Swimming Pool Chemicals & Water Testing
Part II

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Sanitising (revision).

- To keep the water safe.
- To prevent the growth of Bacteria, Algae, Viruses.
- Primary sanitiser throughout water body, especially important in Spas.
- Periodic shock dosing to kill off any organisms that have become immune to standard level of sanitiser, and to oxidise out dead organic matter.

Water Balance (revision).

- To make the water comfortable for the bathers.
- To make the water safe for the pool shell and equipment, neither corrosive nor scale forming.
- To assist the primary sanitiser in its job.
- To aid Clarification and Flocculation.

Water Testing

- You cannot see Bacteria.
- Test kit gives you information on your primary sanitiser level, pH, T/A, Calcium Hardness etc, and therefore determines if the water is safe & comfortable to bathe in
- You must use a quality test kit to be able to rely on the results it gives.
- You must understand the implications of any test result.

For Safe, Comfortable Water ?

- Test Kit
- Chemical Dosing manual or automatic
- Filtration System
- Water flow around pool shell
- Cleaning of the Swimming Pool basin.
- Clarification and Flocculation

Flocculation and Clarification

- Aids Filtration System in removing fine particles from the water. This can include Bacteria spores etc.
- Helps maintain clarity and sparkling water and therefore safety within the pool.
- Prevents or even removes staining caused by precipitating metals & minerals

Flocculation and Clarification

- Flocculant
  - Placed onto the top of the filter bed to take filtration down to a finer level.
- Sequestrant
  - Takes metals & minerals back into solution.
- Chelator
  - Deactivates metals & mineral and stops them combining with other elements and binds them.

NOTE: Chlorine and pH sensitive

Balanced Water
- The Langelier Formula

- pH + Temp F + T/A F + Hard F – TDS F=
- Saturation Index.
- This indicates if the water is in balance, corrosive or scale forming..
- See separate Data Sheets for the formula and for the factors required to work it.
- A positive answer indicates that the water is scale forming.
- A negative answer indicates that the water is corrosive.
- Ideally you want the water to be 0 to 0.2

Langelier Data

Temp ^{0}C	TF	T/A ppm	AF	Calcium ppm	CF	TDS ppm	TDSF
0	0.0	25	1.4	50	1.3	0	12.0
3	0.1	50	1.7	75	1.5	1000	12.1
8	0.2	75	1.9	100	1.6	2000	12.2
12	0.3	100	2.0	150	1.8	3000	12.25
16	0.4	150	2.2	200	1.9	4000	12.3
19	0.5	200	2.3	300	2.1	5000	12.35
30	0.7	400	2.6	600	2.35		
34	0.8	800	2.9	800	2.5		
41	0.9	1000	3.0	1000	2.6		

