NSW HEALTH

TREATED WATER PUBLIC SWIMMING POOLS AND SPA POOLS NEW DISINFECTION PROCESS CRITERIA

Approaches are frequently made to the NSW Health Department for acceptance of alternate disinfectant chemicals and processes. It should remain the responsibility of the proponent to prove, through independent assessment, that a disinfectant or disinfecting process can maintain a public swimming pool or public spa pool in a hygienic condition. The test should clearly demonstrate that the bacteriological criteria can be satisfied during routine and heavily loaded swimming pool use. It is therefore essential to demonstrate that a measurable residual bactericide is available in the pool for continuous disinfection.

1 GENERAL REQUIREMENTS

The general performance requirements of a suitable disinfectant or disinfectant process are:

- a residual disinfectant is available in the body of the pool to provide continuous disinfection at the source of infection;
- that there is no adverse impact or toxic effect on bathers with short term or extended immersion:
- the concentration of the residual disinfectant is capable of being measured by a field test kit, amperometric or redox measuring probe at its point of usage; and
- the disinfectant shall be capable of being continuously dosed.

2 LABORATORY EFFICACY TEST

Prior to commitment to any situational testing it would be useful to estimate the efficacy of the proposed disinfectant or disinfectant system by the use of a laboratory microorganism inactivation rate test. Therefore the new process criteria is based on an initial independent tests for laboratory assessment and actual use testing.

The test is to be designed to simulate inactivation of *Pseudomonas aeruginosa* under heated pool conditions where a 4 $\log_{10}$ inactivation is required in 30 seconds. The test is to be carried out by a NATA registered or similarly accredited laboratory without any affiliation or connection to the proponent. The medium to be used is prepared using deactivated swimming pool water, pH adjusted to 7.6 and sterilised. No chemical with disinfecting properties other than the disinfectant or process under test at the recommended concentration is to be present in the water. *Pseudomonas aeruginosa* is to be used as the test organism, and the test is to be conducted at 35°C. The final results of the calculated inactivation rate (I) of three separate trials when averaged should be greater than 8.

$$I = \frac{\{ \log_{10}(i) - \log_{10}(f) \}}{T}$$

Where:

I = inactivation rate
(i) = initial organism concentration (cfu/mL)
(f) = final organism concentration (cfu/mL)

T = time (minutes)

Once a disinfecting process satisfies the laboratory efficacy test then it would be appropriate that an independent trial be conducted at a busy public swimming pool or spa pool. The trials should be conducted by an independent agency accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) and the results presented to the Department of Health for evaluation. The following minimum methodology considerations should be used and the methodology found to be satisfactory to the Department prior to commencement of trials.

3 POOL TESTING METHODOLOGY

The aim is to demonstrate the efficacy of the swimming pool or spa pool disinfectant or process under actual usage conditions. The proponent shall design a suitable test protocol of not less than six months duration on the type of pool in which the disinfectant or disinfecting process is to be utilised (eg indoor heated swimming pool) and incorporating the following features:

i) Background information
- Pool design, dimensions and volume
- Water distribution and circulation pattern
- Turnover rates of the pool(s) under test
- Balance tank details
- Method of dosing of disinfectant
- Details of other chemical usage and adjustment
- Filtration, flocculation and backwashing details
- Details of laboratories used
- Test methodology of all bacteriological and chemical tests
- Material Safety Data Sheets
- Details of toxicity trials.

ii) Testing protocol
- Bacteriological and chemical sampling location, replication and transport methodology.
- Sampling design and strategy.
- Details of other parameters at sampling:
  - Bathing load for previous hour,
  - Concentration of disinfectant at time of sampling,
  - pH,
  - Reserve (total) alkalinity,
  - Concentration of any other relevant chemical.
  - Millivolt equivalence of disinfection agent if it is proposed to control the disinfectant using redox potential.

iii) An accumulation of evidence which clearly shows compliance with the Departmental bacteriological standard under field conditions.

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Pseudomonas aeruginosa Disinfection in Swimming Pool Water - Laboratory Efficacy Testing.

Tweed Laboratory Centre - Paul Wright PhD.

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Introduction

Copper and silver ionisation of swimming pool water in conjunction with low levels of chlorine is proposed as an alternative for the maintenance of swimming pool waters. The system uses ultrasonics and electronic ionizers to produce copper ions (algacide) and silver ions (bactericide) to the water flow of the swimming pools.

Guidelines for measuring the efficacy of a disinfection system have been drawn up by the NSW Health Department ("Treated Water Public Swimming Pools and Spa Pools New Disinfection Process Criteria"). The guideline requires a 4 log reduction in *Pseudomonas aeruginosa* within 30 seconds of exposure to the disinfection system.

Experimental Procedure

A colony of *Pseudomonas aeruginosa* (ACM 495) was used to inoculate 100 ml of Tryptone Soy Broth, which was incubated for 24 hrs at 35°C. The resulting suspension was further diluted in phosphate buffer from which I ml was introduced to equal proportions of the test treatments and thoroughly mixed.

