POOL WATER TREATMENT ADVISORY GROUP

Chlorine oxidation – the secret to healthy, clear, sparkling water

Janice Calvert MSc,CChem,FRSC,FRSPH,FPWTAG
Chair PWTAG

13th November 2019

Swimming Pool disinfection

- Undertaken using oxidising biocides:
  chlorine, bromine and ozone
- The oxidation process breaks down organic and inorganic pollutants
- Not all oxidisers are good disinfectants. The disinfection power is not linked to the oxidation reduction potential (redox) The higher the value the stronger is the oxidation power.
- Oxidisers such as hydrogen peroxide, persulphates oxidise bather pollutants but the disinfection power is poor at safe swimming concentrations

The power of oxidation

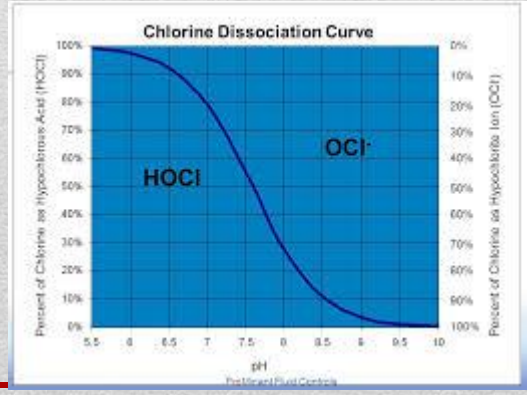
Can be seen on first filling the pool with water

This water contains suspended solids and causes light scatter making it appear green and cloudy

A combination of oxidation and filtration breaks down the suspended material and removes it enabling the blue light absorption from the sky to be reflected and return to the surface giving a bright sparkling blue appearance.

The effect of pH on disinfection

- Lower the pH the greater the concentration of hypochlorous acid and the greater the disinfection power
- Higher the pH the lower the concentration of the hypochlorous acid and the lower the disinfection power



POOL WATER TREATMENT ADVISORY GROUP

What happens when we pee in the pool?

Urine is added to the pool water which causes:

- Stinging eyes
- Unpleasant odours
- Higher pollution demand, greater disinfectant usage,
- Greater water replacement required
- Greater potential for bacterial growth, provision of nutrient source for bacteria
- Higher running costs
- Poor swimming experience

What causes us to pee in the pool?

1. Involuntary action arising from water immersion

- female swimmers release 50 mls
- male swimmers release 25 mls

How can this be reduced? – pre- swim showering

2. Deliberate Act –too lazy to get out of the pool to use the toilet facilities, elite athletes do it all the time!

How can this be reduced? – education, increased awareness of the issues

POOL WATER TREATMENT ADVISORY GROUP

How much urine is being added to the pool here?

POOL WATER TREATMENT
ADVISORY GROUP

What does Urine consist of?

Compound	Weight g/100mls	mg/l
Water	92	-
Urea	2	20,000
Creatinine	0.15	1,500
Uric Acid	0.05	500
Hippuric Acid	0.44 g/l	4400
Ammonia	0.04	400

Urine content cont.

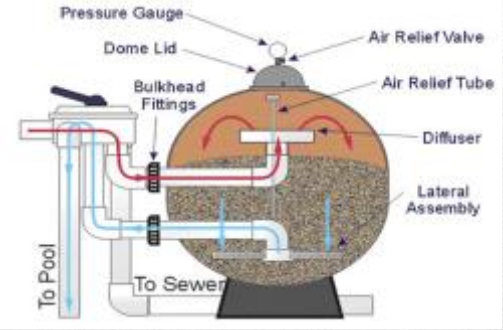
Compound	Weight g/100mls	mg/l
Sodium	0.35	3,500
Potassium	0.15	1,500
Calcium	0.035	350
Magnesium	0.01	100
Chlorite	0.60	6,000
Sulphate	0.18	1,800
Phosphate	0.12	1,200

The pollution effect from bathers on untreated water

Pollution	Concentration before bather use mg/l	Concentration after bather use mg/l
Ammonia N	0.1	0.75
Albuminoid nitrogen (organic)	0.1	0.2
Oxygen absorbed	0.9	1.7
Dissolved oxygen	100%	33%
Organisms/ml @37°C @22 °C	 4 Less than 100	 32,000 480,000

How does the pool water treatment deal with it?