Langelier Calculation

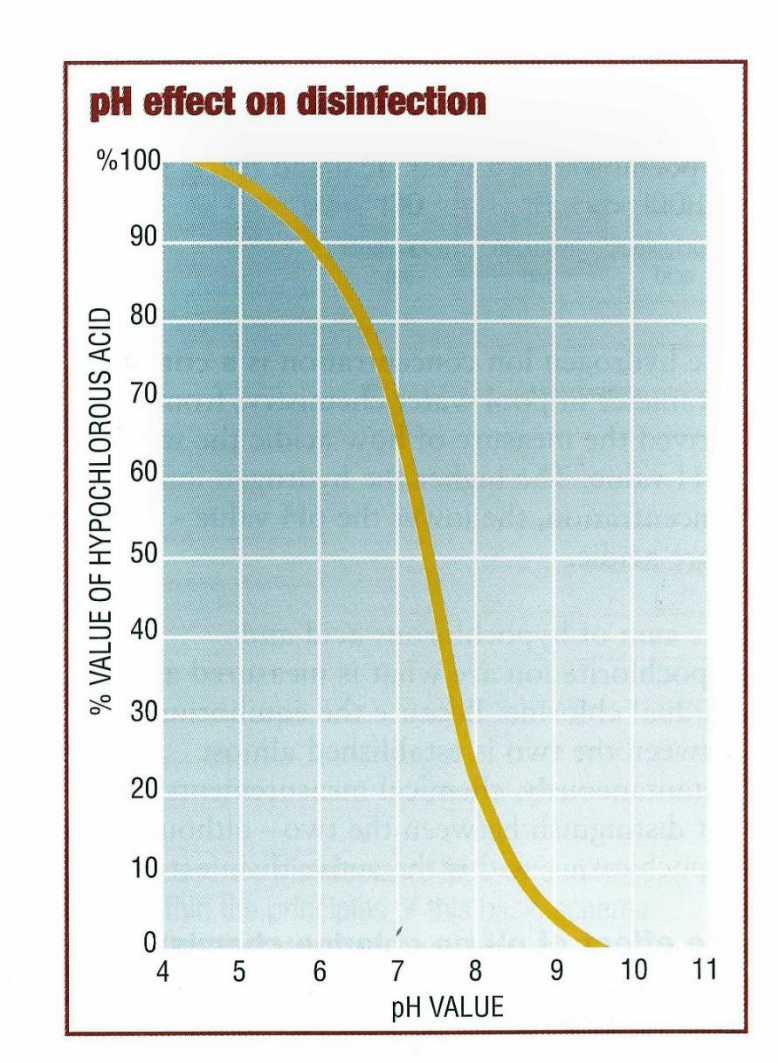
pH + Temp F + T/A F + Hard F – TDS F = Saturation Index.

Example

Pool A Readings		Langelier Factor
pH	7.4	7.4
Alkalinity	100	2.0
Hardness	100	1.6
Temp	84^0F	0.7
		11.7
TDS 2950		-12.25
Saturation Index		-0.55
		Corrosive

Pool B Readings		Langelier Factor
pH	7.4	7.4
Alkalinity	100	2.0
Hardness	600	2.35
Temp	84^0F	0.7
		12.45
TDS 1350		-12.15
		+ 0.30
		Scale Forming

pH effect on Cl



This graph illustrates the effect of pH on Chlorine. It is more effective at lower pH levels, but for bather comfort we keep the pH at around 7.4

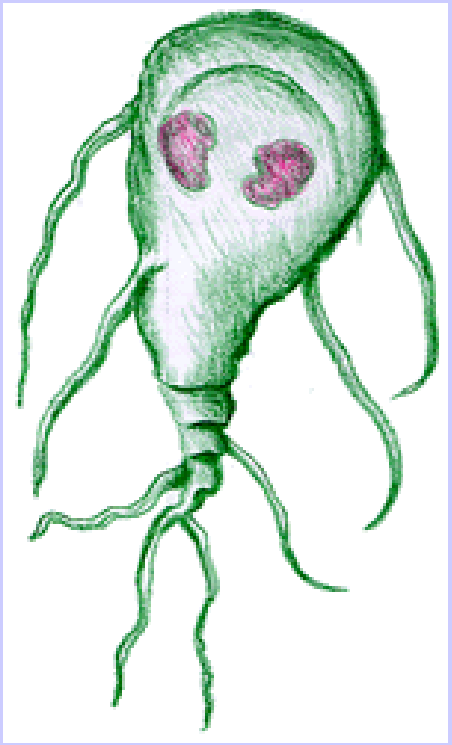
If sorting out a problem such as an Algae bloom, lower the pH level and the chlorine is more effective at killing, then correct the pH level afterwards.

