New Zealand Pool Industry Association Inc. PO Box 17069 Greenlane 1546 – email executive@poolguild.org.nz

PAPER 4
SWIMMING POOL FILTRATION & MAINTENANCE EQUIPMENT

3.1 INTRODUCTION

In this PAPER and also PAPER 4, we will look at the various types of swimming pool equipment in common use today. This equipment can be grouped into two categories - ***essential and optional***.

In order to function efficiently, home swimming pools will have specific types of essential equipment installed. We will discuss the features and operation of this equipment so that you are conversant with the broad principles of operation of your particular brand of equipment.

In addition, the range of optional equipment available to reduce the time spent in maintaining the pool and improving its safety, effectiveness and aesthetic characteristics will also be discussed.

3.2 FILTERS

Every swimming pool requires disinfecting (usually chlorination) and filtration regularly to maintain the water in a healthy and sparkling condition.

The disinfecting process oxidises bacteria and algae in the water into an ash which must be removed by the filtration process. You may often see this grey-ish ash on the pool floor after superchlorination. If this ash and other suspended and insoluble matter is not removed, future additions of oxidizers may react with it instead of performing its essential job of killing bacteria.

Efficient and sufficient filtration then is vital to the sterilisation process, and, of course, the reverse is also true. ***Inefficient filtration is the cause of many of the pool owner's most serious problems***. Filtration also removes undissolved solids such as mineral salts, calcium or dust particles which decrease the clarity and purity of the water.

3.2.1 HOW FILTERS WORK

In simple terms, a filter works because water is pumped from the pool into the filter where it passes through a layer of filter medium which traps and holds dirt suspended in the pool water. The “filtered” water is then pumped back to the pool following a system termes “consecutive dilution”. This process continues until, theoretically, all the water in the pool has passed through the filter and is cleaned of debris. An efficient filter should clean all the water in a pool in no more than six hours, and this cleaning process should take place every day.

After a couple of weeks - or perhaps longer - depending on the size of your filter and how polluted the pool was, the layer of filter medium that has been collecting the dirt and debris becomes packed and can no longer collect the dirt and other suspended matter efficiently. This is generally indicated by the increase in pressure on the pump side of the filter – often rising into the “red zone” on the pressure gauge. This is an indication that the filter medium must now be cleaned by reverse-flowing the water in the opposite direction of the filter cycle, a process called “backwashing”.

There are three basic types of filtration as outlined in PAPER 1, namely “High Rate” sand, Septum Cartridge, or Diatomaceous Earth (DE) – the most common type used in residential swimming pools being the High Rate Sand Filter.

This type of filter is called “high rate” because in some cases you might encounter “Rapid Sand” filtration, whereas the pool water is filtered downwards (gravity fed) through a “graduated medium” filled tank by being continually topped up from the top, and percolating through the Filter Media then exiting back into the pool through the bottom of the tank.

Rapid Sand filters are rarely encountered in the 21st century, but nevertheless may still be in operation so it pays to know what they are, otherwise they might look very confusing to you.

Diatomaceous Earth filtes are not common in New Zealand, and many Councils will look adversely on the practice of dumping the contaminated DE powder into the septic sewer system (or worse, the stormwater system!) so they are rarely encountered.

Some pool builders use a cup or two of DE Powder to "tighten up" the sand filter bed, which is then lost in the next backwash cycle (Warning! This powder is extremely fine – almost like Talcum - and can cause health problems if inadvertently inhaled, so be careful).

DE is named for the small Diatom creatures that inhabited the oceans millennia ago, and are now commercially excavated for swimming pool use in only one place in the world, the deserts near Santa Barbara, California USA. It is also marketed as "Fuller's Earth" in some countries.

FILTRATION EFFICIENCY: Generally, High Rate sand filters remove particles to a size of 15 to 30 microns, a Septum cartridge to 10 to 20 microns, and DE down to 2 microns. With sand and cartridge filters, a flocculent (Potassium Aluminimum Sulfate) is required to assist in finer filtration, and thus obtain the same clarity of water as is achieved through the use of DE. This is because the sizes of contaminates are so extremely small as the following approximate sizes indicate.

Bacteria - Cylindrical or Rod Shape - Spherical Shape - Spiral Shape.
On average O.5 – 5microns diameter by 6 – 1microns long.

Algae Cells - 10 microns

Algae Spores - 1 micron

Virus Cells - less than 1 micron

By comparison, the size of filter medium grains are as follows

Filter Sand - 500 microns

DE Power - 50 microns

Cartridge - 5 to 50 microns

Remember 1 micron = $\frac{1}{1\ 000\ 000}$ metre = 0.00039 inch

Flocculents are available from many Pool Chemical suppliers, and is also available from your local Chemist Shop under the trade name Alum.

In pressure sand filters used with home pools, it has become quite common to use Alum Sulphate as the flocculent. However, this should only be used in gravity sand filters (Rapid Sand) which are used in large public pools. It should never be used in pressure sand, cartridge or DE filters while they are running, as it will clog the filter medium thus seriously reducing its filtering capacity.

To "Floc" a pool, the filter is switched off, add the Floc and wait 24 hours, then the resultant residue must be vacuumed to waste.

With sand and DE filters, the filter medium is cleaned by reversing the flow of pool water within the filter so that it washes out the dirt (and also the DE powder in the case of DE filters), and discharges this to waste. This is called backwashing, and during this process about 1 kilolitre of pool water is used to clean the filter, depending on its type and size.

When the filter medium has been cleaned in the case of sand filters, or replaced with new DE in the case of diatomaceous earth filters after backwashing, the filtering process can begin again.

