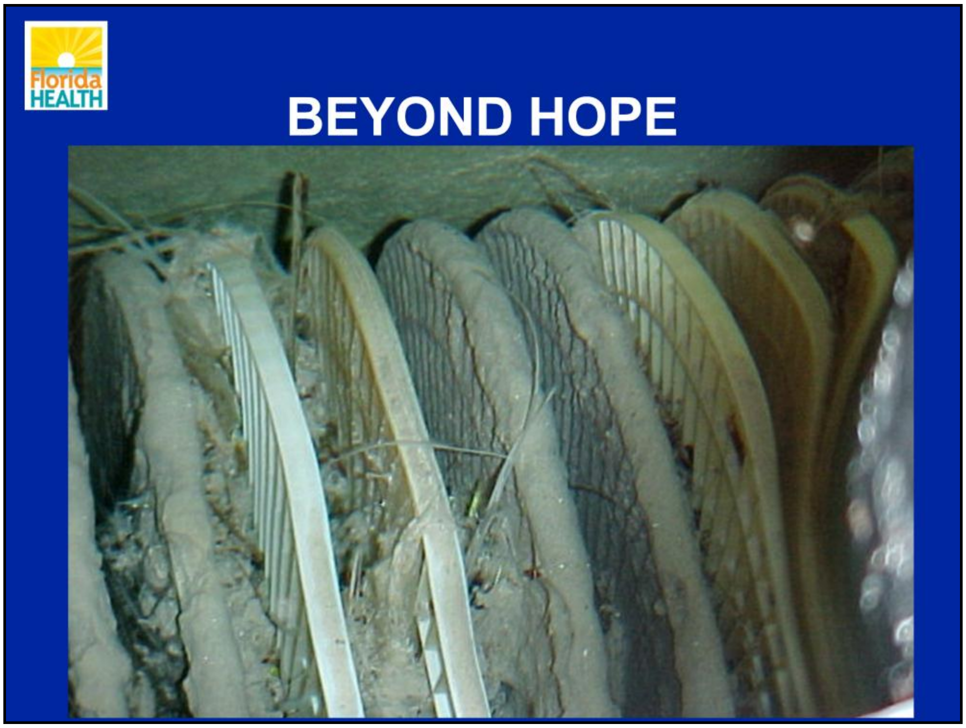
DE filters can be used as either pressure or vacuum systems. In a pressure system, the DE is much like a sand filter. The filter will be backwashed when necessary.

DE is a white powdery material. You must take great care in the storage and handling of the powder. When handling the powder you should wear a mask. The label of one DE supplier will explain why that is; "Breathing crystalline silica dust in excess of the permissible exposure limit, over a prolonged period of time, can cause silicosis, a progressive and sometimes fatal lung disease. Crystalline silica has been classified as a known carcinogenic for humans."

When removing the DE it is important to utilize the DE separators. Used De is considered an industrial sludge and must be disposed of properly, and you must be sure to wash your hands after handling it.

Allowing DE to go to a drain field instead of using the separator bags can cause serious problems, and has even been known to ruin drainfields.

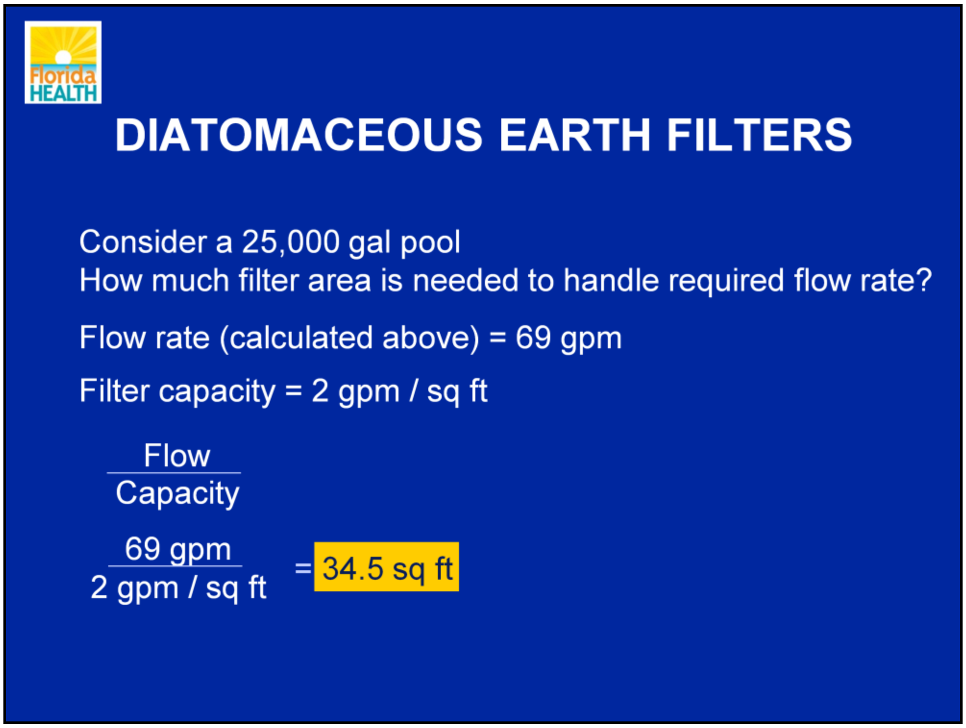
Here is a picture that shows what a DE vacuum system looks like. The filter elements are located in the collector tank in a vacuum system.