pH effect on Hypochlorous Acid

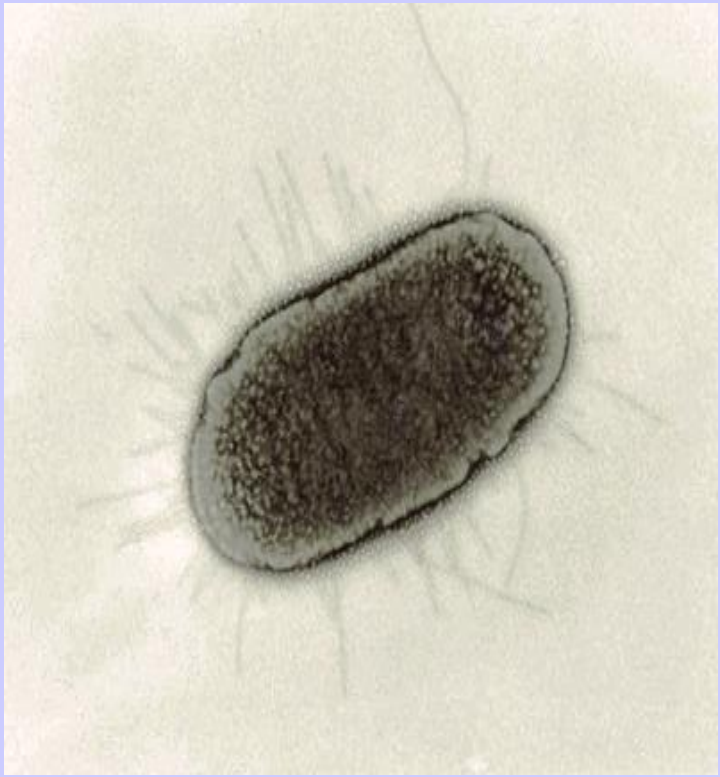
- Add sodium Hypochlorite to water.
- $NaOCl + H_20 < > HOCl + Na^+ + OH^-$
- Sodium Hypochlorite + Water gives Hypochlorus Acid + sodium Ion + Hydroxide Ion
- Hypochlorous is a weak acid and reacts further:
- $HOCl < > H^+ + OCl^-$
- The higher the H^+ concentration, i.e. the lower the pH value of the water, the more the equilibrium reaction is pushed to the left, giving us a higher concentration of Hypochlorous Acid, the actual killing agent.

Nasties, you don't want to swim with!