In the case of cartridge filters, the cartridge is removed for manual cleaning by hosing, and then replaced into the filter tank hence a considerable amount of water is saved over inappropriately long backwashing tims, as it's not uncommon for a pool owner to put the filter on backwash and forget it, noticing only when the pool starts to look "empty". This potential problem is eliminated if the Pool Builder does not allow a suction line to be directly plumbed into the deepest part of the swimming pool, but rather through the skimmer system – which will de-prime the pump once the pool water goes below the skimmer mouth.

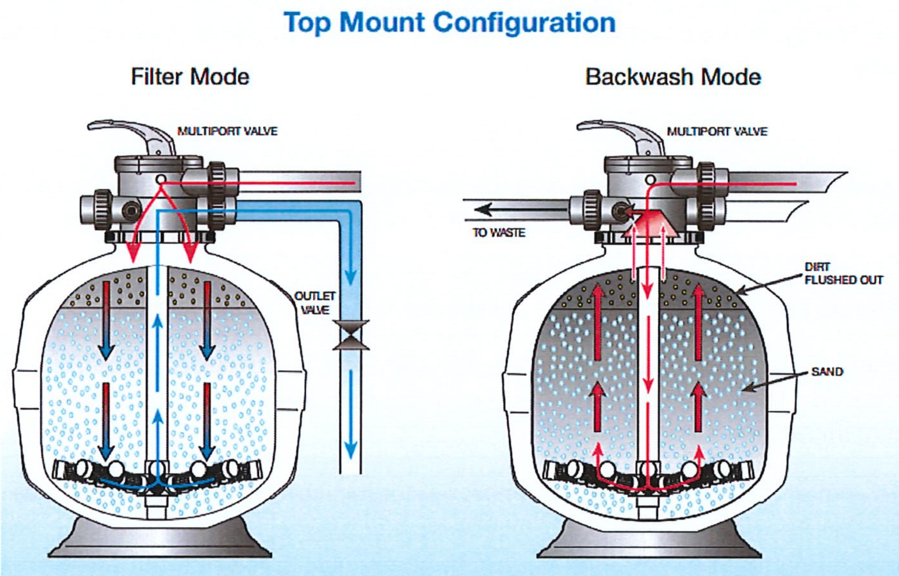
The larger the surface area of the filter medium, the longer is the time lapse allowed between cleanings, and tests over te years show that better fitration results from a higher width to height ratio rather than the the opposite. Good filtration design dictates that a 1:1 ratio is the maximum width/height ratio, while 1.5:1 W/H is preferable.This results in more efficient filtration and also savings in the cost of operation due to reduced water and chemical losses which necessarily occur during backwash cycles. The fewer the backwashes needed means the greater the waste water savings.

The kind of filtration media used can also affect both filtration cycles and wasted pool water: some options to sand (as in a high-rate sand filter) include Perlite™ Zelbrite™ Micro-Media™ Powdered Cellulose and electrostatic Glass Media, and in completely different types of filters there are Centrifugal Cyclone™ pre-filters, "Antimicrobial, Non-woven Cartridge" filters, all of which will extend the filtration cycles (and reduce waste water)

Providing the size of your filter is sufficiently large so that the number of back-washes can be reduced to from four to six times a year, it will be a step closer to the 'automatic pool'. If your filter requires a greater number of cleanings, you must make sure that you keep this in mind throughout the year.

3.2.2 SAND FILTERS

Termed "Mechanical Filters" these consist of an electric motor, pump incorporating a hair and lint strainer, main pressure tank and multiport flow control valve (MPV), pressure gauge, filtration media, and may include an air release valve.



CROSS-SECTIONAL VIEW
A TYPICAL SAND FILTER

Inside the sealed pressure tank, typically one or more grade of gravel and fine silica sand is used as the filter medium – unless an alternate media is used as described above.

Pool water enters the tank by way of a Multiport distributor and is pumped through the sand under pressure of .5 to 1.5 bar at a "high rate". Dirt and bacteria in suspension are trapped in the sand, and filtered water leaves the tank through an underdrain, back through the MPV and returns to the pool.

This kind of filtration is called "consecutive dilution" as you are simply adding "clean" water into a "gradually improving" dirty pool.

Think about a farmland stream filling a dammed-up swimming hole that floods over the top of the dam at the far end. The swimming hole is kept reasonably clean and clear by the continual stream of fresh water entering from the other end – at least it would have until the advent of chemical run-off from farms upstream! You get the picture: consecutive dilution!

As the filter media accumulates dirt, the flow rate is reduced, and the gauge pressure increases towards the recommended pressure for backwashing – usually 15. Bar or higher.

When this condition occurs, the filter is turned off, the multiport valve handle turned from FILTER to the BACKWASH position, and the filter turned back on. Water flow within the tank is reversed and the debri is washed to waste through the backwash drainpipe. Backwashing continues until the water observed in the sight glass on the MPV (if provided), or discharging into an observanble waste drain, is clean and clear.

The filter is turned off; the valve handle returned to the RINSE position for a few seconds to clean any remaining debri out of the MPV, then off again to move the handle to FILTER (the normal filtering position) and the filter is then turned back on.
It is not unusual for a small quantity of dirt to settle on the bottom of the pool when filtering is resumed after backwashing, but the RINSE cycle may eliminate this. This may be avoided by allowing the filter to stand for an hour or so before being switched on again, but most pool owners won't bother with the wait.

The life of granular sand media in a filter is approximately 4 to 5 years after which it should be replaced as the "sharps" are rounde off by the water flow and start to pack together closely, eliminating their usefulness in filtering the debis out as "channels" in the sand start to form.