The different treatments were prepared by adjusting the pool water, supplied by Watertech Services International Pty Ltd., to pH 7.2 and adjusting the chlorine levels to that required by the addition of chlorine (Wyunna Pools Liquid Pool Chlorine). The water containing copper and silver provided by Watertech Services, was taken from a pool using an ESI unit incorporating ultrasonics and electronic ionization.

The levels of copper and silver were measured using Inductively Coupled Plasma Optical Emissions Spectroscopy (ICP-OES) on the day testing was to commence.

Chlorine levels were checked just prior to inoculation with P. *aeruginosa* using the chlorine method no. 80 on a HACH 2010 spectrophotometer. All testing and treatment exposure was conducted with pool waters at 20 °C.

To end a particular disinfection period for each treatment, a 50 ml aliquot was dispensed into a sterile bacto jar, containing sodium thiosulphate (250ml BactoLabs). Counts of P. *aeruginosa* were determined with the membrane filtration method using mPAC medium (Amyl media -batch 6160) as described by TLC method B8. Plates were incubated at 35°C for 48 hours, before colonies were counted which are expressed as colony forming units (cfu).

Results

Results Experiment A (12/7/01)

This experiment compared ionised treated pool water having copper (0.43 mg/L) and silver (0.008 mg/L) plus chlorine (0.5 mg/L) to that of pool water with just chlorine (0.5 mg/L). The reduction of P. *aeruginosa* was determined after both 15 min and 30 min exposure time for each treatment. The total hardness for these two water types were 90 and 75 mg/L respectively. The alkalinity prior to pH adjustment was 108 and 59 mg/L respectively.

Treatment	*P. aeruginosa* cfu/100ml	*P. aeruginosa* Lo /100m1	*P. aeruginosa* Lo reduction
Untreated 30min.(control)	3.8 x 10"	6.58	--
Chlorine only 15 min.	370	2.75	4.01
Chlorine only 30 min.	274	2.44	4.14
Chlorine + Cu/Ag 15 min.	90	1.95	4.63
Chlorine + Cu/Ag 30 min.	<2	<0.30	>6.28

Experiment B (17/7/01)

This experiment compared ionised treated pool water having copper (0.70 mg/L) and silver (0.02 mg/L) plus chlorine at three different rates (0.5, 1.0 and 2.0 mg/L) to that of pool water with just chlorine at the same three rates. The reduction of P. *aeruginosa* was determined after 30 sec, 15 min and 30 min. exposure time for each treatment period. The total hardness for the ionised water was 84 mg/L, and the unionised water was 86 mg/L. The alkalinity prior to pH adjustment was 93 and 61 mg/L respectively.

Experiment B (17/7/01)

Treatment	Exposure Time	P. *aeruginosa* cfu/10 ml	*P. aeruginosa* Log /10 ml	*P. aeruginosa* Log reduction
Untreated (control)	30min. (control)	74,000	4.87	--
Chlorine only, 0.5 mg/L	30 sec.	>1,000	>3.00	<1.87
	15 min.	No Result	--	--
	30 min.	6	0.78	4.09
Chlorine only, 1.0 mg/L	30 sec.	>1,000	>3.00	<1.87
	15 min.	180	2.26	2.61
	30 min.	2	0.30	4.57
Chlorine only, 2.0 mg/L	30 sec.	>1,000	>3.00	<1.87
	15 min.	8	0.90	3.97
	30 min.	<1	0	4.87
Chlorine 0.5 mg/L + Cu/Ag	30 sec.	250	2.40	2.47
	15 min.	4	0.6	4.27
	30 min.	<1	0	4.87
Chlorine 1.0 mg/L + Cu/Ag	30 sec.	3	0.48	4.39
	15 min.	<1	0	4.87
	30 min.	<1	0	4.87
Chlorine 2.0 mg/ L + Cu/Ag	30 sec.	<1	0	4.87
	15 min.	<1	0	4.87
	30 min.	<1	0	4.87

Discussion

The two experiments outlined above demonstrate that copper and silver ionisation in conjunction with chlorine is more efficient in disinfecting water containing P. *aeruginosa* than chlorine alone.

In relation to the criteria set by the NSW Health Department, 4 log reduction of P. *aeruginosa* was achieved after 30 seconds exposure with the ionised water with chlorine levels at both 1.0 and 2.0 mg/L. In contrast, 4 log reduction within 30 sec of exposure was not achieved by any of the three levels of chlorine alone (Experiment B).

The guidelines set by both NSW Health Department (June 1996) and Queensland Health (February 2000) recommend that disinfection achieve <1/100 ml P. *aeruginosa* in public swimming pools. If the experiments outlined above were extrapolated to these guidelines, then even when a pool was initially contaminated with the equivalent of 740,000 cfu P. *aeruginosa* /ml, <10/100ml would be achieved with copper/silver ionisation with only 1.0mg/L chlorine after 30 sec exposure compared to >10,000 cfu P. *aeruginosa* /ml with 1.0mg/L chlorine alone (Experiment B).

It should be noted that the levels of copper and silver recorded in both experiments were lower than that normally prescribed by the ionisation system, and it could be expected that better disinfection could be achieved with lower levels of chlorine.

References

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7/8/01