- Filtration



- Disinfection using an oxidising biocide

- Water replacement

Effect of sand filtration alone

Pollution	Concentration before filtration mg/l	Concentration after filtration mg/l
Ammonia	0.20	0.12
Albuminoid nitrogen	0.31	0.14
Oxygen absorbed	27	<0.1
Organisms/ml @37°C @22°C	 20,000 300,000	 1,400 8,000

Effect of the disinfectant

The majority of bather pollution is in the form of ammonia.

Simply

- Chlorine + ammonia = Chloramines
- Chloramines + chlorine= Nitrogen & Hydrochloric Acid

3 types of chloramines are formed which make up combined chlorine

$HOCL + NH_3 \rightarrow NH_2Cl + H_20$

Monochloramine

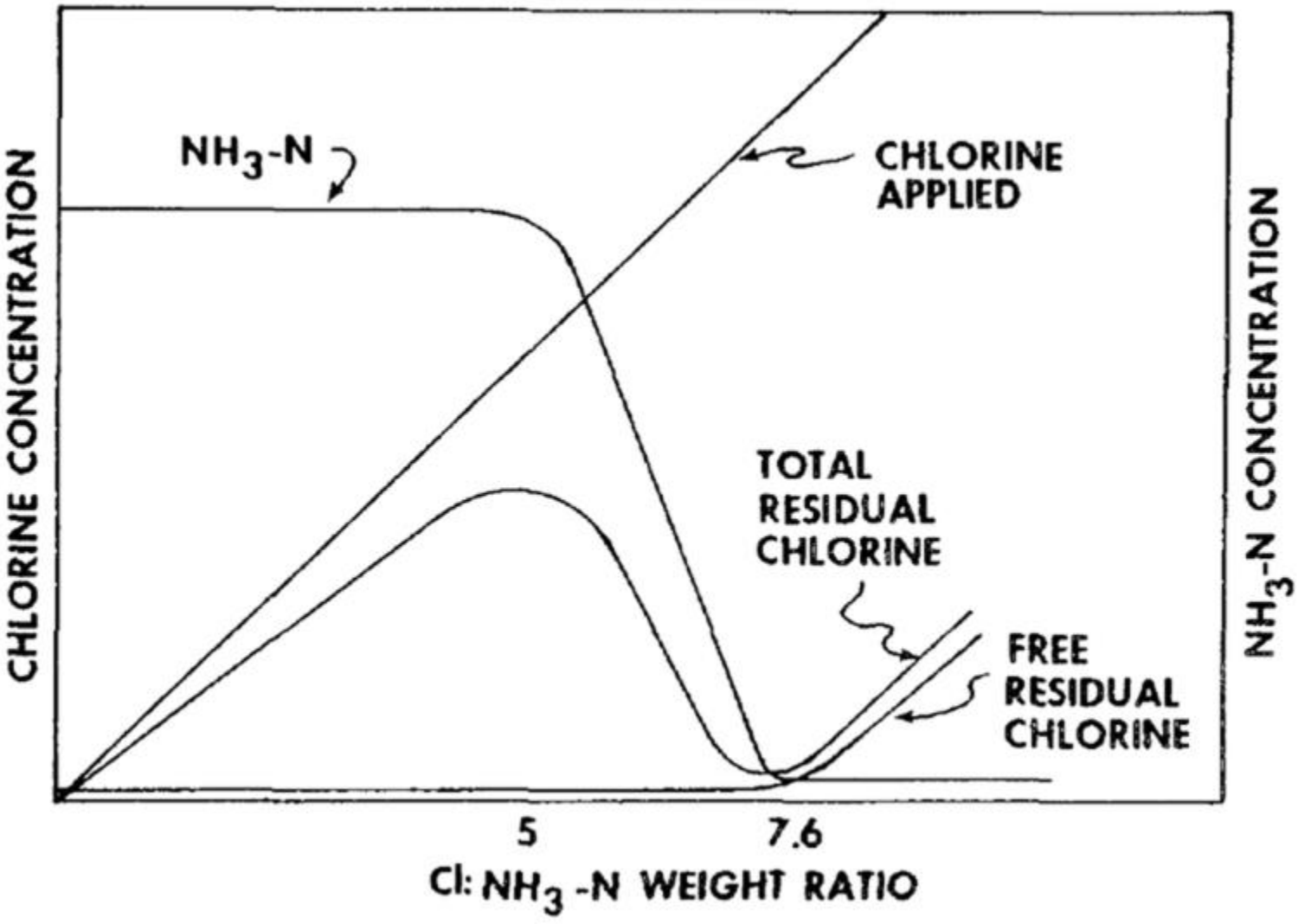
$NH_2Cl + HOCL \rightarrow NHCl_2 + H_20$