Within the filter tank when operating, the filter media compacts and traps dirt throughout the media bed. The entrapped debris itself then acts as a filtering medium in conjunction with the regular media thus reducing the size of contaminates which can be trapped to 10 to 15 microns. Fibrous matter from trees or other vegetation nearby, or hair from a dog, will cake on top of the sand. This could become a problem only discovered by dismantling the filter & MPV off the pressure tank. This type of blockage will show as premature high pressure readings and inefficient filtration, and should be removed manually from the tank once every year or so in extreme contamination conditions.

CORRECT pH IS ESSENTIAL TO THE OPERATION OF THE FILTER: If the pool is allowed to become excessively alkaline, any calcium compounds present in the water will combine with the filter media to form a solid mass, which becomes unsalvageable and must then be replaced with new media.

Some High-Rate pressure filters have automatic backwash valves fitted, whereby when the pressure inside the tank reaches a predetermined level, the backwashing cycle is commenced automatically. Readily available, there items are not common due to the high cost of purchase.

3.2.3 CARTRIDGE FILTERS

These consist of an electric motor, pump, tank, hair and lint filter, one or more cartridges, pressure gauge, and an air release valve. As the pool water is pumped through the tank, dust and bacteria in suspension are trapped in the cartridges.

Vacuum Skimmer/Filter typical for above-ground pools as the pool pump pulls water through the filter septum.

When the water flow rate reduces as the gauge pressure increases towards the recommended cleaning pressure, the filter is truned off and the cartridges are removed. They are cleaned by hosing, preferably with warm water, or are replaced with new ones, depending on the manufacturer's specification.

The cartridges are made of paper, polyester, cotton, etc. Under even the most favourable conditions, they need to be replaced approximately every 3 to 5 years.

This type of filter should NEVER be backwashed. Backwashing is not possible with specifically designed cartridge filter tanks, but sometimes, cartridge filters are installed at a later date inside DE filter tanks which have a backwash facility originally built into the tank and an inexperienced operator might be tempted to backwash. DON'T do so, as backwashing is not required, there is no loss of water from the pool due to this.

Problems will occur if the specified maximum flow rate through the cartridge filter is exceeded. This results in fine debris being forced through the filter elements and remaining in the water, or in some cases, the cartridge being lifted from its base, allowing the water to bypass the filter medium.

A recommended maximum flow rate through cartridge filters is 34 L of water per square metre of cartridge filter medium per minute. Hence a cartridge filter with 5 m2 of filter medium should not have more than 10.2kL of water pumped through it per hour.

The maximum flow rate recommended by manufacturers depends on the density of the filter medium installed.

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A recent development is the cartridge filter incorporated in the skimmer box as one combined unit.

CARTRIDGE VACUUM FILTER SYSTEM

The water is drawn down through the leaf basket; through the cartridge filter to the pump from where it then passes directly back into the pool through the normal outlets.

To clean the cartridge, it is lifted out of the skimmer box and hosed. Its main advantage is that it is installed completely out of sight, below the pool coping.

This type of filtration is called a cartridge vacuum filter system since pool water is not pumped into a filter under pressure, but drawn through the skimmer box and cartridge.

It requires a smaller sized pump and motor than would be necessary with a pressure type filter system.

In general, cartridge filters are ideal for areas where water is scarce, due to the negligible water losss during cleaning of the cartridges where wastewater disposal from backwashing is a problem, or for spas where there is little water available for backwashing.

3.2.4 DE FILTERS

DIATOMACEOUS EARTH FILTER

These are not common in New Zealand – not because they are not efficient, but because of the problem of discharging the Diatom Earth into the public sewerage system. It is so fine, it blocks the systems up, causing maintenance work on the part of the Regional Authority. Howeber, you may come across these DE filters occasionally as they are privately imported.

Inside the tank is a plastic frame which holds the filter septums in position. The septums are generally made of fibreglass cloth material, the purpose of which is to hold the DE which, when introduced to the filter via the skimmer box in a slurry, coats the septums completely. The DE traps the dirt and bacteria in suspension, as the pool water is pumped through the filter.

The filtering area of the septums is large compared to the filter tank dimensions. The number, shape and size of filter septums within the tank varys from one manufacturer to another. Both sides of the septums are used for filtering. When the filter is dirty, the water flow rate is reduced as the gauge pressure increases towards the recommended pressure for backwashing. To backwash the filter is turned off, the multiposition flow control valve turned to the backwash position and the filter turned on again.

The water flow within the tank is thus reversed and the DE is washed off the filter septums and discharged to waste through the backwash drain pipe.

When the water in the sight glass or the discharge from the backwash drain pipe is clean, the filter is turned off and the multi-position valve turned to the normal filtering position. The correct amount of DE as recommended by the manufacturer is then mixed with water in a bucket until it forms a thick slurry. The filter is turned on, and the DE slurry is poured gently into the skimmer box. Normal filtering will then resume.

REMEMBER

POURING D.E. INTO THE SKIMMER BOX AFTER THE FILTER HAS BEEN BACKWASHED OR CLEANED, AND DE HAS BEEN MIXED AS A THICK SLURRY IN A BUCKET.

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However, to ensure quick and efficient cleaning of the filter with minimum water wastage, it is a good idea to backwash for approximately two minutes, then rotate the flow control valve to the filter position and filter normally for approximately half a minute. Following this, again backwash for a further two minutes and repeat this procedure three or four times as necessary until the waste water is clean.