Giardia lamblia

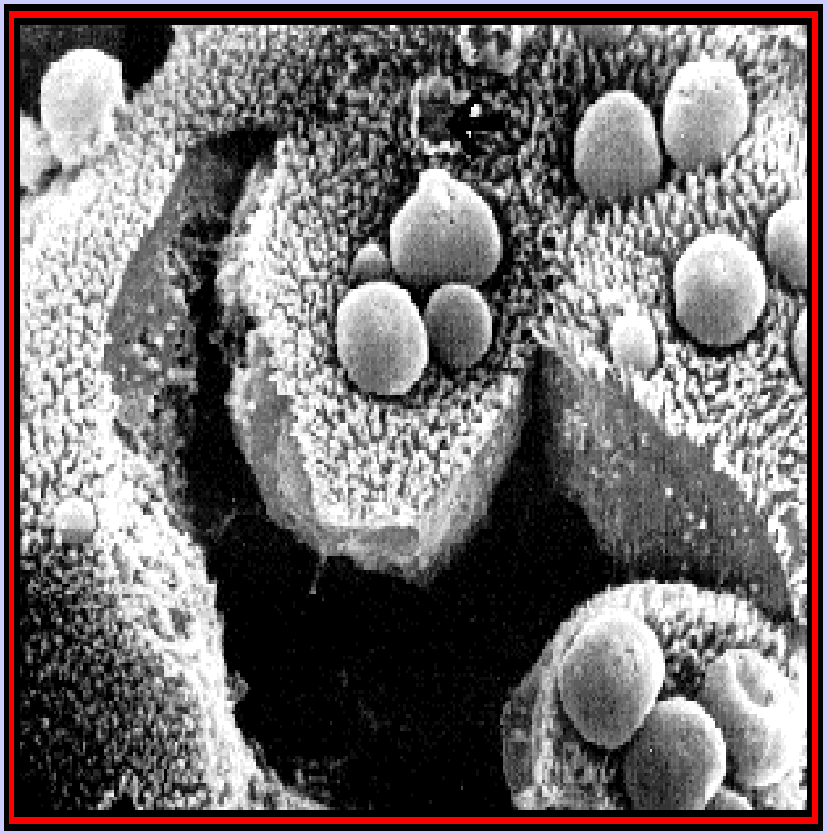


E. Coli 0157:H7



Cryptosporidium

- Major germ that causes outbreaks.
- Extreme chlorine resistance.
- Small size.
- Will challenge even the best equipped and maintained pool.



Germ-resistance to Chlorine.

Disinfection Times for Fecal Contaminants

♦ E.coli	<< 1 minute
♦ Hepatitis A	16 minutes
♦ Giardia	20-45 minutes
♦ Cryptosporidium	9600 minutes

*1 mg / L (1 ppm) chlorine, pH 7.4 /25 C

Shock Dosing / Oxidising

- Calcium Hypochlorite
- Sodium hypochlorite
- Potassium Monopersulphate (non Chlorine shock)
- Oxygen Tablets
- Hydrogen Peroxide
- UV
- Ozone
- Sodium Dichloroisocyanuric Acid
- Trichloroisocyanuric Acid
- Lithium Hypochlorite
- Chlorine Gas

Other Sanitisers

- There are many other Sanitisers available, some are only applicable to the domestic market, but some are very important in the commercial sector as well.
- Many are only suitable to run with Chlorine in addition, but generally speaking you can run with a much lower level of Chlorine.

Ozone and UV

- Both these dosing methods are only secondary Sanitisers, as they have to be created on-site and only dose the water passing through the apparatus.
- All pools should still have a primary sanitiser such as Chlorine or Bromine dissolved in the water, and circulated around the whole pool water volume, especially important in Spas.
- Ozone and UV are excellent at destroying Chloramines, and kill or disable Algae, Bacteria and Viruses.
- Any pool with Ozone or UV dosing can run with a lower Chlorine or Bromine level, and is generally more pleasant to swim in.

Ozone and UV

- Bromine and Ozone are particularly compatible and work very well in indoor pools (domestic market), but you must test and ensure that the Ozone unit is working at all times.
- For UV dosing, the water is passed into a suitable container (Polished Stainless Steel, the reflection increases the effectiveness) with a strong UV light source.
- The UV light is surrounded by a Quartz sleeve so the water does not touch the bulb.
- The UV light needs to have a certain wavelength and this affects the DNA in the Bacteria Cells and stops it reproducing.

Ozone and UV

- In a UV system all the water flowing through the filtration system is exposed to the UV light preferably, or in a slipstream method only a % is exposed. This is obviously less efficient.
- Ozone can be generated from the oxygen in the air under a strong UV light. The Ozone is drawn into the water under the action of a venturi, dissolves and the ozone reacts with anything organic that it comes in contact with.
- This is the method used in spa disinfection, and small domestic pool dosing systems. It is very hard to measure the output from these units. It is also imperative that the bulb is renewed as per the manufacturers specification on the number of hours the bulbs last (normally about 9000).
- Neither Ozone or UV have any effect on the water such as affecting the pH, TDS etc.

Ozone

- For commercial applications Ozone O_3 can also be produced from atmospheric Oxygen molecules O_2 to a higher concentration with the use of a Corona Discharge unit. The feed air must be filtered and dried to increase the efficiency.
- High voltage is applied across two electrodes and the gases drawn between them and on into the water via a venturi or via a booster pump and injector. Electrical sparking breaks the O_2 down, and a percentage recombines as O_3.
- The Ozone needs a contact period of at least two minutes for maximum efficiency and should then be removed by an activated charcoal filter before the water is returned to the pool. This step is left out on small domestic units.
- Ozone acts as a sanitiser, an oxidising agent and a flocculant.

