SWEETWATER SPRINGS WATER DISTRICT

TO: Board of Directors **AGENDA NO. V-D**

FROM: Steve Mack, General Manager

Meeting Date: July 3, 2014

SUBJECT: CHANGE IN MONTE RIO TREATMENT PLANT CHLORINATION SYSTEM

RECOMMENDED ACTION: Receive a report on staff's investigations into changing the chlorination system at the Monte Rio Treatment Plant and provide direction to staff.

FISCAL IMPACT: none

DISCUSSION:

At the June meeting we presented information on changing the chlorination system at the Monte Rio Treatment Plant from Mioxx chlorine generation which gets chlorine from the electrolysis of salt (sodium chloride) to Trichlor Feeders which use trichloroisocyanuric acid to generate chlorine and, as a result of the process, adds cyanuric acid into the treated drinking water. The Board wanted more information on the health impacts of cyanuric acid, if any, what investigations have been made into the health impacts, and other related questions.

I have talked with staff at the California Department of Health Services regarding the toxicity of cyanuric acid and that person stated that cyanuric acid in the amounts that would be added to the Monte Rio water supply is not toxic. It does not bioaccumulate in the body (passes through), does not cause birth defects, is not a mutagen and is not carcinogenic in any tests done. He added that it's been used in the swimming pool industries for years with no health issues reported.

Attached with this report is a list of communities using the Trichlor feeder. It's a fairly short list.

This is a fairly short report because of the press of time; we can do more research if additional information is needed.

ARDEN INDUSTRIES
Innovators in Water Treatment Technology

4720 Fawn Street
Shingle Springs
California
95682

Phone: 530-677-3671
Fax: 530-677-3672
E-mail: info@ardenindustries.com
Web site: ardenindustries.com

SOME CUSTOMERS USING TRICHLOR

1. Mr. Lorenzo Martinez -Water Production Super. II
CITY OF LAS CRUCES
P.O. Box 20000
Las Cruces, NM 88004
575/642-8312 Cell
lm@las-cruces.org e-mail
Use: approximately 9 years (2005)

2. Mr. John Bennett
LA PAZ COUNTY PARKS DEPARTMENT
7350 Riverside Drive
Parker, AZ 85344
928/677-2069 Phone
parks@co.la-paz.az.us e-mail
Use: approximately 2 years

3. Mr. John Anderson
ASPEN CONSOLIDATED SANITATION DISTRICT
400 Service Center Drive
Aspen, CO 81611
jhanderson@aspensan.com (must contact via e-mail)
Use: approximately 6 years

4. Mr. Jim Albu, PE
BUCKSKIN ARTISTS C.W.D.
13940 E. Geronimo Road
Scottsdale, AZ 85259
602/797-4614 Phone
jalbu@cox.net e-mail
Use: approximately 6 years

5. Mr. Todd Heidrick –Water Superintendent
6. Mr. Jesse Cain - Public Utilities Manager
CITY OF COLUSA
425 Webster Street
Colusa, CA 95932
Jesse's cell 530-682-2933
Todd's cell: 530-682-9361
Use: approximately 4 years

7. Mr. Anthony Stromer
BUENA VISTA CORRECTIONAL FACILITY
15125 Highway 285
Buena Vista, CO 81211
719-395-2404 x 3410
Use: approximately 4 years

8. Mr. Jim Aguirre
CAMP ROBERTS SUPPLY/SERVICES
CALIFORNIA STATE MILITARY DEPT.
ARMY NATIONAL GUARD
BOX 58, BUILDING 3022
CAMP ROBERTS, CA 93451-5000
(805) 602-8757 cell
Use: approximately 4 years

9. Mr. Parry Salsi
ROLLING HILLS CASINO
2655 Barham Avenue
Corning, CA 96021
530-528-3577
Use: approximately 3 years

10. Mr. Laken Eoff 702-249-6135 cell
11. Mr. Kurt Wright 702-278-5319 cell
LAKE MEAD NATIONAL RECREATION AREA
UNITED STATES NATIONAL PARK SERVICE
NATIONAL PARK SERVICE WAREHOUSE
601 Nevada Way
Boulder City, NV 89005
Use: approximately 3 years

