



POSTER 3

ASSESSING CYANURIC ACID LEVELS FOR CHLORINE STABILIZATION AND EFFECTIVE DISINFECTION IN SWIMMING POOLS

Oikonomidou ED

Analytical Laboratory of Rhodes, Greece

Aims

To propose an acceptable level for cyanuric acid in swimming pools, in order to balance its stabilizing effect with the negative effects of overuse. There is a correlation between high levels of cyanuric acid and the presence of *Pseudomonas aeruginosa* in swimming pools, even in the presence of free chlorine. Cyanuric acid is a by-product of commercial pool disinfectants commonly used in outdoor pools, such as trichloroisocyanurates and dichloroisocyanurates. Its use is very important in outdoor pools as cyanuric acid acts as a stabilizer for chlorine, reducing photochemical reduction. Cyanuric acid is a mild irritant in case of skin contact, eye contact, ingestion and inhalation. There are no available data on its long term effects. The Joint FAO/WHO Expert Committee on Food Additives and Contaminants (JECFA) has considered the chlorinated isocyanurates with regard to drinking-water disinfection and proposed a tolerable daily intake for anhydrous sodium dichloroisocyanurate (NaDCC) of 0–2 mg/kg of body weight. From a water chemical balance point of view, high levels of cyanuric acid significantly lower pH and bind free chlorine reducing its disinfection ability. Being a stable component it can only be removed by replacing water, thus increasing cost of treatment.

Legislation in Greece does not include cyanuric acid as a regulated parameter, so its use is many times uncontrolled. In the United States, legislation is diverse concerning cyanuric acids. In some states a maximum of 100mg/L is stated, while in others it shouldn't be present at all. Australian legislation sets the limit of 50mg/L. According to W.H.O. guidelines for safe recreational waters, a level of 100mg/L cyanuric acid is set. There are numerous scientific papers comparing cyanuric acid's stabilizing effectiveness with disinfection, both for common bacteria and various algae. In all available research 25mg/L of cyanuric acid produced adequate results, and higher concentrations did not seem to increase stabilization, yet markedly decreased disinfection rates. For the presented work *Pseudomonas aeruginosa* is the bacteria monitored in outdoor pools with regard to cyanuric acid levels. *Pseudomonas aeruginosa* is an aerobic, non-spore-forming, motile, Gram-negative, straight or slightly curved rod with dimensions 0.5–1 μm \times 1.5–4 μm . It can metabolize a variety of organic compounds and is resistant to a wide range of antibiotics and disinfectants. *P. aeruginosa* is ubiquitous in water, vegetation and soil and shedding from infected humans is the predominant source of *P. aeruginosa* in pools and hot tubs. In swimming pools, the primary health effect associated with *P. aeruginosa* is otitis externa or swimmer's ear. *P. aeruginosa* is not a regulated parameter in Greek legislation.

Methods

In existing scientific work the effectiveness of cyanuric acid as a stabilizer and potential disinfection inhibitor is tested in laboratory conditions, yet real samples from swimming pools can have different results. Every swimming pool is different in operation, load and current weather conditions, so reproducing results is a problem, therefore results can only be as part of an assessment. Work