Over time the filter elements of a DE system can begin to lost their fabric and even become warped. This is an example of filter elements are that beyond hope of redemption and must be replaced.

As I mentioned earlier, DE should never be allowed to go to a drainfield. This shows what happens if it does; the DE has filled the drainfield pipes.

When the drainfield pipes become filled with DE there is no other way to correct the problem than by having to completely replace the drainfield. This is a major expense.

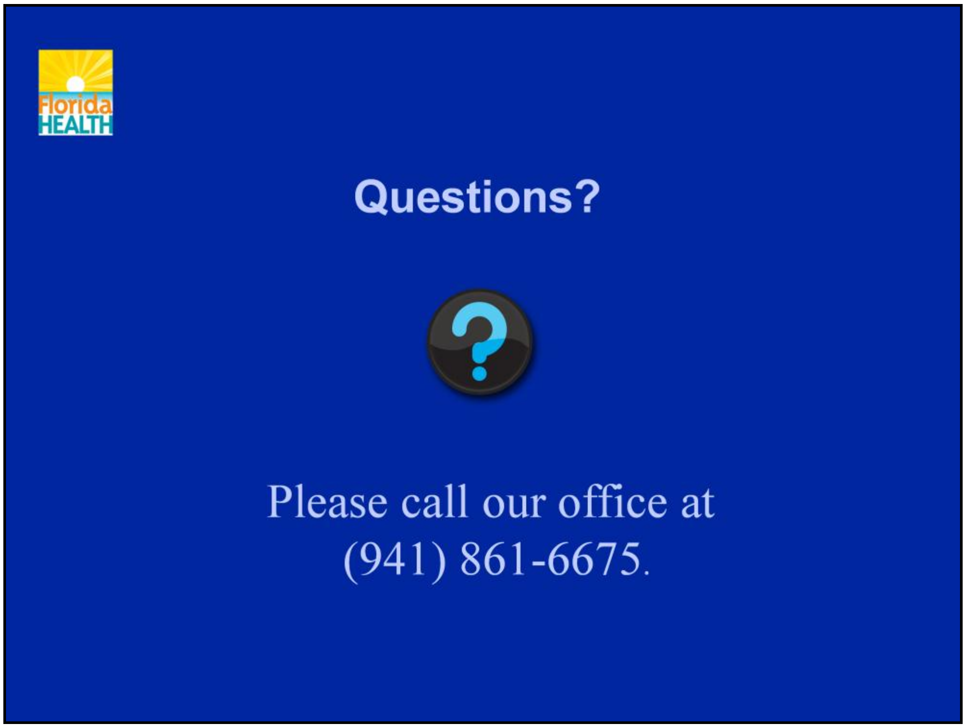


Now it's time for a DE filter calculation. We are back once again to our 25,000 gallon pool. Now we want to know how much DE filter area will be needed to handle our required flow rate.

Our flow rate is again 69 gpm and in the case of DE, the filter capacity is 2 gpm per square feet.

We divide our flow of 69 by our capacity of 2

And we get our answer, which is 34.5 square feet.



If you have any questions about anything that was discussed, please give us a call.