Dichloramine

$NHCl_2 + HOCL \rightarrow NCl_3 + H_20$

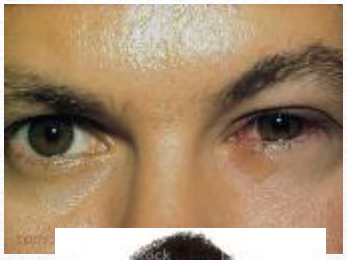
Nitrogen trichloride
or trichloramine

Breakpoint Chlorination



Breakpoint chlorination is the point where the demand for chlorine has been fully satisfied in terms of chlorine addition to the water. Thereafter a free chlorine residual is achieved.

The greater the pollution, the greater the chlorine demand



If breakpoint chlorination is not achieved then stinging eyes and mal odours will result.

If breakpoint chlorination is achieved then chloramines are reduced to nitrogen gas and nitrate and no mal odours and stinging eyes occur.

Organic chloramines

Chlorine also oxidises proteinaceous organic nitrogen such as creatinine found in urine and sweat.

Reaction time – slow
Stable and increase with excess chlorine

Can only be significantly reduce by dilution with fresh water and UV irradiation or ozonisation.

If the combined chlorine is over 1mg/l, but monochloramine levels are low, then organic chloramines are likely; the pool water should be diluted by replacing some of it with fresh make-up water.

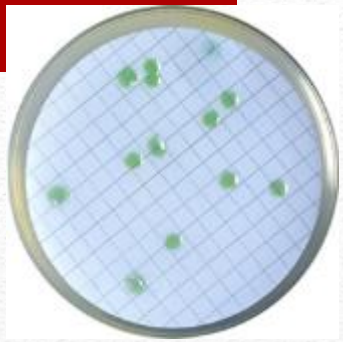
Water Replacement

Water replacement removes and dilutes the contaminants within the water.

PWTAG recommends a water replacement rate of 30 litres per bather.

This means that most pools will replace 10 to 20 per cent of their pool volume per week. This is reflected in the measurement of the total dissolved solids which should be no more than 1000 mg/l over the incoming supply water value.