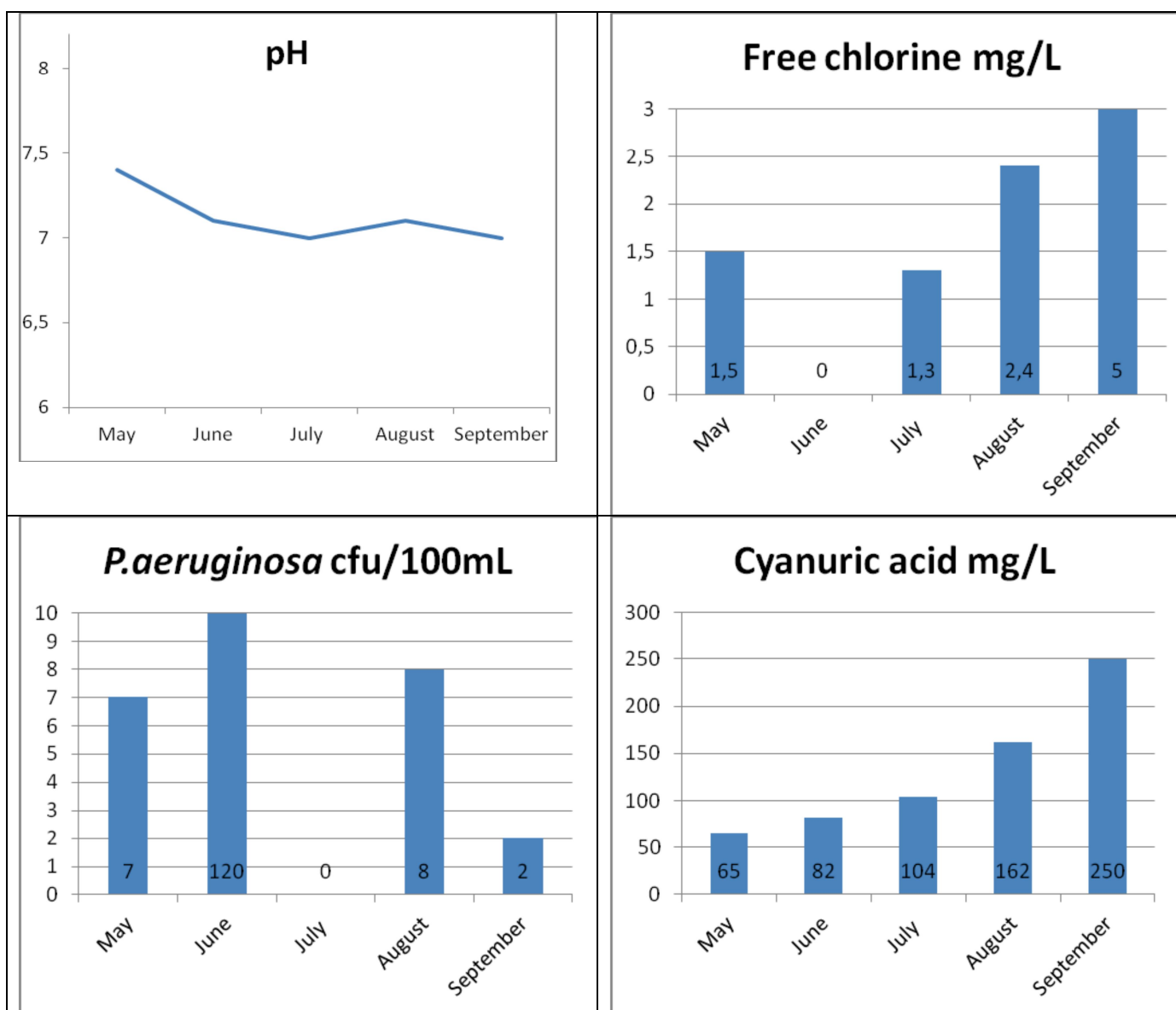
presented here, provides real results of swimming pool samples, their operation monitored throughout the working season in monthly intervals. Swimming pools tested are in hotels in the Dodekanese area, working in the summer season and most of them are large, outdoor semi-public swimming pools, using potable water as source. Most swimming pool managers use isocyanurates as a means of disinfection, both trichloro-isocyanurate for routine disinfection and dichloro-isocyanurates for shock treatments. The laboratory is privately held, providing sampling services and using accredited testing methods. All samples collected were delivered in less than 2h for sites in Rhodes (8h for sites in the Dodekanese). Presented are measurements for pH (measured electrochemically - Standard Methods 4500-H B), free chlorine (measured colorimetrically, dpd), Cyanuric acid (measured by turbidity, Hach), and *P. aeruginosa* (membrane filtration, ISO 16266 method).