If, after backwashing is carried out, the gauge pressure and water flow rate do not return to normal, the filter will have to be turned off, the stop valves, if fitted, closed to prevent syphoning, and the filter tank opened up by releasing the tank clamp and removing the lid.

The filter septums should then be removed and cleaned by washing and gently scrubbing with water, detergent, and a nail brush

Normally the filter septums should be removed twice a year for this purpose, and as well, checked for possible structural damage. The filter septums have a life of 4 to 5 years, perhaps even 7 to 8 years if the water is maintained well. 10mL of hydrochloric acid to 500 mL of water may be needed to remove stubborn dirt. Always wear rubber gloves and do not splash on your skin or clothing. Hose the septums after the acid wash.

Before replacing the cleaned septums, the bottom of the tank should be cleaned out thoroughly. In addition, the 'O' ring seal between the tank lid and bottom half of the tank should be checked to ensure it is clean and sound, and should be lightly smeared with a light waterproof grease to help it to re-seal. Check to see that it is located centrally.

Be sure to correctly seat the base of each septum in the recess at the bottom of the tank and attach the manifold to the top of the septums if there is one, before replacing and clamping the lid. See FIG. 3.8.

At this stage, the hair and lint basket should be removed, cleaned and replaced, filling the pot surrounding the basket with water to assist in priming the pump.

Before restarting the filter, check that the multi-position flow control value is in the 'filter' position, open the air release value and re-open the shut-off valves if fitted for syphoning reasons. Turn on the pump, leaving the air release valve open until spurting water issues, indicating that the system is full. Close this value firmly. DE slurry should be added in the usual manner. A DE filter should never be operated without an adequate supply of Dk as rapid clogging of the filter cloth will then occur.

3.2.5 FILTRATION CYCLES

An efficient filter will recirculate the entire contents of a pool in a maximum period of six (6) hours. Thus a pool of 64,000 litres would require a filter with a flow rate of at least 11,000 litres per hour. However, the flow rate through the filter will decrease as dirt particles become trapped and accumulate inside the tank. Most pool builders tend to oversize the filter when selecting it, to offset this decreased flow rate and to increase the period of time between backwashing or cleaning the filter medium in order to decrease maintenance.

Your filter should be operated each day for a sufficient time to turn over all the water in the pool. This time should be divided into two periods, one in the morning and one in the evening, so that most floating debris can be drawn into the skimmer box before it becomes waterlogged and sinks, thus reducing the need for vacuuming. A time clock controlling the power supply to the filter pump will perform this task efficiently and will save you much consternation.

3.2.6 CALCULATING THE MINIMUM FILTRATION CYCLE FOR YOUR POOL

Step 1 - Pool Capacity
If you do not know the volume of water your pool holds, calculate its capacity using the information in PAPER 2 as an aid, and, of course, knowing its dimensions. Express this volume in litres (L).

Step 2 - Maximum Flow Rate
Check the maximum flow rate of your filter. This information is usually shown on the tank itself or it may be obtained from the manufacturer's brochure. Express this rate in litres per hour (L/h).

Step 3 - Minimum Filtration Time
To obtain this, divide the Pool capacity (L) by the Maximum Flow Rate (L/h).

Example
If the pool capacity is 64 000 L and the maximum flow rate of the filter is 16 000 l/h

$$\text{Minimum filtering time} = \frac{64\,000}{16\,000} = 4 \text{ hours}$$

Hence, the filter should be run for at least 2 hours in the morning and 2 hours again in the evening. It is preferable to turn the water over daily in one uninterrupted cycle, and to have a shorter second cycle to remove surface debris and to distribute chemicals.

3.2.7 CHECKING THE INSTALLATION OF THE FILTER

To do this, the following points should be noted and corrective action taken, where necessary, at the appropriate time.

(1) Platform
The pump, motor and filter tank should be installed on a solid level area, preferably on a concrete slab.

(2) Flexible Couplings
Also known as MAC UNIONS these should be used between the suction pipe and the pump, and between the filter tank and the return line, to allow the easier removal of the filtering equipment for maintenance. Alternatively, barrel unions which are safer to use on the pressure side, may be installed.

(3) Location & Depth of Pipes below ground Level
Pipes forming the suction and return lines should have been installed at a minimum depth of 300 mm and backfilled with sand or a similar buffer material. If they are not covered by a permanent solid covering such as concrete or brick paving, their location should be known to the following sub-trade (the Pavers) and preferably clearly marked to avoid repair costs of fracturing them with a shovel or similar tool. Subtrades using compactors should be aware of their location.

(4) Non-Return or Stop Valves
These should be installed when the pump is higher or lower than the normal water level of the pool, to prevent syphoning when the lid of the hair and lint basket is removed.

(5) Anti-backflow devices
There are required in most New Zealand council areas and usually consist of low-cost brass sprin-loaded device which is fitted to the outside tap nearest to the swimming pool. Other councils may require an expensiv (currently $900) device installed at the entry point of the mains water onto the house site. Why a $900 device is required when a $35 unit functions perfectly well is another question to be pondered on the activities of Local Authorities!

(6) Ventilation
Provide ventilation around the pump if enclosed, to allow the fan within the motor to draw in air for cooling purposes.

(7) Labelling
Label all pipes clearly and unambiguously, to provide ease of understanding of the pipe layout for persons servicing your equipment. For example, "FROM SKIMMER" with an arrow indicating the direction of flow attached to the relevant pipe may well save time and expense.

(8) Pressure Testing
Good practice requires all pool circulation pipes to be Pressure Tested and labeled as having been so by the installer. The simplest pressure testing device is a common external tap connected into one end of a 40mm elbow into which a standard filter Pressure Gauge has been tapped on the curve of the elbow.