Bacteria



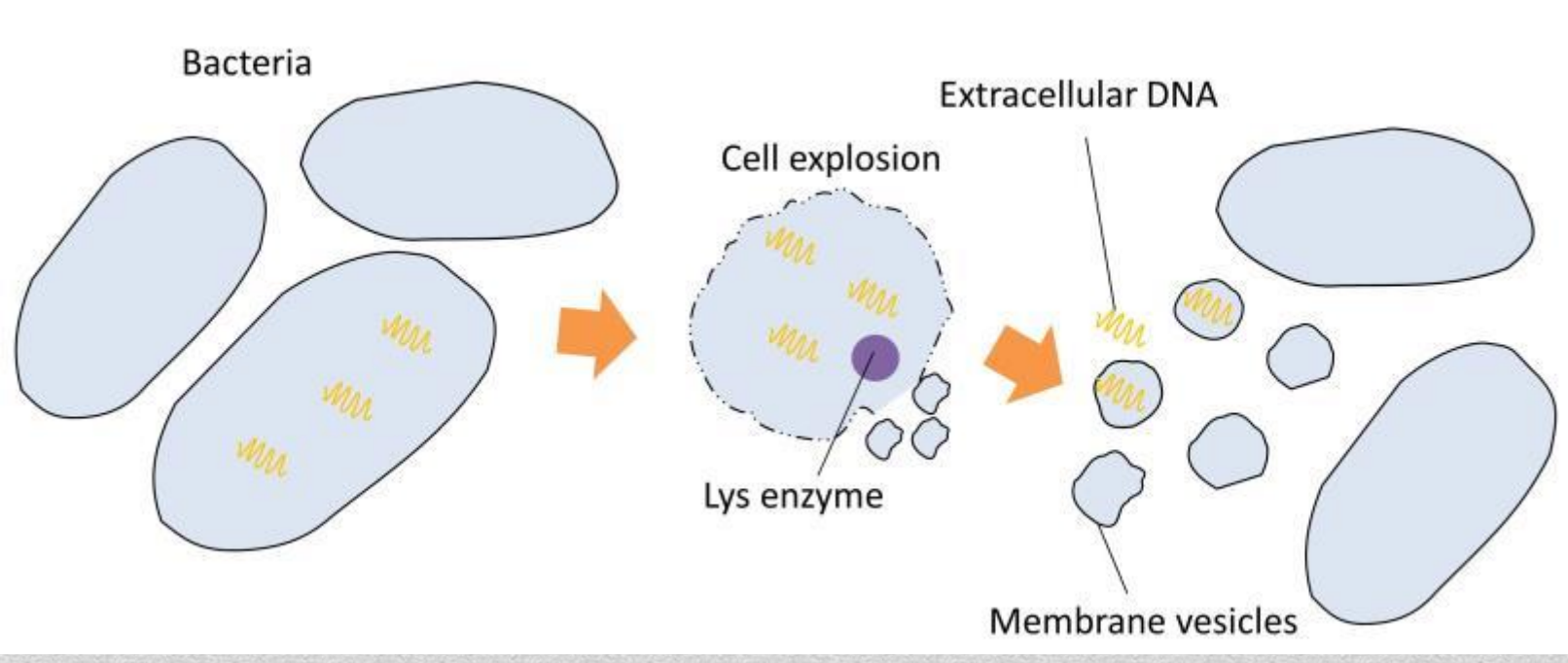
Urine provides a nutrient source for bacteria and will cause subsequent contamination of the pool water.

The greater the urine content the greater the potential risk of infection.

Disinfection using an oxidising biocide will in most instances deal effectively with such bacteria.

The higher the bacterial numbers the greater the consumption of disinfectant

Bacterial Oxidation



The Human Skin

Natural bacterial flora -our skin hosts about 100 trillion micro-organisms, bacteria, viruses, mites and fungi. Well protected within the skin structure, unlikely to be washed off by swimming.

Skin cells - we loose 100 million every day, host to millions of bacteria, shed into the pool water.

Disinfection using an oxidising biocide will in most instances deal effectively with such bacteria.

The secret to good pool water

Effective oxidation, good filtration and disinfection

Contact Details

PWTAG |Pavilion, SportPark
3 Oakwood Drive,
Loughborough University,
Leics LE11 3QF
T: 01509 640730
E: admin@pwtag.org.uk | W: www.pwtag.org
| Twitter: @PWTAG_UK

POOL WATER TREATMENT
ADVISORY GROUP