Results

A select number of monitored sites are presented, where high levels of cyanuric acid are measured and the presence of *Pseudomonas aeruginosa* is detected throughout the season. Most sites are outdoor pools of various sizes. Special cases are outdoor pools intended for children. Swimming pools intended for children are very small pools around 25 m³ capacity and receive high stress from the children using it. Large amounts of cyanuric acid, as well as the significantly lowered pH may cause irritation and the swimming pool may be unsafe due to inadequate disinfection rates, even if highly chlorinated. A few indoor pools are presented where isocyanurates were selected as means of disinfection by the management. Variation of the parameters during the working season, show ever decreasing pH values with steady increase in the levels of cyanuric acid, and presence of *Pseudomonas aeruginosa* even at high levels of free chlorine. Required actions for remediation were proposed in all cases, the responsibility of carrying them out lying with the hotel management.

Outdoor pool A (capacity approx. 80m³)

	May	June	July	August	September
Cyanuric acid (mg/L)	65	82	104	162	>200
<i>P. aeruginosa</i> (cfu/100mL)	~7	>100	N/D	~8	<4
pH	7,4	7,1	7,0	7,1	7,0
free chlorine (mg/L)	1,5	N/D	1,3	2,4	>>3



Conclusions

Results presented validate theoretical conclusions. Presence of high levels of cyanuric acid in swimming pools reduces the disinfection effectiveness of chlorine. *Pseudomonas aeruginosa* survives even with high levels of chlorine. Cyanuric acid is important in stabilizing chlorine for use in outdoor pools, but overuse must be avoided. High levels of cyanuric acid significantly decrease pH, inhibit the disinfecting properties of chlorine and create a protective environment for *Pseudomonas aeruginosa*. Cyanuric acid can be lowered only by significant water replacement therefore increasing the cost of pool maintenance. Cyanuric acid should be a monitored and regulated parameter concerning swimming pool hygiene. Initially, recommended levels of cyanuric acid can be as high as 100mg/L for large outdoor pools in order to balance cost, effectiveness, stability and avoid negative effects. For smaller pools, with capacity 25cm³ or less, a much lower level can be suggested, preferably 50mg/L or less. In indoor pools use of cyanuric acid is not suggested, since chlorine is protected from photochemical degradation. However, low levels of cyanuric acid, less than 25mg/L, can be accepted.

References

1. Canelli E., Chemical, Bacteriological, and Toxicological Properties of Cyanuric Acid and Chlorinated Isocyanurates as Applied to Swimming Pool Disinfection: A review, AJPB FEBRUARY, Vol. 64, No. 2, 1974
2. Fitzgerald G.P. and Dervartanian M.E., *Pseudomonas aeruginosa* for the Evaluation of Swimming Pool Chlorination and Algicides, Applied Microbiology, Mar. 1969, p. 415-421, 1969
3. Robinton E.D., and Mood E.W., An evaluation of the inhibitory influence of cyanuric acid upon swimming pool disinfection, vol. 57. No. 2, A.J.P.H., February. 1967
4. Sommerfeld M.R. and Adamson R.P., Influence of Stabilizer Concentration on Effectiveness of Chlorine as an Algicide, Applied and Environmental Microbiology, Feb. 1982, p. 497-499
5. Williams K., Cyanurics ~ Benefactor or bomb?, Executive Director of the Professional Pool Operators of America, *Newcastle, California, December 12, 1997*
6. Wojtowicz J.A., Effect of Cyanuric Acid on Swimming Pool Maintenance, The Chemistry and Treatment of Swimming Pool and Spa Water, pg. 99-104
7. Health Protection NSW. Public swimming pool and spa pool advisory document. Sydney: 2013.
8. World Health Organization. Guidelines for safe recreational waters and similar environments. 2006
9. Cyanuric Acid SDS, CAS No. 108-80-, <http://www.sciencelab.com/msds.php?msdsId=9923614>