12. Mr. Tony Gutsch 707-588-3300
CITY OF ROHNERT PARK
Department of Public Works
600 Enterprise Drive
Rohnert Park, CA 94928
Use: approximately 1 year

13. Mr. Gil Hermosillo 661-510-1097
VALENCIA WATER COMPANY
24631 Avenue Rockerfeller
Valencia, CA 91355
Use: approximately 1 year

Review of the Toxicity of Cyanuric Acid

Occidental Chemical Corporation
October 28, 2013

Introduction

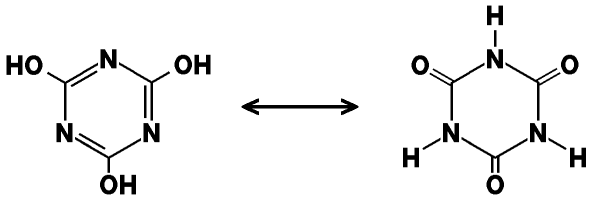
Trichloroisocyanuric acid ("trichlor") is a solid chlorine donor which is approved for continuous (non-emergency) use in drinking water. Trichlor tablets are sold for use in treating drinking water by Occidental Chemical Corporation under the brand name ACL® 90 Disinfecting Tablets. Trichlor has been used to treat swimming pool water since the early 1960's. Occidental Chemical Corporation has been a leading manufacturer of trichlor since 1993, when it purchased the chlorinated isocyanurates business from Monsanto Company, and has extensive experience in the manufacture, storage and use of trichlor. Additional product information is available at: http://www.oxy.com/OurBusinesses/Chemicals/Products/Pages/ACLandSodiumChlorite.aspx.

It is important to insure that use of trichlor is safe. Available chlorine is the toxic part of the trichlor molecule, but trichlor has the same toxicological effect as the same amount of free chlorine from any other source of available chlorine. Ingestion of water treated with low levels of trichlor will also lead to ingestion of small amounts of cyanuric acid.

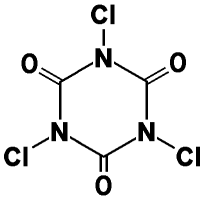
At normal drinking water concentrations, virtually all of the available chlorine in a trichlor solution is rapidly reduced to chloride by reducing agents in human saliva and stomach fluid. The only product remaining after ingestion is cyanuric acid. Since cyanuric acid is the stable reaction product, its toxicity is of interest and is reviewed in this document.

Cyanuric acid is also known as isocyanuric acid, trihydroxy-*s*-triazine, *s*-triazinetrione, or CYA. Its structure is shown below. Regulatory agencies and the scientific literature generally use the triazinetrione nomenclature, while cyanuric acid is preferred in commerce. In aqueous solution, cyanuric acid actually exists in two isomers, which are shown below. Trichlor is based on the structure on the right, with the three H-atoms replaced by three chlorine atoms.

Chemical Structure of Cyanuric Acid



Chemical Structure of Trichloroisocyanuric Acid



Toxicity Data for Cyanuric Acid

Trichlor produces hypochlorous acid (HOCl) and cyanuric acid when dissolved in water. HOCl is rapidly destroyed in the stomach, so the only persistent product from trichlor is cyanuric acid.

Despite the similarity of names, cyanuric acid ($C_3N_3O_3H_3$) has absolutely NO chemical relationship to cyanide (CN^-). This is obvious from the chemical structure. Cyanuric acid is made by the pyrolysis of urea. Cyanide is not used in or formed as a by-product of the manufacture of cyanuric acid. Furthermore, cyanide is not a degradation product of cyanuric acid or trichlor. In fact, cyanide is rapidly destroyed by reaction with the available chlorine in trichlor.

The toxicity of cyanuric acid has been extensively tested due to the use of trichlor in swimming pools. The toxicity studies on cyanuric acid, summarized in Table 1, show that:

- Cyanuric acid is practically nontoxic.
- Cyanuric acid does not bioaccumulate.
- Cyanuric acid is not fetotoxic (toxic to fetuses) or teratogenic (causes birth defects)
- Cyanuric acid is not mutagenic or carcinogenic.
- Cyanuric acid is not metabolized in the body, therefore no metabolites need to be considered.
- At low doses, cyanuric acid is completely absorbed and then rapidly passed from the body unchanged in the urine. At higher doses, it is incompletely absorbed, passes through the GI tract unchanged and is eliminated in feces as well.
- If fed at very high concentrations (> 2000 ppm), it can precipitate in the kidneys causing kidney blockage. This does not occur at concentrations well under the solubility limit of 2000 ppm.