Organic Biocides

- Or Polymeric Biguanide (Revacil, Baquacil or Blue Crystal), are used as a Chlorine free sanitiser, (not recommended).
- They kill bacteria but need an oxidising agent such as Hydrogen Peroxide to burn out the particles of debris.
- These are only suitable for domestic pools and spas.

Ionic Purifier

- These have sacrificial electrodes made up of Copper, Silver and possibly Zinc.
- The copper acts as an algaecide.
- The Silver and Zinc are Sanitisers
- The electrodes are contained in a cell that is plumbed into the filtration system.
- The electrodes are supplied with a DC voltage to create an Anode and a Cathode.
- The polarity is regularly switched to help even wear and avoid build up of Calcium on either electrode.
- You should still have a residual level of a Primary Sanitiser dissolved in the water, and still carry out periodic shock dosing.

Salt Pools

- You can generate Chlorine by electrolysis of a solution of salt (Sodium Chloride) water.
- Modern salt systems work with a concentration of about 4-5000 ppm, older systems often required 10,000 ppm plus.
- Plumb in the cell in the plant room, after the filter.
- The filtration system pushes the salt water through the unit, and the control and power system supplies a current to two titanium electrodes, normally like a mesh, inside the cell.
- This breaks down some of the salt as it passes through, and liberates Chlorine, which is the sanitiser.

Salt Pools

- People who swim in salt pools tend to really like them, and often if they have moved and have a new pool built, they will insist on a new salt pool.
- They are very common in Australia and South Africa.
- Unfortunately, the salt water is much more corrosive than normal, and various other pieces of equipment must be specified for the salt water.
- Heating systems, pumps and access ladders are amongst the most affected pieces of equipment.
- 316 grade stainless steel ladders must be specified.
- Salt water grade pumps are available, but special care must be taken when specifying a heating system, as it will invalidate the warranty on some pieces of equipment.

Automatic Chemical Dosing

- The simplest method is a manually controllable erosion feeder such as the Rainbow 320.
- The off line model is more controllable as the water flow is lower.
- On the plumbed in unit, with a high flow rate from the filtration system, it is possible to overdose.
- The next step up is to have a sensing Redox (Reduction/Oxidation potential) sensing probe in-line, with a control system activating a solenoid valve on the erosion feeder water flow.

Automatic Chemical Dosing

- The next step would be a Redox sensing and dosing system for the sanitiser, with a pH sensing and dosing system in addition.
- In any commercial installation it is preferable to opt for the more expensive but more accurate Free Chlorine sensing and dosing system instead of a Redox unit.
- All sensing probes should be plumbed in to a flow cell with a water feed from prior to the filter, utilising the pressure drop across the filter to produce a sufficient flow of water for the probes to obtain an accurate reading.

Automatic Chemical Dosing

- Dosing can be either by pumps, of chemical solutions, or of dry chemicals on some systems.
- The injection points should of course be after the take off for the flow cell, and far enough apart for the different chemicals not to mix in strong solutions.
- The effectiveness of any automatic chemical dosing system is often determined by the knowledge and aptitude of the staff or client using the equipment, and the whole pool water flow and filtration system set up.
- If the staff or clients are well trained and check and calibrate the system correctly, these systems generally perform very well.

Automatic Chemical Dosing

- The flow cell should has isolating valves on either side, and these need to be shut if dosing any strong chemical solutions or flocculants to avoid damaging or coating the probes.
- Once sufficient time has elapsed, (about 1 hour), then the valves can be opened, and fresh water admitted to the flow cell.

Automatic Chemical Dosing

- Calibration of the control unit and probe cleaning should be carried out to the manufacturers specification.
- A periodic double check of the readings with an independent test kit (good quality comparator type) is recommended.