The external tap has to be slightly modified to accept water in both directions (a simple matter of removing a spring) then connected to the household water supply by a hose.

The opposite end of the elbow will have a short (60mm) length of 40mm pipe protuding which is fitted with a 40mm flexible coupling. This coupling is then joined onto the pipeline being tested. At the terminating end of the pipeline, a 40mm Adjustable Plug (available from most Para Rubber stores) is inserted. When the garden hose is turned on, the mains-pressure water floods the pipeline under test, and the Pressure Gauge will rise – typically – to 1.0 bar (15psi) This pressure should remain stable for a minimum of fiver minutes – preferably 15 minutes. If it passes the test, put the Test Label on where it can be seen in the pool shed or filtration area.

(9) Accessibility
Provide accessibility to the filtering equipment (and spa equipment, if fitted) to allow ease of service and maintenance of each item.

(10) Proximity of Equipment to Pool
Filtering equipment will operate more efficiently the closer it is installed to the pool, since a lesser total length of piping will be used, resulting in smaller friction loss. However, in New Zealand the Electrical Code prescribes the minimum set distance that electrical equipment of this kind can be installed from the edge of water, to reduce the possibility of electrocution. These are named "Zones" Chek the relevant information on-line, but generally any electrical devide or equipment must be able to be touched by anyone in the swimming pool (Zone 1) so preferably all equipment must be located in Zone 2 or Zone 3

Reference: NZECP 24:1993 - New Zealand Electrical Code of Practice for: The safety of electricity in a hazardous area (Ministry of Commerce, ISSN 0114-0663); and their subsequent amendments and replacements.

(11) Backwash Discharge Line
The backwash capacity and backwash efficiency of the filter are important. A backwash line with a minimum diameter of 40 mm is adequate. Check that the backwash pipe is not restricted with bends, nor that a pipe with a diameter smaller than 40 mm is used. A stop valve should be installed on the backwash line if the discharge end of the line is lower than the pool water surface. Otherwise, the rotary flow control value near the pump may become blocked open with grit or other debris, allowing water to flow from the pool.

The backwash line will usually terminate at a Gully Trap (Septic Sewer trap) and will require a "U" shape up and over so that there is an Air Gap of at least 100mm to prevent backflow of waste water back into the swimming pool. Modern building trends oftem don't include gully traps, so you may have to employ a Plumber/Drainlayer to fit a new one. In a worst-case scenario (no access to the Septic Sewer line) you may have to excavate a drainage soak trench, or even fit the system up with a Cartridge Filter.

Check the local Territorial Authority requirements for rules on backwash lines, but typically any backwash from a swimming pool filter must be directed to the Septic Sewer line and NOT the stormwater service. If the property with the pool is not connected to a Septic Sewer system UNDER NO CIRCUMSTANCES connect the backwash to a Septic Tank or Bacterial system! A separate drainage trench may have to be installed, typically 3,0m long x 300mm wide & deep into which a bed of drainage material is installed, then a weed mat, then backfilled woth soil. This will act as a soak-trench for the minimal amount of water being discharged periodic by backwashing. NOTE: this trench will NOT be suitable for emptying the pool.

Resource Consent Rules regarding discharging "contaminated waste water" onto land may complicate backwash discharge in some Rural Council areas. Some may require a secondary filtration unit on the backwash discharge line (as illogical as this seems) which may be a Cartridge Filter. The purpose is to remove debris & chemicals from the water being sent to the backwash trench. What method is then expected to "clean" the Cartridge Filter Septum has not been clarified at this time. It is expected that this will simply be washed out over the ground, thus defeating the purpose, but this is another example of how the TA's think.

3.2.8 FILTER MAINTENANCE

The following points should be kept in mind, in addition to the preceding discussion of the cleaning and backwashing of the various types of filters.

(1) Manufacturer's Instructions
Re-read the instruction booklet provided with your filter when installed, to familiarise yourself with the correct operation of the filter and routine servicing which may be required.

(2) Backwash Valve
This requires regular cleaning and lubricating as directed by the manufacturer.

(3) Air Leaks
These may develop in flexible couplings, hose clamps, pipe joints, rubber 'o' sealing rings, and at the hair and lint strainer lid. Eliminate these leaks as quickly as possible by repair or replacement since the presence of air-leaks reduces the efficiency of the equipment significantly.

(4) Pump and Motor Bearings
The ball bearings at both ends of the motor/pump shaft are normally sealed and permanently lubricated, requiring no maintenance. The pump should be returned to the manufacturer's agent if repair of this nature is warranted.

3.3 AUTOMATIC CHLORINATORS

There are three basic types of automatic chlorinators, namely floating dispensers, automatic pump type chlorinators and electrolytic chlorinators. More about this in further Papers.

3.3.1 FLOATING DISPENSERS

This type of chlorinator consists of a circular float surrounding a basket into which are placed tablets consisting of a chlorine compound. Three types of tablets are available, namely calcium hypochlorite which will dissolve quite rapidly and must be added every day, sodium dichlor (dichlorisocyanurate) which also dissolve rapidly but contain cyanuric acid as a stabilizer, and sodium trichlor (trichloro-s-triazinetrione) which dissolve slowly continuing to release chlorine for up to a week.

These dispensers will only provide for the average chlorine demand. However, the chlorine demand may vary widely depending on the swimming load and weather conditions. Hence regular testing must still be carried out and additional chlorine added when necessary.