The major adverse effect observed in the toxicity studies is the formation of precipitates in the urinary tract of male rats when fed at high dose rates, leading to kidney failure. Precipitates form when cyanuric acid's solubility limit in urine is exceeded. This effect is observed to much greater extent in males rat due to physiological differences between male and female rats; similar effects were absent from both male and female mice.

The Acceptable Daily Intake (ADI) can calculated from the lowest No Observed Adverse Effect Level (NOEL) reported in the toxicity studies. Therefore, defining the NOEL is a critical step in defining the toxicity of a chemical. The accepted NOEL for cyanuric acid is 132 mg/kg bw/day in male rats, which is from the two-year carcinogenicity study on rats.

The acceptable daily intake is calculated by multiplying the NOEL by the body weight and then dividing by a safety factor of 100:

ADI (for a 70 kg adult) = 132 mg/kg bw/day x 70 kg / 100 = 92 mg/day
ADI (for a 10 kg child) = 132 mg/kg bw/day x 10 kg / 100 = 13 mg/day

These values can be compared to the corresponding values for estimated daily intake, which are calculated in the next section.

Table 1
Summary of Toxicity Studies for Cyanuric Acid

Type of Study	Species/ Strain	Duration of Study	Results
oral acute	mouse	single dose	LD_{50} = 3400 mg/kg bw
oral acute	rat	single dose	LD_{50} > 10,000 mg/kg bw
oral acute	rat	single dose	LD_{50} = 7700 mg/kg bw
oral acute	rabbit	single dose	LD_{50} > 10,000 mg/kg bw
dermal acute	rabbit	single dose	LD_{50} > 7940 mg/kg bw
eye irritation	rabbit	--	Slight irritation
eye irritation	rabbit	24 hr	500 mg resulted in a mild reaction
eye irritation	rabbit	24 hr	20 mg resulted in a mild reaction
skin irritation	rabbit	--	Non-irritating
repeated dose	rat	6 mo	Dystrophic changes in kidney at high doses
repeated dose	guinea pig	6 mo	Dystrophic changes in kidney at high doses
eye irritation	rabbit	3 mo	Non-irritating
genotox (Ames)	S. typhimurium	--	Not mutagenic
metabolism	human	120 min	1-compartment open model elimination kinetics
repeated dose	$B_6C_3F_1$ mouse	13 wk	No effect except for increased water consumption
repeated dose	$B_6C_3F_1$ mouse	14 wk	No adverse effects
repeated dose	mouse	2 yr	Not carcinogenic
repeated dose	CD rat	13 wk	No compound related effects
repeated dose	Fisher 344 rat	14 wk	No adverse effects
repeated dose	Rochester rat	20 wk	Renal failure at high doses
repeated dose	rat	6 mo	Dystrophic changes in kidney at high doses
repeated dose	CD rat	2 yr	Not carcinogenic Renal precipitate at high doses in males **NOEL = 132 mg/kg bw (males)**
repeated dose	guinea pig	6 mo	Dystrophic changes in kidney at high doses
repeated dose	beagle dog	6 mo	No adverse effects at 0.8% in diet
repeated dose	beagle dog	2 yr	Adverse effects on kidney at 8% in diet
skin irritation	rabbit	3 mo	No adverse effects up to 8% solution
eye irritation	rabbit	3 mo	Non-irritating up to 8% solution
eye irritation	rabbit	3 mo	Non-irritating up to 6.8% solution
genotox (Ames)	S. typhimurium	--	Not mutagenic
genotox	hamster ovaries	--	Not mutagenic
genotox	mouse cells	--	Not mutagenic
genotox (bone)	S-D rat	46 hr	Not mutagenic
genotox	albino mouse	single dose	No effect on reproduction
metabolism	S-D rat	15 day	Minimal metabolism, no bioaccumulation
metabolism	beagle dog	15 day	Minimal metabolism, no bioaccumulation
teratology	rabbit	13 day	Not teratogenic
teratology	CD rat	10 day	Not teratogenic
reproduction	CD rat	3 generation	No maternal or teratogenic effects