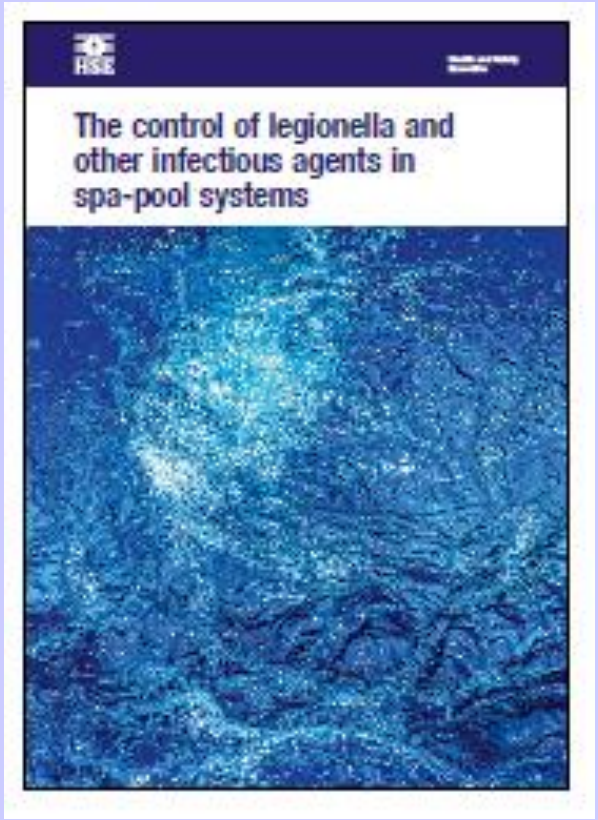
Auto Dosing Problem Check List

- Are the solutions topped up in the tanks.
- Are the pumps working, or the injection points jammed.
- Has the unit been calibrated and the Probes cleaner recently.
- Is there flow through the system and the flow cell.

Further training & learning

- Health & Safety Executive
- Institute of Swimming Pool Engineers
- British & Irish Spa and Hot Tub Association
- Pool Water Treatment Advisory Group

HSG179 & HSG282



Institute of Swimming Pool Engineers

- The Institute of Swimming Pool Engineers was set up in 1978 to establish an organisation for the individual swimming pool engineer.
- ISPE Technician: (Certified) - Student Members who have passed examinations after taking the Institute's Home Study Course.

ISPE

THE INSTITUTE OF
SWIMMING POOL ENGINEERS

BISHTA Hot Tub & Swim Spa Water Hygiene Management Training Course

- One-day training course offers practical and technical advice to individuals working in the industry. Suitable for retailers, service engineers, holiday park operators and holiday let owners.

BISHTA
PROMOTING SAFE HOT TUB STANDARDS

BISHTA
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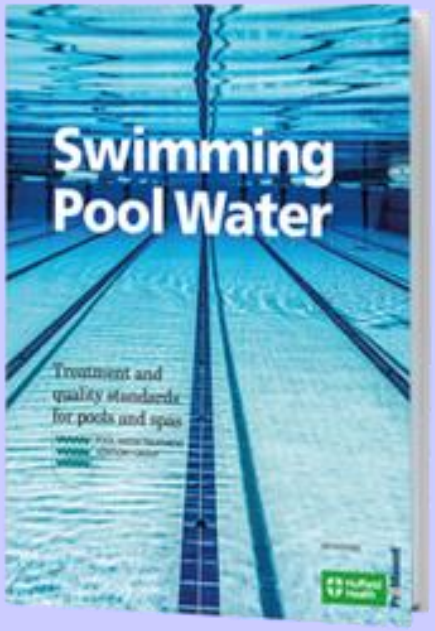
The British and Irish Spa and Hot Tub Association

Pool Water Treatment Advisory Group

- UK-based independent, non-commercial membership organisation, dedicated to raising standards in pool water treatment.



POOL WATER TREATMENT
ADVISORY GROUP

Swimming Pool Chemicals & Water Testing
Part II

Presented by Will Dando FISPE