These chlorinators can cause damage to pool surfaces, as the lids keeping the Tri-Chlor tabs in can become loose, resulting in the Tabs falling onto the pool floor if upended, This is a possible danger to swimmers if the tread on them, and the pool finish if it is anything other than a white plaster finish. Fibreglass and Vinyl Liners are particularly damage-prone to this kind of event, as would be a dark colour plaster pool subjected to a high-strength and acidic localized dose of chlorine.

3.3.2 AUTOMATIC CHLORINATORS

These can be sub-divided into two types, namely the dual cartridge type which relies on the water flow of the filter to function, and electrically operated metering devices which inject liquid chlorine normally from a container into the return line.

(1) Dual Cartridge Type

This consists of a tank divided by partitions into one float chamber and two solution chambers.

The tank is connected by separate small diameter tubes to the suction line and to the return line of the pool. When the filter is working, water passes through the tank, slowly dissolving the chlorine chemical in the cartridges and then passing into the pool. A float or valve regulates the water level in the tank.

The cartridges normally consist of chlorine tablets. As the tablets below water dissolve, others drop down to take their place until the cartridge is empty.

When the filter stops, flow to the tank stops and a check valve automatically closes to prevent air entering the suction or return lines. Water from the solution chambers bleeds back into the pool and the float valve isolates the chlorinator from the filtering system until the filter pump starts again.

The precise details of operation of this type of chlorinator vary from manufacturer to manufacturer, but the principle is the same.

(2) Metering Devices (Peristaltic Pump)

When this type of automatic chlorinator is installed, each time the filter is operated, a measured quantity of chlorine is injected from a container of chlorine (usually liquid sodium hypochlorite). When this device is plugged into the power supply controlled by the same time switch as the filter pump, it will automatically chlorinate the pool for several weeks without attention. The chlorine tank has to be refilled occasionally and superchlorination carried out as discussed elsewhere. The metering device may provide for superchlorination to be carried out by pressing a button or similar means.

More complex units consist of three basic parts as follows:

(a) A probe inserted in the return line to the pool.

(b) An electronic brain mounted on the wall of the filter housing.

(c) An injector valve inserted in the suction line just before the pump.

The probe tests for the oxidation potential (ORP) of any chlorine present in the water, sending a corresponding signal to the electronic brain which interprets the signal and operates the injector valve. As with all automatic chlorination, efficient filtration and circulation of the pool water are vital.

Even more advanced units also check the pH of the pool water, and a secondary peristaltic wheel will inject liquid Hydrochlroic acid as required. These machines require a secure, ventilated location to avoid unauthorized persons (or children) accessing the dangerous chemicals present.

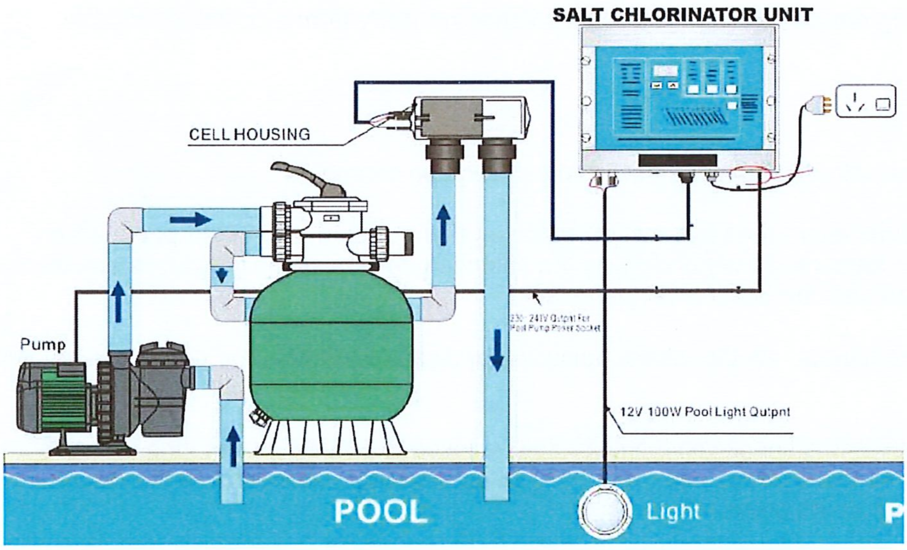
Regular maintenance is minimal apart from the injector valve which may require some attention after a lengthy period. It must be remembered that liquid sodium hypochlorite is an unstable product that rapidly deteriorates in storage and hence there is a limit on the size of the container used with those metering devices.

3.3.3. ELECTROLYTIC CHLORINATORS

These are commonly referred to as saltwater chlorinators or "Salties", which manufacture liquid chlorine (sodium hypochlorite) by the ionization of saline water – usually at .04ppm concentration.

Common everyday salt is dissolved in the pool to produce a salinity approximately one-sixth that of sea water.

This saline solution is circulated by the pool pump through the filter and then through a special tubular cell containing platinized titanium electrodes. A low, uniform direct current voltage, less than that of a car battery is applied to the cell and the saline solution is ionised to produce liquid chlorine.