Abbreviations:
LD_{50} = dose that is lethal to 50% of the tested population
bw = body weight

Exposure Calculations for Drinking Water Use

This section calculates the estimated daily intake (EDI) of cyanuric acid from use in drinking water chlorination. The EDI is calculated for different doses of available chlorine, assuming that trichlor is used as the chlorine source, using the equation below. The results are given in Table 2. Note that the maximum dose of available chlorine allowed by the EPA is 4 mg/L, so the maximum CYA concentration, when using trichlor, is 2.5 mg/L.

EDI = V x C x 0.62

where: V = volume of water consumed (L/day), 2 for adult, 1 for child
C = the dose of available chlorine used (mg/L as Cl_2)
0.62 = Ratio of mg of cyanuric acid to the mg of available chlorine in trichlor

Table 2
Estimated Daily Intake of Cyanuric Acid from Treated Drinking Water

Chlorine dose (mg/L)	CYA concentration (mg/L)	EDI of cyanuric acid (mg/day)	
		Adult	Child
0.5	0.31	0.62	0.31
1	0.62	1.2	0.62
2	1.2	2.5	1.2
4	2.5	5.0	2.5

In all cases, the estimated daily intake (EDI) is well under the acceptable daily intake (ADI) from the previous section, so this use is considered to be safe.

In fact, the estimated exposure to cyanuric acid from treated drinking is less than the estimated exposure from swimming in a pool containing more than 40 mg/L of cyanuric acid. Cyanuric acid has been used as a “stabilizer” in outdoor swimming pools for over 50 years, with no reports of any human adverse effects from ingestion of cyanuric acid.

Alternately, the EDI values can be used to calculate the safety margin using the equation below. If the safety margin is over 100, the use is considered to be safe.

Safety margin = NOEL x body weight (kg) / EDI

Table 3
Safety Margin for Cyanuric Acid from Treated Drinking Water

Chlorine dose (mg/L)	CYA concentration (mg/L)	Safety Margin for cyanuric acid	
		70 kg Adult	10 kg Child
0.5	0.31	15,000	4,200
1	0.62	7,700	2,100
2	1.2	3,700	1,100
4	2.5	1,800	520

Table 3 shows that the safety margin for ingestion of cyanuric acid from treated drinking water is at least 1,800 for a 70 kg adult and at least 520 for a 10 kg child. Both are well above the minimum acceptable safety margin of 100.

The U.S. EPA extensively reviewed the toxicity studies for cyanuric acid before approving the use of trichlor for drinking water in 2001. The World Health Organization (WHO) has also reviewed the use of chlorinated isocyanurates for drinking water and concluded, in 2004, that the use was safe.

More details of the toxicity studies for trichlor and cyanuric acid can be found in the following references (copies available upon request):

-- B. Hammond, et al., "A review of toxicology studies on cyanurate and its chlorinated derivatives", Environmental Health Perspectives, 1986, 69, 287-292.

-- World Health Organization, "Evaluation of certain food additives and contaminants", 61st Report of the Joint FOA/WHO Expert Committee on Food Additives, WHO Technical Report Series 922, 123-127 (2004).

-- Robust summaries on trichlor and cyanuric acid submitted to the EPA's High Production Volume Challenge Program in 2004: http://www.epa.gov/chemrtk/pubs/summaries/tricltrz/c14659tc.htm.

Conclusions

The following conclusions summarize the results of the toxicity studies on cyanuric acid:

- Cyanuric acid is essentially non-toxic (NOEL = 132 mg/kg bw/day) and shows no adverse human health effects at concentrations well below the solubility limit.

- The estimated intake of cyanuric acid for drinking water use is well below the maximum acceptable intake.

- The safety margins for use of trichlor in drinking water are at least 1,800 for a 70 kg (154 pound) adult and at least 520 for a 10 kg (22 pound) child.

- The presence of less than 3 ppm of cyanuric acid in drinking water due to treatment of the water with trichlor is not a health concern.

Prepared by Thomas C. Kuechler, Ph.D.
ACL® Technical Service
Occidental Chemical Corporation
tom_kuechler@oxy.com