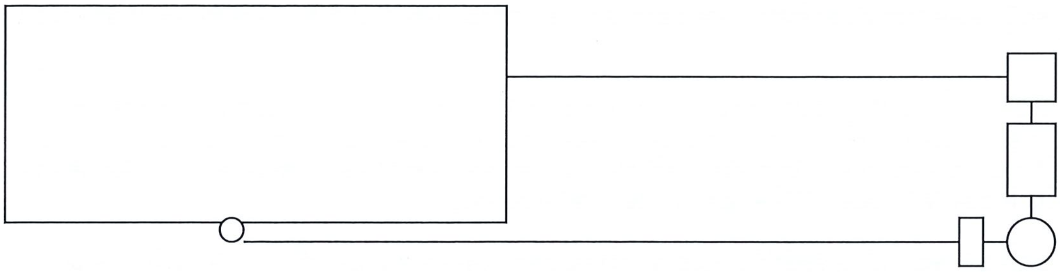


IN-GROUND SALTWATER POOL

The amount of liquid chlorine produced is dependent on the salt content in the water and the length of time the filter and chlorinator operate.

Generally, sufficient chlorine will be produced for the average domestic pool, if the pump and filter turn the pool contents over once to twice daily in peak swimming periods. The size and quality of cell material are also most important in chlorine production.

The cell of the chlorinator has to be cleaned on average four to six times a year, depending on the composition of the pool shell and the pool water.



The diagram (above) shows the relationship of the Saline Cell to the pool and filtration: i.e. the Cell is the last item in the system (the small rectangle) before the pool, Never have the Cell fitted BEFORE other items in the system – especially a Pool Heater, as premature deterioration may occur!

CAUSTIC SODA PRODUCTION: A by-product of chlorine production is the production (in equal amounts) of Sodium Hydroxide – commonly known as Caustic Soda – which has a pH of 14 - the highest in the range.

This provides the possibility that the pool water will suffer from a high pH - often around pH 10 or more. Remember that once the pH goes above pH 8.0 the usefulness of HOCL (the GOOD chlorine) is reduced to 15% or less and is overtaken by the OCL present (the BAD chlorine) in the form of chloramines (the "chlorine smell") so often and accurate adjustments to the pH must be undertaken.

Some SALT Units incorporate a pH test and are connected to a peristaltic pump which injects hydrochloric acid as it is required, but many others rely simply on the local conditions (acid rain, sweaty swimmers etc.) to keep the pool in balance. If you intend to fit SALT chlronators to your pools, you must be aware of – and inform your customer of – the need to monitor the pH levels of the pool in the interests of the safety of children & swimmers using the pool.

Salt levels have to be monitored (a test kit is available for this) and replaced in the water due to some loss of chlorine in the process of disinfection and also to the atmosphere and rainfall. In New Zealand, 100mm (4") of rain overnight is common – and in Auckland at least the average rainfall is between 1.2m and 2.4m annually! Four to six or more 25kg bags are required each year for the average domestic pool in our conditions, as the salt level needs to be maintained within reasonable limits.

In some countries, mild salt chlorination was considered especially suited to spa chlorination due to the antiseptic advantage of hot mildly salty water; however OZONE has virtually replaced saline chlorinators on most Spa pools. Manually dosing Cholrine was never considered appropriate for spa pools, its chemical cousin Bromine being more popular due to the slow dissolving tablets available

Maintenance of the SALT chlorinators includes regular dismantling of the Electrode Unit and a careful wash in mild hydrochloric acid – usually 1:8 acid to water. Using a handy container (a one liter washed out PVC Milk container with the top cut off is useful) fill ¾ with tap water, then carefully add the acid to the water (NOT the other way around!) then immerse the Electrode so that the mixture covers all the element. Watch carefully for three to four minutes – or until it stops fizzing – then carefully remove the electrode and replace into the Unit housing. Dispose of the waste acid/water carefully. It is unlawful to tip it out on the ground (adding a chemical to alter the pH of the soil is unlawful) so be judicious in your disposal method.

Some SALT units have a reversing polarity switch, timed to reverse the + and – voltage every now and then, which increases the time lapse between the need to acid-wash the electrode, but overseas experience indicates that these units may suffer from premature electrode replacements requirements so the acid-wash method will ensure both an effective unit and a long lasting electrode regardless of the type of chlorinator being used.

An electronic control box (sometimes fitted with an audible alarm) monitors the water flow, electrical overload, and chlorine production. The units automatically turn themselves off when any malfunction occurs in the pumping system. Some manufacturers do not house electronic control box in a waterproof casing and it is left to the pool owner to provide for this if the warranty on the equipment is not to be invalidated.

Note the following:

(1) The incorrect installation of electrolytic chlorination systems can potentially be dangerous, so read the documentation provided by the manufacturer, and if you don't understand it, seek professional help. There

have been cases of the electrician wiring the 12v electrode to the 240v mains, (with disasterous AND dangerous results) so ensure that clear instructions are left if electrical wiring of the unit is to occur after you have fitted the unit.

(2) Power to the pool pump and electrolytic chlorination system should be mutual so one cannot operate without the other. Often the Saline Control Box has a three-pin outlet which is interlocked to the chlorine production unit, so endue that this is used for the pool pump (and clearly marked as such) so that potentially dangerous chlorine gas production can NOT occur if the pool pump is not running!

(3) The chlorinator should be fitted with a safety device which automatically switches off the chlorinator power pack when water ceases to flow through the chlorinator cell.

(4) The design of the electrolytic chlorinator may allow all water to drain from the cell on the build-up of gas.

(5) The location and attitude of the electrolytic chlorinator when installed allows all water to drain from the cell on the build-up of gas which must not exceed two litres.

(6) Any gas generated is confined to the electrolytic chlorinator and associated pipework, but must not be able to collect in the filter tank.

(7) Any device that introduces voltage into the pool water – a condition called "voltage leak" – must be earthed - so ensure that the pool and any pool equipment (such as a Stainless Steel pool ladder) are properly earthed. Many problems occurred in the early days of Saline Chlorinators enanticipated propensity for voltage leak - destroying pool pumps - caused the pool equipment industry to re-think the construction materials used in pumps, gas heaters, heat pumps etc. to stop premature deterioration of the internals, but more important is the potential for electric shock for swimmers. 12v it may be, but still nasty and potentially lethal!

3.4 IONIC STERILIZERS

Algae and bacteria cannot live or breed in water containing ions of copper and silver, so there are a few equiment manufacturers that market such devices for use in residential swimming pools. Some brands (i.e. "Floatron") float about on pool surface and are Solar Powered.

Others have a control box providing a 240vAC – 12vDC transformer and Electrode Cell mounted in the return flow in a similar fashion to the Saline Cels mentioned previously. Others are fitted into the pump Hair & Lint Strainer so that the emissions are drawn through the filtration unit and other ancilliary equipment, apparently without harm to either.

A concentration of copper of about 0.3 mg/L is considered sufficient for residential pools, although 1.0 mg/L is usually recommended to provide a margin of safety. The concentration requirement of silver ions in the pool water is considerably less.

Low voltage (12v DC) current is supplied to the two electrodes inserted into the lid of the hair and lint strainer, from the electronic control unit mounted on a nearby wall. Both electrodes are made from an alloy of silver and copper. The electrical current causes the positive electrode to waste away forming ions of copper and silver. After a short period of time, the polarity of the two electrodes is reversed, ensuring that they wear evenly and preventing the build-up of scale.

By connecting the unit to the same power supply as the filter, preferably controlled by a time switch, the unit operates only when the filter is turned on. A further time selector switch on the electronic control unit switches the unit off automatically after the recommended operating period has expired, even though the filter may still be operating. The electrodes last approximately two years and are easily replaced.

Ionized pools require oxidizing every four (4) weeks to bleach out leaf stains and to oxidize minute contaminates which may be present. These contaminates have been sterilized and are harmless, but give the pool a cloudy appearance. Oxidizers which may be used are as follows:

(1) Calcium Hypochlorite
Two cups of the powder should be dissolved in water and only the liquid added to the pool, the residual being discarded. Otherwise, copper and silver chlorides are precipitated, forming black spots on the floor and walls.

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(2) Sodium Hypochlorite
Approximately one litre should be used.
Either of these oxidizers should also be added after the pool is topped up by the addition of tap water or after heavy rain, or after an abnormally heavy bathing load, particularly after children who may have introduced urine into the pool.

The pH level for ionized pools must be kept between 6.8 and 7.2 and the Total Alkalinity must be maintained within the normal range of 80 to 100mg/L. If the pH is allowed to climb over 7.6, the copper and silver ions precipitate out and lose their effectiveness.

Since this is difficult to continually achieve in marble plastered pools unless an automatic pH controller is installed to monitor the pH of the pool, the use of an ionic sterilizer is not recommended with this type of pool. The low pH may not suit fiberglass or vinyl liner pools, so check with the respective manufacturers of these types of pools and follow their guidelines for pH requirements.

A test kit is available for determining the concentration of copper ions present in the water. If the concentration of copper is found to be too low or too high, the operating time of the unit is altered accordingly. A normal 4 in 1 test kit described in PAPER 6 is used to monitor pH and Total Alkalinity.

3.5 AUTOMATIC pH CONTROLLERS

In most cases, (especially with the use of Saline Chlorinators) the pH of a pool will tend to rise, i.e., become more alkaline, rather than fall, due to such factors as the alkaline nature of the chemicals added and the leaching of alkaline compounds from the walls of plastered concrete pools. Additionally, tap water tends to be slightly alkaline. In order to lower the pH to the desired level, an acidic chemical is required to be added to the pool.

Automatic pH controllers operate in a similar fashion to automatic chlorine metering devices. They electronically measure the pH of the water and if found to be high, they will automatically inject a measured quantity of acidic chemical – usually htdrochloric acid- into the water. A manual dosing button is sometimes provided to inject an extra quantity of the chemical if the need arises.

Two chemicals are commonly used to lower pH. These are either liquid hydrochloric acid or carbon dioxide gas in the case of commercial pools. In the first type, hydrochloric acid is stored in a reservoir drum connected to an injecter valve which is controlled by an electronic control box.

A combined controller for pH using hydrochloric acid and chlorine using a liquid form of chlorine, is commercially available providing diluted liquid acid solution injected into the pool, using a sensor, electronic control box and injector valve.

The less common type of automatic pH controller used in residential pools uses carbon dioxide gas which dissolves in water to form carbonic acid. A probe is inserted in the return line to the pool to measure the pH of the pool water. This is connected to a control box which monitors the signal from the probe and compares it to the desired pH reading to which the controller has been set.

An injector valve is then controlled by this control box to inject carbon dioxide gas into the pool suction line on some models and into the pool return line on other models, via a gas line connected to a gas cylinder through a regulating non-return valve (to prevent water entering the cylinder).

Carbon dioxide gas is usually supplied in 6kg gas cylinders. The consumption of gas varies, a cylinder lasting 3 to 4 months in summer with an average size pool, to up to 6 months in winter, dependent on the amount of alkaline material leaching into the pool water.

If a cylinder is consumed within a week, however, a gas leak is highly likely, This can be detected by gently pouring soapy water over the gas line and fittings. The operator should be on the lookout for any efferescence of the soapy water which would indicate the presence of a leak.

The life of the probe may last up to 10 years and can be easily replaced. It is recommended that it be set at the last minute on site using the standard buffer solution supplied. This last-minute setting is due to the electrode in the probe having to chemically stabilise itself.

-end-